Scottish Sanitary Survey Report

Sanitary Survey Report
Loch Kanaird
RC-625-1233-13
May 2014

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Partner Organisations

The hydrographic assessment and the shoreline survey and its associated report were undertaken by SRSL, Oban.

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I. Executive Summary

Under (EC) Regulation 854/2004, which sets forth specific rules for the organisation of official controls on products of animal origin intended for human consumption, sanitary surveys of production areas and their associated hydrological catchments and coastal waters are required in order to establish the appropriate representative monitoring points (RMPs) for the monitoring programme.

The purpose of the sanitary survey is to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004. The sanitary survey results in recommendations on the location of RMPs, the frequency of sampling for microbiological monitoring, and the boundaries of the production areas deemed to be represented by the RMPs.

A sanitary survey was undertaken on the fishery at Loch Kanaird on the basis recommended in the European Union Reference Laboratory publication: “Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application” (http://www.crlcefas.org/gpg.asp). This production area was selected for survey on the basis of the receipt of an application for standard classification of the area. The following is a summary of the main findings of the sanitary survey.

Loch Kanaird is a small inlet near the mouth of inner Loch Broom on the northwest coast of Scotland. The shellfishery consists of Pacific oyster culture on trestles in a small area on the east side of the mouth of the River Canaird. Although the area is sparsely populated, it attracts significant numbers of campers, yachts, and tourists relative to the permanent population, particularly from April to September when the campsite at Ardmair Point is in operation. Most of the land adjacent to the loch is rough heather moorland and bog, there are farms and crofts located at Ardmair, around Keanchulish House and along the Allt Glutton east of the oyster farm, and along the River Canaird. Although only a few sheep and sheep droppings were seen along the shoreline southeast and north of the oyster farm, large numbers of sheep are kept on pasture along the River Canaird.

Tidal currents are predicted to be weak and complex north of Ardmair Point, though surface transport distances are predicted to be low, in the order of 0.5 km and therefore sources arising relatively near the fishery and those carried via the River Canaird and watercourses to the east of the fishery are likely to be most significant. These are:

- Septic tank discharges associated with dwellings north and east of the oyster farm
- Sheep and droppings deposited on the shoreline east and north of the oyster farm
- Diffuse pollution from livestock and human sources upriver from the fishery

Calculated *E. coli* loadings, based on shoreline survey observations, were highest for the River Canaird and for a small watercourse on the north side of Keanchulish House.

Summary of recommendations

It is recommended that the production area boundaries be retained as those recommended in the provisional representative monitoring point (pRMP) assessment, as these boundaries exclude the main observed sources of faecal contamination both north and south of the fishery. It is recommended that the RMP be moved from a dedicated trestle higher up the shore east of the oyster farm to NH 1174 9918, a position on the north side of the oyster farm itself. Further details of the recommended boundaries and RMP can be found in the Sampling Plan.

II. Sampling Plan

Production Area	Loch Kanaird
Site Name	Loch Kanaird
SIN	RC-625-1233-13
Species	Pacific oyster
Type of Fishery	Trestle aquaculture
NGR of RMP	NH 1174 9918
East	211738
North	899183
Tolerance (m)	20
Depth (m)	NA
Method of Sampling	Hand
Frequency of Sampling	Monthly
Local Authority	Highland Council, Ross & Cromarty
Authorised Sampler(s)	Hamish Spence Bill Steven
Local Authority Liaison Officer	Alan Yates
Recommended Production Area	The area bounded by lines drawn from NH 1170 9900 to NH 1170 9940 to NH 1203 9940 and extending to MHWS

III. Report

1. General Description

Loch Kanaird is a small inlet near the mouth of inner Loch Broom on the northwest coast of Scotland. It falls within the Ross and Cromarty district of Highland Council.

Loch Kanaird is bounded by Isle Martin to the west and the estuary of the River Canaird to the east. The area of the loch is approximately 3 km^2.

The sanitary survey was undertaken on the classified fishery at Loch Kanaird on the basis recommended in the European Union Reference Laboratory publication: “Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application” (http://www.crlcefas.org/gpg.asp). This production area was selected for survey at this time as it is a newly classified area.

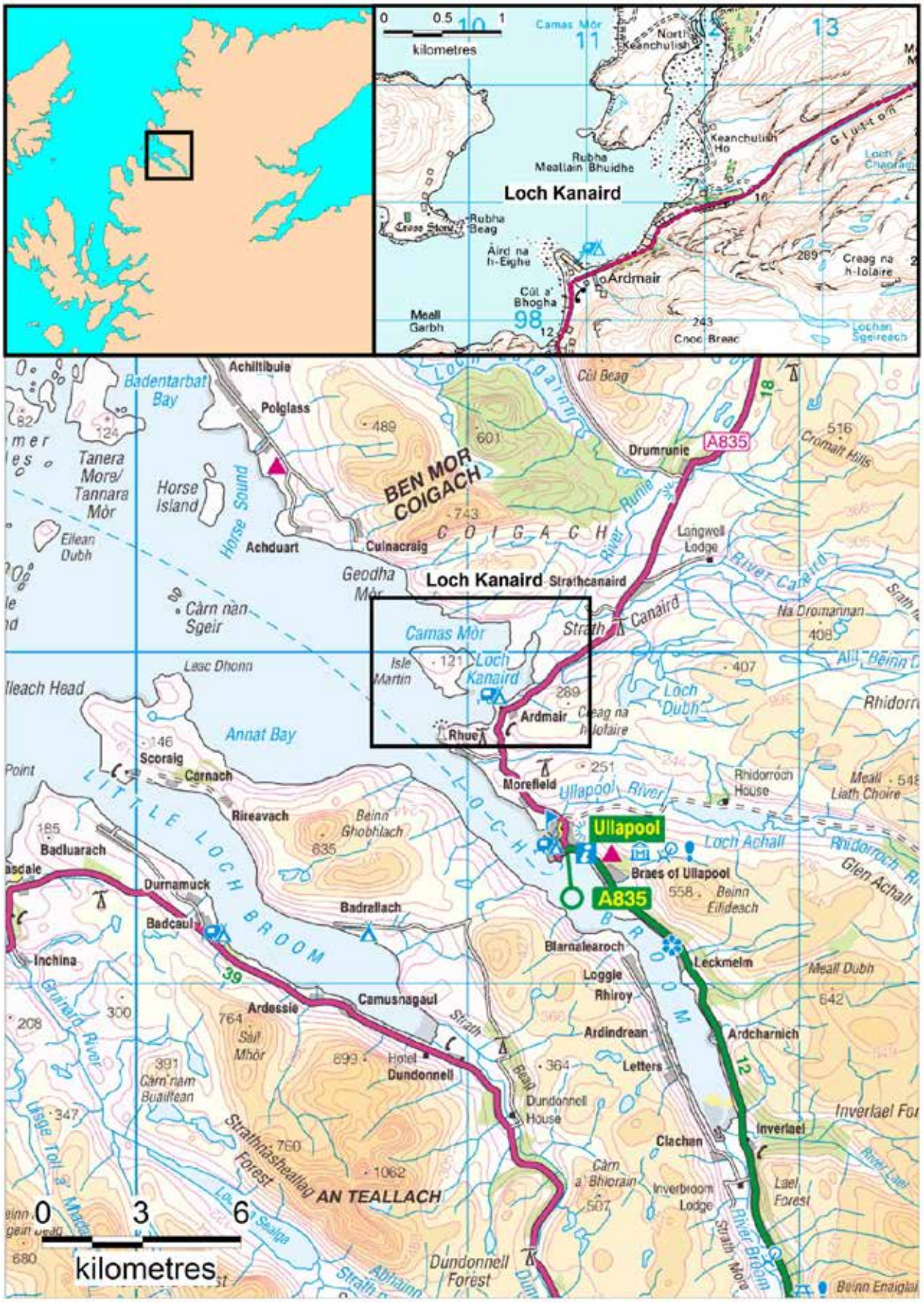

Figure 1.1 Location of Loch Kanaird

2. Fishery

Loch Kanaird is a new Pacific oyster (*Crassostrea gigas*) fishery. As it is a new fishery the site is not currently classified. Specifics of the site are presented in Table 2.1

Table 2.1 Loch Kanaird fishery

Production area	Site	SIN	Species	pRMP
Loch Kanaird	Ardmair	RC-625-1233-13	Pacific oyster	NH 1179 9918

The production area boundaries recommended in the provisional representative monitoring point (pRMP) assessment were: the area bounded by lines drawn from NH 1170 9900 to NH 1170 9940 to NH 1203 9940 and extending to MHWS.

Pacific oysters are grown in poches and baskets supported on trestles located low in the intertidal zone; therefore the site is only accessible at low spring tide. Another trestle is located at the pRMP location, 50 m east. It is higher up the intertidal zone to allow easier access for sampling.

The fishery area recorded in the shoreline survey has been plotted and is presented in Figure 2.1 below.

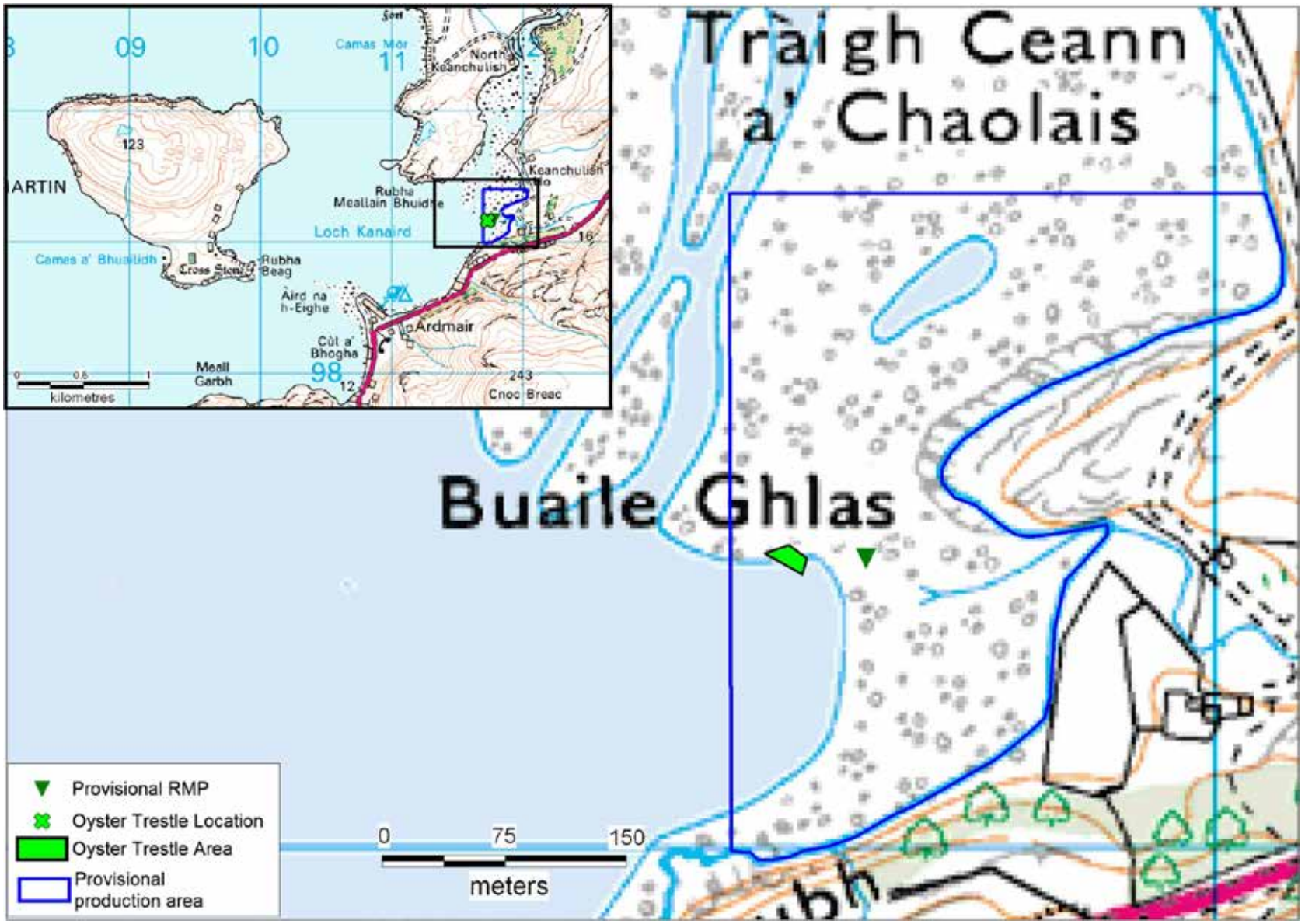

Figure 2.1 Loch Kanaird Fishery

3. Human Population

Information on the population for the area around Loch Kanaird at the 2011 census was obtained from the General Register Office for Scotland. The census output areas are shown mapped by population density in Figure 3.1. Overall, population density for the area is low, with the majority of the resident population concentrated around crofting townships along the southern shore. The north shore is inaccessible and uninhabited. Isle Martin is not currently permanently occupied, though it has two cottages that are sometimes used for holiday letting (Isle Martin Trust, 2013)

The A835 road runs along the southern side of the loch; the majority of dwellings in the area are located along this road. The main settlements in the area are Ardmair, Rhue, and Strathcanaird (located approximately 4 km northeast of the oyster fishery).

The closest habitations to the fishery are homes located along the Allt Glutton watercourse, the closest of which is 250 m southeast of the oyster farm. Keanchulish House is 500 m to the northeast of the oyster farm. The harvester reported that the house was not permanently occupied and was not in use at the time of the shoreline survey.

On the eastern shoreline of Isle Martin there is pontoon with berthing facilities and a anchorage (Clyde Cruising Club, 2007). During the shoreline survey, a pier with ten anchored boats plus an additional seven empty buoys and a slipway, which could potentially be used for access by boat users were observed on Ardmair Point. There is also a pier with outbuildings and four moorings midway between Ardmair Point and the fishery. On the shoreline southeast of the fishery were 3 boats and one empty mooring in the bay. A second anchorage is identified north of Ardmair Point (Hydrographic Office of the United Kingdom, n.d.).

Ardmair Point has visitor accommodation including a caravan and camping park (seasonal) and self catering chalets and lodges (available all year). Further visitor accommodation is available in the surrounding area with tourist facilities including boat hire. The presence of tourist accommodation suggests that the local population may increase significantly during the tourist season, roughly from April to September (Ardmair Point - Ullapool, 2010)

Overall, impacts from human sources to the water quality of the shellfish bed are likely to be low due to the low population density of the overall area, with any effects predominately from residential dwellings to the east of the fishery and south of the fishery where the majority of the tourist accommodation is located on Ardmair Point. A seasonal increase in human population and activity is expected during the spring and summer, and therefore any potential impact to the fishery would be higher at this time.

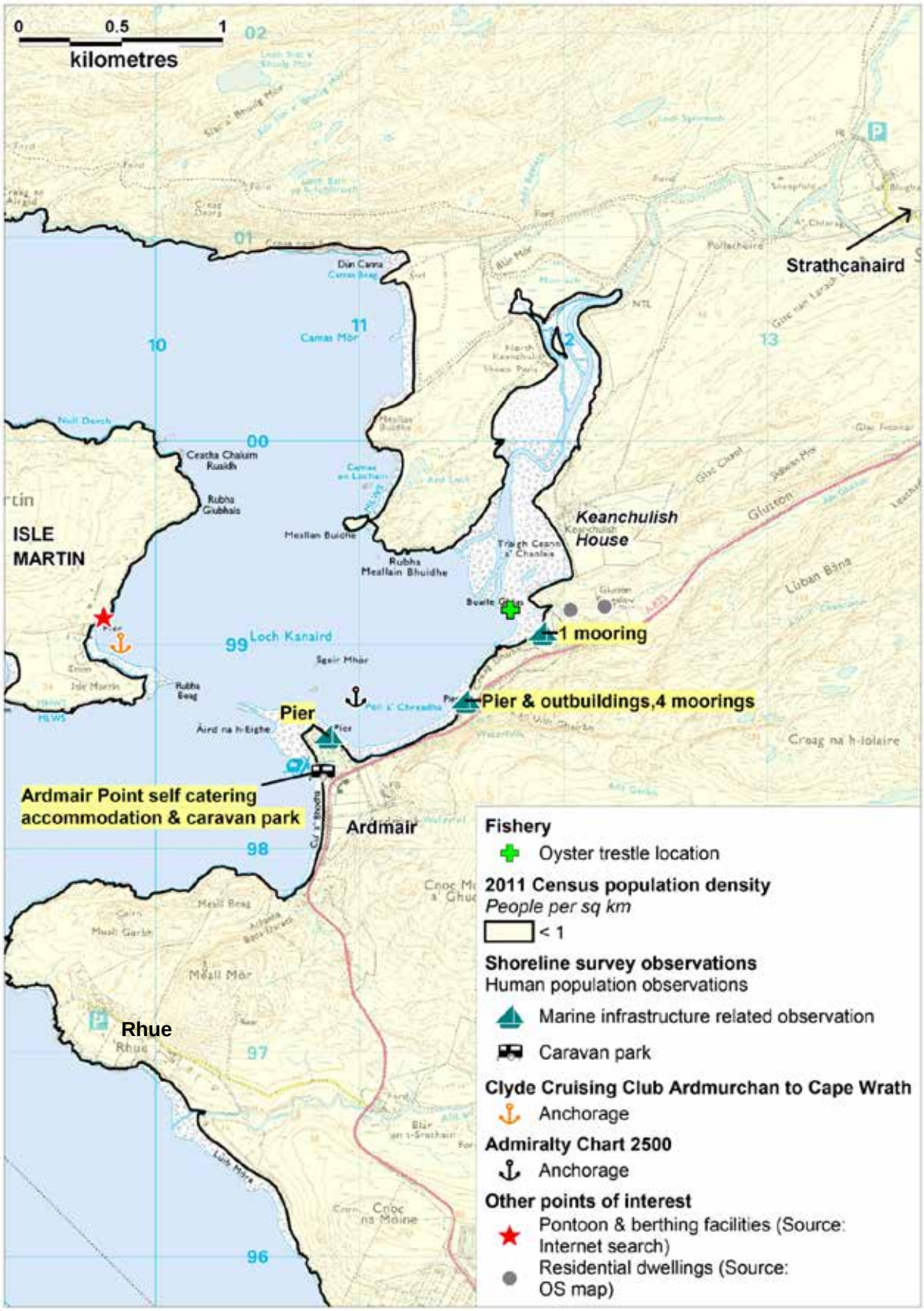

Figure 3.1 Population map for the area in the vicinity of Loch Kanaird

4. Sewage Discharges

Information on sewage discharges within a 7.5 km radius around point NG 1099 9900 was sought from Scottish Water and the Scottish Environment Protection Agency (SEPA). Data requested included the name, location, type, size (in either flow or population equivalent), level of treatment, sanitary or bacteriological data, spill frequency, discharge destination (to land, watercourse or sea), any available dispersion or dilution modelling studies, and whether improvements were in work or planned.

4.1 Community Discharges

The community of Ullapool is served by a public sewerage network operated by Scottish Water. Both Scottish Water and SEPA provided information on the waste water treatment works (WWTW) and associated intermittent outfalls at Ullapool, as well as information pertaining to two smaller community septic tanks; one at Braes of Ullapool and one at Ardmair. Four combined sewer overflows and emergency overflows (CSO/EO) were associated with the public sewerage network at Ullapool. This information is summarised in Table 4.1.

Table 4.1 Scottish Water discharges

Licence Number	Site Name	Location (NGR)	Discharge Type	Treatment Level	DWF (m^3/d)	PE
CAR/L/1097638	Ullapool WwTW	NH 1168 9488	FE	Primary	792	4308
CAR/R/1019247	Ullapool Ardmair SEP 1995	NH 1078 9790	FE	Septic Tank	*	34
CAR/L/1002125	Ullapool Braes SEP 1974	NH 1400 9260	FE	Septic Tank	*	300**
CAR/L/1082554	Ullapool, Garve Rd CSO	NH 1322 9370	CSO/EO	6mm screen	*	*
CAR/L/1082554	Ullapool, Morefield SPS CSO	NH 1190 9470	CSO/EO	6 mm screen	*	*
CAR/L/1082554	Ullapool, Shore Street SPS CSO	NH 1304 9396	CSO/EO	6 mm screen	*	*
CAR/L/1082554	Ullapool Point WWPS CSO	NH 1240 9360	CSO/EO	6 mm screen	*	*

WwTW = Waste Water Treatment Works FE = Final Effluent DWF = Dry Weather Flow, PE = Population Equivalent, SEP = Septic Tank, CSO = Combined Sewer Overflow, EO = Emergency Overflow, SPS = Sewage Pumping Station, WWPW = Waste Water Pumping Station, NGR= National Grid Reference * = No data provided ** = Design PE

No flow information for Ullapool Braes septic tank was provided by either data supplier within the original tables, nor were any values included in the consent document provided by SEPA. The original application document included information and capacity of the septic tank and indicates the system has a combined PE of 300.

Both Ullapool Braes septic tank and Ullapool WwTW discharge to Loch Broom while Airdmair septic tank discharges to the south of Ardmair Point 2.5 km from the production area. The expected faecal coliform content of these discharges is 1.0 x 10^7 cfu/100 ml for primary treated effluent and 7.2 x 10^6 for septic tank effluent (Appendix 2).

The four intermittent discharges are located around Ullapool and all discharge to Loch Broom.

4.2 Consented Private Discharges

SEPA provided information regarding consented discharges within the request area identified. Discharges relating to abstraction or engineering works have been excluded from assessment as they do not contribute to any faecal input to the area.

Information was provided on 48 sewage discharge consents around Loch Kanaird and one marine cage fish farm (MCFF) on the east side of Isle Martin. The consented discharges assessed in this report are given in Appendix 5.

Private discharges close to the fishery are listed in Table 4.2 below.

Licence No	NGR	Site_Name	Discharge_Type	Discharges_to	PE
CAR/R/1011609	NH 1147 9865	Dwelling	Sewage (Private) Primary	Soakaway	6
CAR/R/1034446	NH 1198 9851	Dwelling	Sewage (Private) Primary	Soakaway	7
CAR/R/1036935	NH 1063 9778	Dwelling	Sewage (Private) Secondary	Loch Kanaird	6
CAR/R/1036938	NH 1063 9778	Dwelling	Sewage (Private) Secondary	Loch Kanaird	6
CAR/R/1043025	NC 1182 0040	Dwelling	Sewage (Private) Primary	Soakaway	5
CAR/R/1066365	NH 1082 9814	Dwelling	Sewage (Private) Primary	Loch Kanaird	5
CAR/R/1076831	NH 1176 9955	Dwelling	Sewage (Private) Primary	Loch Kanaird	12
CAR/R/1076839	NH 1219 9916	Dwelling	Sewage (Private) Primary	Soakaway	5
CAR/R/1082126	NH 1063 9778	Dwelling	Sewage (Private) Secondary	Loch Kanaird	6

Historically, there has been no requirement to register septic tanks in Scotland. Registration is now required for all new properties and upon sale of existing properties, therefore there are likely to be unconsented septic tank discharges in addition to the consented discharges listed. The majority of registered septic tanks are consented to discharge either to land or soakaway. SEPA have previously identified that in remote areas, consents originally registered as discharging to land may have been diverted to sea or watercourses upon failure of the soakaway fields.

Further information identified that an automatic feed barge has been put on the site (The Highland Council: North Planning Application Committee, 2013). This would reduce the chance of faecal impact from this site as personnel would not be required on site continuously. However, if there are toilet facilities on board there may be a risk of discharge when personnel are present.

Nine consents were for discharges around Strath Canaird, along the River Canaird. This river flows directly to the production area and any sewage input to it would be expected to impact on the production area.

Shoreline Survey Discharge Observations

Observations made during the shoreline survey of sewage discharges and sewage-related infrastructure are listed in Table 4.3. The shoreline survey covered the shoreline from Ardmair Point to Keanchulish House, and did not include the Ullapool area.

Table 4.2 Discharge-associated observations made during the shoreline survey

No.	Date	Location (NGR)	Associated Photograph (Appendix 4)	Description
1	05/11/2013	NH 1081 9840		Two raised pipes on beach - caravan park above.
2	05/11/2013	NH 1075 9852		Manhole on shore immediately below chemical toilet emptying point & laundrette on campsite. Discharge pipe visible on shore (10cm uPVC), but disappears below tide line.
3	05/11/2013	NH 1073 9855	Fig 4	Second discharge pipe running from caravan site, smell of sewage present in the air. This pipe connects with the pipe seen in observation 2. Not possible to see the discharge due to the state of the tide.
4	05/11/2013	NH 1073 9856	Fig 5	Third pipe running onto foreshore - several broken sections present, with no flow observed in broken sections.
6	05/11/2013	NH 1089 9852		Manholes (two) noted on shoreline below chalet style dwellings - no pipes visible on foreshore.
7	05/11/2013	NH 1097 9844	Fig 6	A third manhole cover (concrete)* below chalet style buildings - no pipe visible on foreshore.
8	05/11/2013	NH 1197 9962	Fig 14	Photo taken of outflow pipe at low tide at Keanchulish House. Pipe was only visible at low tide after finishing the survey.
9	05/11/2013	NH 1196 9953		Manhole on road next to Keanchulish House. No discharge pipe visible on shoreline.

*A small, vertical vent pipe is present adjacent to the tank, suggesting that this may be a septic tank.

Observations 1-7 were related to discharges from properties around the holiday park at Ardmair Point. The concrete cover identified in Observation 7 appears to be at the tideline. The ventilation pipe next to it suggests a septic tank, however it would be highly unusual to site a septic tank where it was susceptible to seawater inundation. No consent information was available for any these discharges. The remaining two observations relate to Keanchulish House, which has a consented PE of 12.

A seawater sample taken from near the discharge pipes (Observations 3, 4 & 5) at Ardmair Point returned a result of 77 *E. coli* cfu/100 ml, which is moderately high for seawater and indicates significant faecal contamination in this vicinity.

Summary

The largest input of sewage is the Ullapool WWTW and associated overflows, which discharge to Loch Broom approximately 7.5 km from the fishery.

The nearest public sewage discharge to the oyster farm is at Ardmair. This septic tank is relatively small, with a PE of 34, and discharges to Loch Kanaird approximately 2 km southwest of the oyster farm.

There are several private discharges within 500 m of the oyster farm. The discharge from Keanchulish House lies approximately 370 m north of the oyster farm, along the channel of the River Canaird. This house was not in use at the time of shoreline survey, and is only used intermittently. There are other septic tanks consented to discharge to soakaway upstream along the river. Any of these that have been diverted to discharge to the river or are malfunctioning would potentially cause additional impact to the fishery.

Similarly, if the consented soakaway near the Allt Glutton has been rerouted to discharge to the burn this would be expected to have a relatively direct impact on the fishery, as the watercourse discharges very near the trestles.

A number of discharge pipes were observed around Ardmair Point, the nearest of which lie approximately 1 km southeast of the oyster trestles. As these are related to seasonally occupied accommodation, it is likely that any impact from these would be greatest during the main tourist season of April to September.

List of Acronyms

PE=	Population Equivalent	DWF=	Dry weather flow
WWTW=	Wastewater Treatment Work	SEP=	Septic Tank
FE=	Final Effluent	CSO=	Combined Sewer Overflow
EO=	Emergency Overflow	WWTW=	Waste Water Treatment Works
SPS=	Sewage Pumping Station	WWPS=	Waste Water Pumping Station

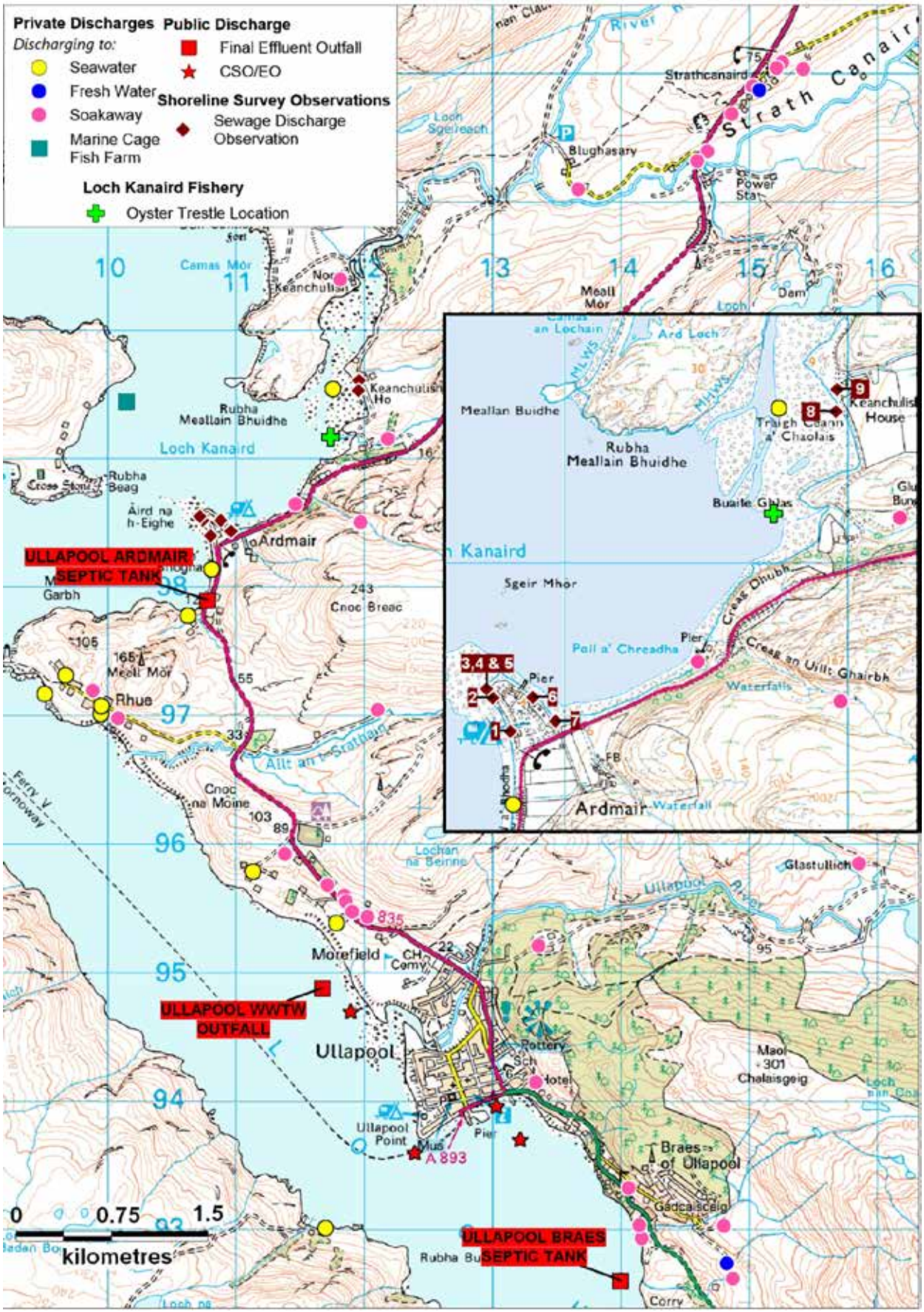

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Figure 4.1 Map of discharges for Loch Kanaird

5. Agriculture

Information on the spatial distribution of animals on land adjacent to or near the fishery can provide an indication of the potential amount of organic pollution from livestock entering the shellfish production area. Parish-level data from the 2012 Agricultural Census was requested from the Scottish Government Rural Environment, Research and Analysis Directorate (RERAD) for Lochbroom parish. Reported livestock numbers are listed in Table 5.1.

Table 5.1 Livestock numbers in the Lochbroom agricultural parish 2012

	Lochbroom	
	1098 km^2	
	Holdings	Numbers
Pigs	11	55
Poultry	48	924
Cattle	24	669
Sheep	85	24869
Other horses and ponies	8	43

The Lochbroom parish covers a very large area of 1098 km^2 and therefore it is not possible to determine the spatial distribution of the livestock in relation to the Loch Kanaird area or identify how many animals are likely to impact the catchment around the fishery. Sheep production is the predominant activity in the parish, with lower numbers of other livestock types also present.

The most significant source of spatially relevant information on livestock population in the area was therefore the shoreline survey (see Appendix 4), which only relates to the time of the site visit on the 5th November 2013. Observations made during the survey are dependent upon the viewpoint of the observer and some animals may have been obscured by the terrain. The spatial distribution of animals observed and noted during the shoreline survey is illustrated in Figure 5.1.

During the shoreline survey, three sheep in total were observed in a field southeast of the fishery and sheep droppings were present on the shoreline north of the fishery. Despite the low numbers of animals seen from the shoreline, it is likely that a much larger number of sheep are normally present in the area. Satellite images from Bing Maps (http://www.bing.com/maps/?mkt=en-gb) dated as having been taken in May 2012 (http://mvexel.dev.openstreetmap.org/bing/) showed large numbers of sheep present on fields along the upper River Canaird as well as at Keanchulish and Ardmair. At least some of the fields along the river and at Ardmair appeared to be used for silage production. Areas that appeared to be used for crop production and/or grazing are identified in Figure 5.1.

Any contributions of faecal contamination from livestock grazing in the area would be most likely to affect the areas of shellfish bed closest to the shoreline. Although few livestock were present during the survey, the sheep were in close range of the fishery

and any impact would be greatest on the side of the shellfish bed closest to the shoreline: however, the distribution of animals around the area may change with time. Numbers of sheep would be expected to be approximately double during late spring following the birth of lambs, and decrease again in the autumn when they are sent to market.

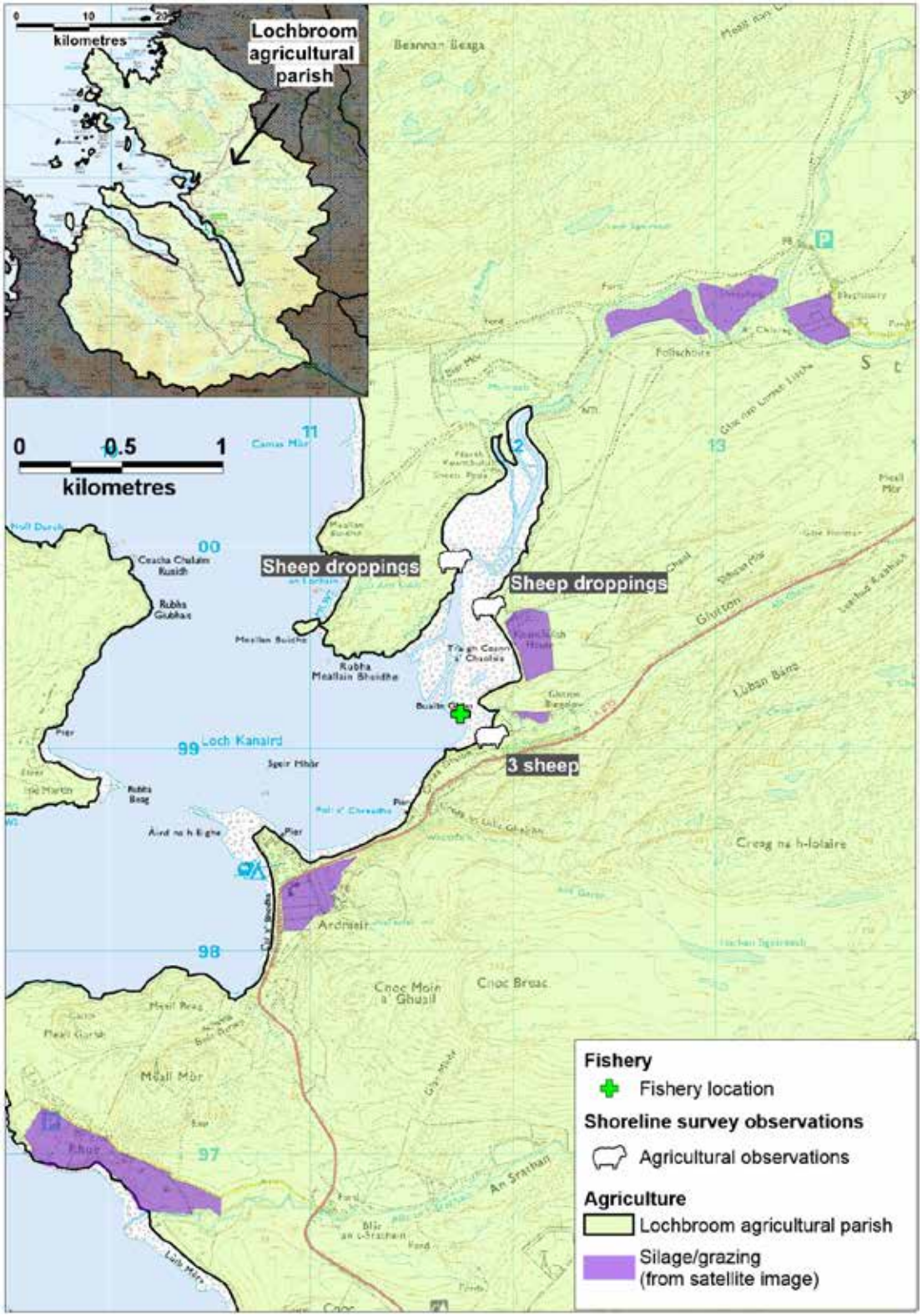


Figure 5.1 Livestock observations at Loch Kanaird

6. Wildlife

Wildlife species present in and around the production area will contribute to background levels of faecal contamination at the fishery, and large concentrations of animals may constitute significant sources when they are present. Seals, cetaceans and some seabirds may deposit faeces directly into the sea, while birds and mammals present on land will contribute a proportion of any faecal indicator loading carried in diffuse run-off or watercourses.

The species most likely to contribute to faecal indicator levels at the Loch Kanaird Pacific oyster fishery are considered below.

Pinnipeds

The west coast of Scotland is recognised as supporting a healthy, stable population of harbour seals with approximately 4696 seals present between Cape Wrath and Ardnamurchan Point. In the Special Committee on Seals (Special Committee on Seals, 2012) report, it was highlighted that there were between 50-100 harbour seals in the vicinity of Loch Kanaird, whilst only 10-50 grey seals were observed in the same time period of 2007-2011. Grey seal populations across most of Scotland are also shown to be increasing, with pup production reported as having increased though information specific to the Loch Kanaird area was not available. There are anecdotal accounts of seals around Ardmair Point (Anon., 2007).

Three seals were observed during the shoreline survey; one offshore approximately 1.5 km to the south of the fishery, adjacent to the caravan park, and two approximately 200 m north of the fishery.

Cetaceans

There are anecdotal accounts of cetaceans including whales, porpoise and dolphins using Loch Kanaird to forage in for fish (Ardmair Bay Cottages, 2014). No cetaceans were seen during the shoreline survey.

Birds

Seabird 2000 census data (Mitchell, *et al*., 2004) for the area within a 5 km radius of Loch Kanaird was obtained and is summarised in Table 6.1. This census, undertaken between 1998 and 2002 covered twenty five species of seabird that breed regularly in Britain and Ireland.

Table 6.1 Seabird counts within 5 km of the Loch Kanaird

Common name	Species	Count*	Method
Northern fulmar	*Fulmarus glacialis*	138	Occupied nests
European shag	*Phalacrocorax aristotelis*	6	Occupied nests
Black guillemot	*Cepphus grylle*	128	Individuals on land

*The counts have been adjusted where the method used was occupied nests to reflect the probable number of individual birds (i.e. counts of nests were doubled).

Anecdotal accounts of birds such as red throated divers, dunlin, oystercatchers, gulls, common sand pipers, stonechats, northern divers, Slavonian grebes and eider ducks amongst other species have been reported (Christine's walking & birds blog, 2012).

There are also accounts of sea eagles and golden eagles breeding around the coast, with the small island (Isle Martin) found approximately 1.8 km west of Loch Kanaird a nesting area used by gulls, fulmars, geese and peregrine falcon (Ardmair Bay Cottages, 2014).

The mouth of the River Canaird presents a large intertidal area that is likely to be attractive to wading birds. However, no specific information on the presence and numbers of these birds was found.

During the shoreline survey, a large number of birds were observed to the north and south of the fishery including gulls, golden plovers, and ducks.

Deer

The website for Ardmair Bay Cottages identifies that nearby estates offer red deer stalking (Ardmair Bay Cottages, 2014). No deer were observed during the shoreline survey.

Otters

No information was found regarding the presence and numbers of otters around Loch Kanaird. No otters were observed during the shoreline survey.

Overall

Species potentially impacting on Inner Loch Kanaird include seals, seabirds and wading birds and deer. Much of the information about wildlife is from anecdotal accounts, and therefore it is not possible to establish the extent of potential impact from these animals. However, seasonal trends are expected particularly in seabirds as these animals are more likely to be on or near shore-based nesting areas during the summer nesting season.

Faecal contamination from animals on land, such as deer, are likely to be carried in freshwater runoff and watercourses. Faecal contamination from wading birds is likely to be higher north of the fishery, where there is extensive intertidal area, whereas contamination from seabirds may be higher to the south of the fishery, where there are more nesting areas.

Figure 6.1 Map of wildlife around Loch KanairdLoch Kanaird

7. Land Cover

The Land Cover Map 2007 data for the area is shown in Figure 7.1.

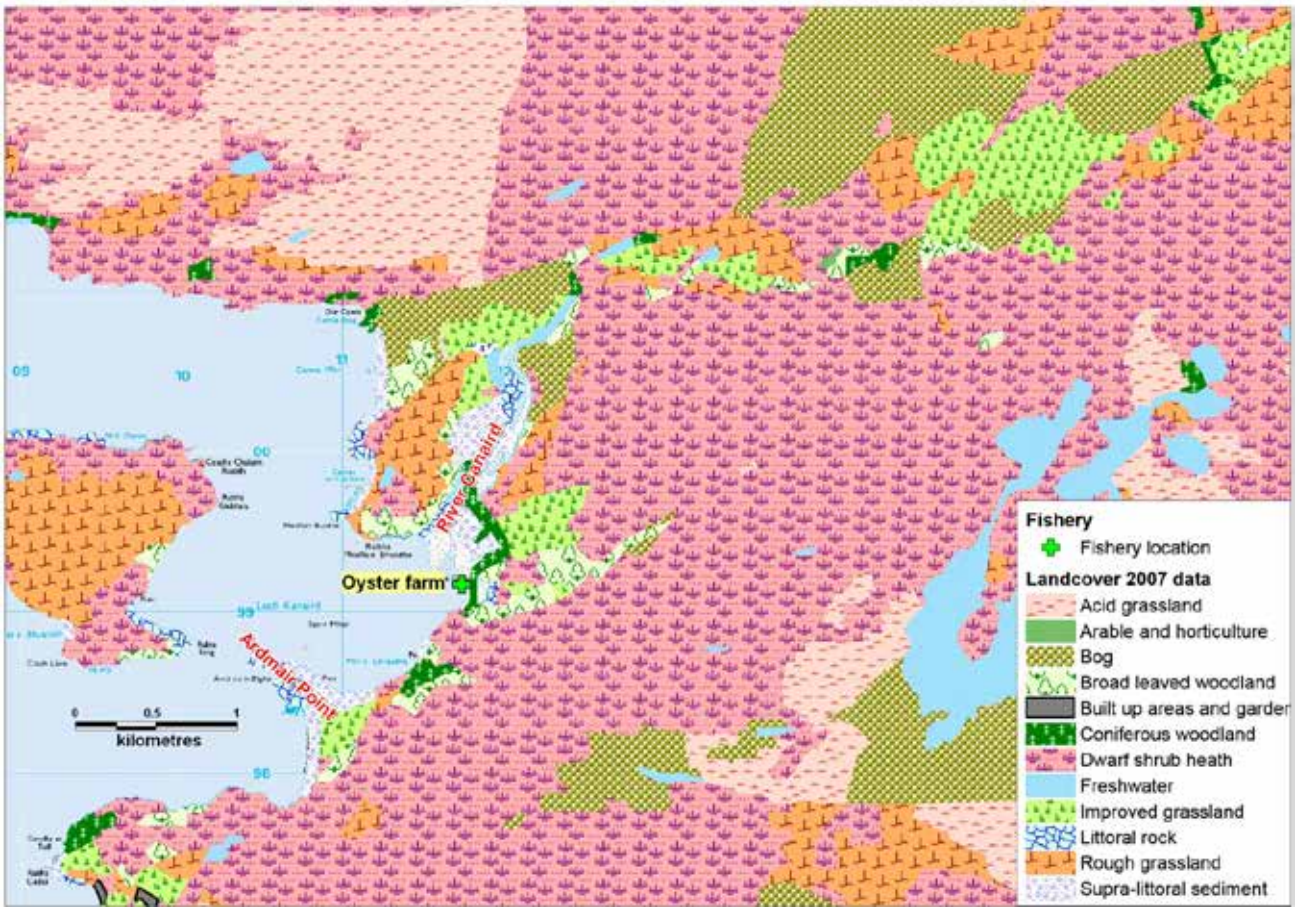


Figure 7.1 LCM2007 land covers data for the area around Loch Kanaird

Landcover type around Loch Kanaird is varied. The land cover east of the fishery is predominantly heathland interspersed with woodland, grassland and bog. The main areas of improved grassland are located along the River Canaird north of the oyster farm, around Keanchulish House to the northeast of the oyster farm, and at Ardmair Point, south of the oyster farm. Further small areas of improved grassland lie along the Allt Glutton (east of the oyster farm) and to the south of the loch entrance, where there are also small areas identified as built up or garden around Rhue.

Faecal indicator organism export coefficients for faecal coliform bacteria have been found to be approximately $8.3x10^8$ cfu/km^2/hr for areas of improved grassland and approximately $2.5x10^8$ cfu/km^2/hr for rough grazing (Kay, *et al*., 2008). The contributions from all land cover types would be expected to increase significantly after rainfall events, however this effect would be particularly marked from improved grassland areas (roughly 1000-fold) (Kay, *et al*., 2008).

The highest potential contribution of contaminated run-off to the Loch Kanaird oyster farm is from the areas of improved grassland located inland to the east and along the River

Canaird to the north. The potential contribution of contaminated run-off to the shellfish bed would be highest from these areas.

8. Watercourses

A gauging station is located at Langwell Lodge on the River Canaird, approximately 6 km northeast of the fishery. The UK National River Flow Archive had not published any archive flow level data for this gauging station at the time of writing this report. As the gauging station is located upstream from the point at which the River Runie joins the River Canaird, any data from this gauging station would not be representative of the total flow entering Loch Kanaird.

During the shoreline survey, significant watercourses along the survey route were recorded and size, flow and *E. coli* concentrations were measured from spot samples. Weather conditions were dry on the day of the survey, although they had been wet during the beginning of November, just prior to the survey. Watercourses recorded on the day are listed in Table 8.1.

In addition, an area of land drainage was identified approximately 200 m southeast of the oyster farm and a second area of land drainage was observed during the survey located < 400 m north of watercourse No 4.

Table 8.1 Watercourses entering Loch Kanaird

No.	NGR	Description	Width (m)	Depth (m)	Flow (m^3/d)	Loading (*E. coli* per day)
1	NH 11053 98451	Stream	0.75	0.09	2110	1.5×10^9
2	NH 11519 98726	Allt Garbh	1.40	0.24	11200	$<1.1 \times 10^9$
3	NH 11914 99187	Allt Glutton	3.50	0.14*	20400*	$<2.0 \times 10^9$
4	NH 11914 99631	Stream	0.55	0.15	912	9.1×10^{10}
5	NC 12451 00963	River Canaird	27.50	1.0***	1240000**	7.4×10^{11}
6	NC 11882 00541	Allt Bealach	1.50	0.06	10900	4.3×10^9

*Average taken from two measurements **Average taken from three measurements ***Nominal 1 m depth based on estimates of depths ranging from 0.5 – 3 m

All of the watercourses measured during the survey entering the area have significant flows. The oyster farm it situated at the mouth of the River Canaird, which carried the highest estimated loading of the watercourses sampled. The trestle area lies within 100 m of the river channel, and is therefore likely to be significantly influenced by contamination carried via this river. An area of land drainage and an unnamed watercourse (No 3) with a moderate estimated loading also discharge within 200 m east of the oyster farm. These are expected to contribute to contamination levels found at the oyster farm though their overall contribution may be less significant that that provided by the River Canaird.

The remaining watercourses discharge within 1 km of the fishery and were found to have moderate calculated loadings. Sheep were seen grazing near watercourse No. 3, and sheep droppings were seen along the shore northwest of No. 4, therefore livestock are likely to have contributed to faecal contamination found in these watercourses.

Watercourse No. 4 had a small flow, but high loading due to the very high *E. coli* result (10000 cfu/100 ml) obtained from the water sample taken there. This watercourse flows

next to Keanchulish house and farm, although these were reported by the harvester to be unoccupied at the time of survey.

The locations and loadings of measured watercourses as well as noted areas of land drainage are shown in Figure 8.1. Higher flows and *E. coli* levels would normally be expected in watercourses after significant rainfall.

Overall, freshwater inputs are expected to provide moderate levels of contamination to the oyster bed in Loch Kanaird, with the highest impact expected from the watercourses that discharge directly to the fishery. Of these, the highest loading was observed from the River Canaird.

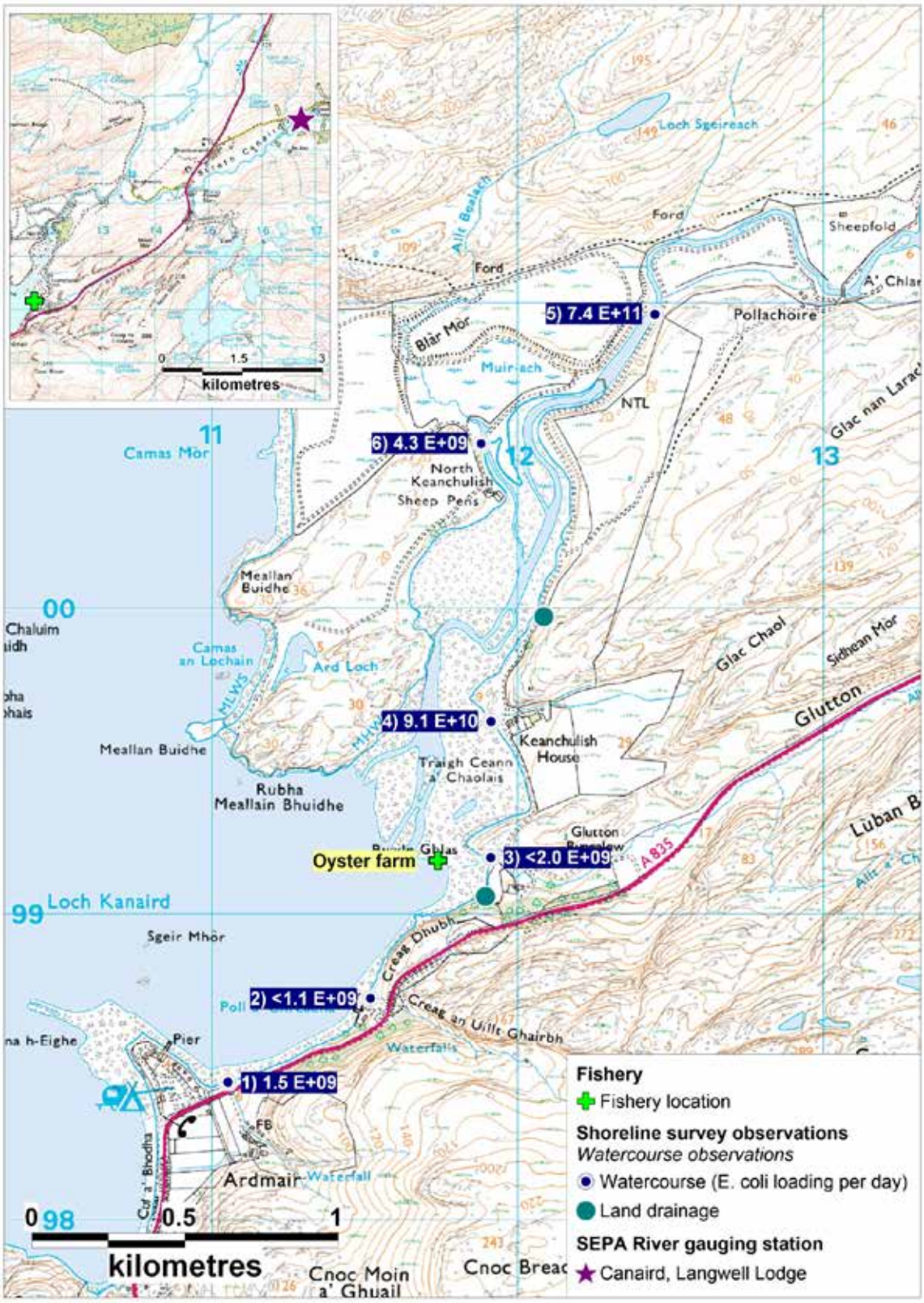


Figure 8.1 Map of watercourse loadings at Loch Kanaird.

9. Meteorological Data

The nearest weather station for which a largely complete rainfall data set was available is located at Aultbea No. 2, situated approximately 28 km to the west of the fishery. Data was missing for two days from 02/12/2008 to 03/12/2008. Rainfall data was obtained for the period January 2007 – December 2012. At the time of writing this report, rainfall data for December 2012 onwards was not yet available. The nearest wind station is situated at Stornoway Airport, located 73 km northwest of the fishery. Conditions may differ between both weather stations and Loch Kanaird due to the large distances between them. Data for these stations was purchased from the Meteorological Office. Unless otherwise identified, the content of this section (e.g. graphs) is based on further analysis of this data undertaken by Cefas. This section aims to describe the local rain and wind patterns in the context of the bacterial quality of shellfish at Loch Kanaird.

9.1 Rainfall

High rainfall and storm events are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or other animals are present, and through sewer and waste water treatment plant overflows (Mallin, *et al*., 2001; Lee & Morgan, 2003). The box and whisker plots in Figures 9.1 and 9.2, present a summary of the distribution of individual daily rainfall values by year and by month. The grey box represents the middle 50% of the observations, with the median at the midline. The whiskers extend to the largest or smallest observations up to 1.5 times the box height above or below the box. Individual observations falling outside the box and whiskers are represented by the symbol *.

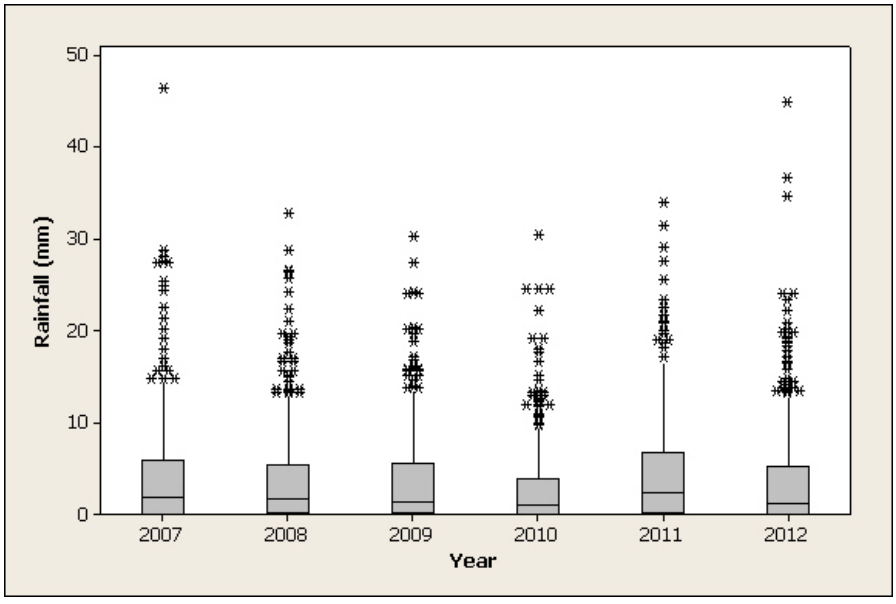


Figure 9.1 Box plot of daily rainfall values by year at Aultbea No.2 (2007 – 2012)

Total rainfall values varied from year to year, with 2010 being the driest year (a total of 1037 mm). The wettest year was 2011 (a total of 1672 mm). High rainfall events of greater than 30 mm/d occurred in all years.

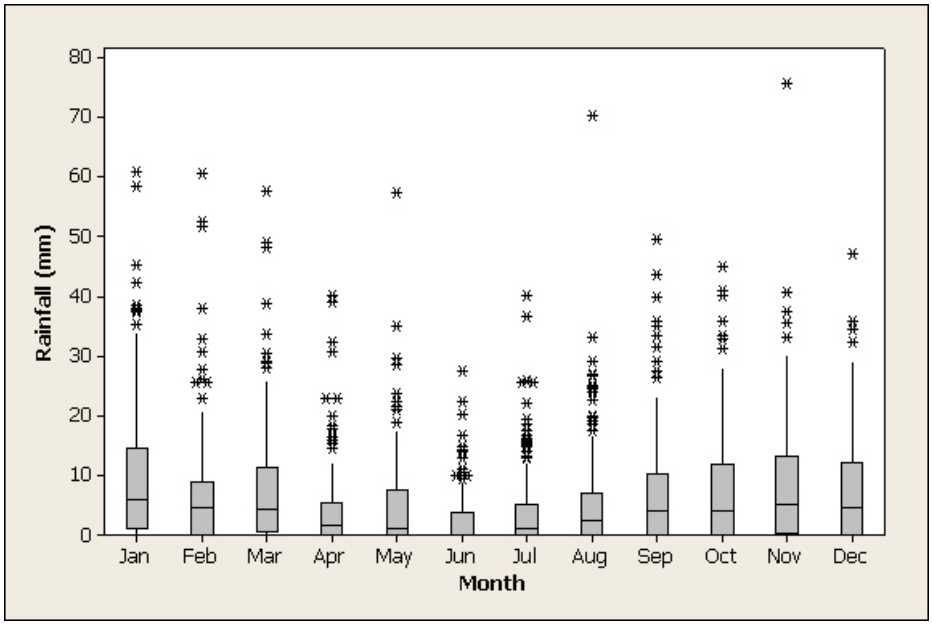


Figure 9.2 Box plot of daily rainfall values by month at Aultbea No.2 (2007 – 2012)

Rainfall was lower from April to July and higher from August to March. Rainfall values exceeding 30 mm/d were seen in all months except June. The highest rainfall events occurred in August and November.

For the period considered here (2007 – 2012) 42 % of days received daily rainfall of less than 1 mm and 11 % of days received rainfall of over 10 mm.

It is therefore expected that run-off due to rainfall will be higher during the autumn and winter months. However, extreme rainfall events leading to episodes of high runoff can occur in most months and when these occur during generally drier periods in summer and early autumn, they are likely to carry higher loadings of faecal material that has accumulated on pastures when greater numbers of livestock were present.

9.2 Wind

Wind data was collected from Stornoway Airport and summarised in seasonal wind roses in Figure 9.3 and annually in Figure 9.4.

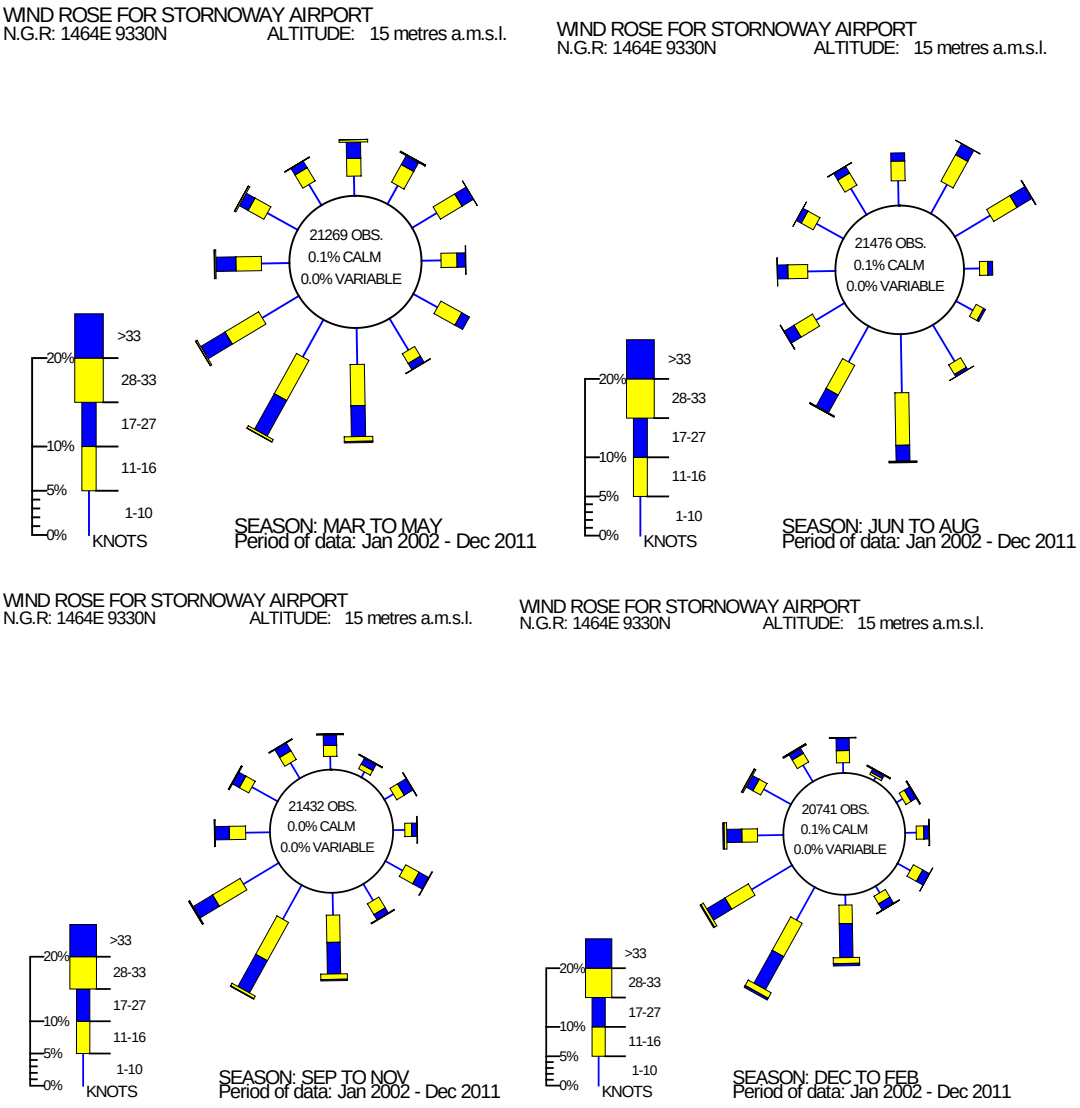


Figure 9.3 Seasonal wind roses for Stornoway Airport

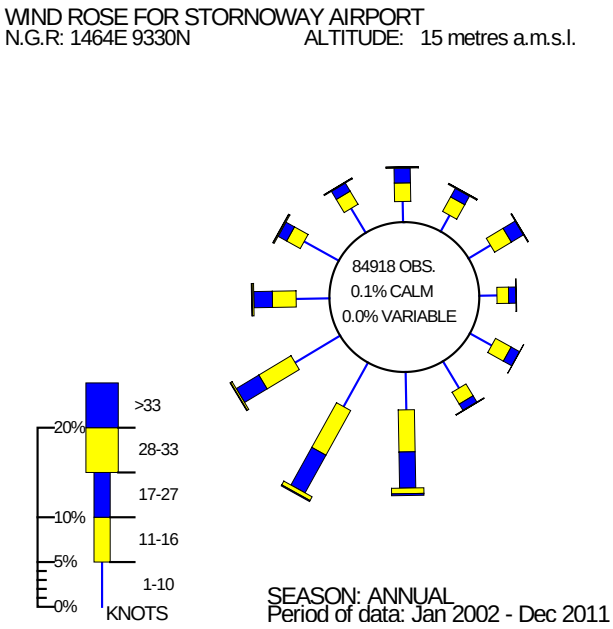


Figure 9.4 Annual wind rose for Stornoway Airport

Overall, winds were predominantly from the southwest. However, during summer, there were more frequent southerly winds, and there were also relatively strong winds from the north-east. Wind is an important factor in the spread of contamination as it has the ability to drive surface water at about (3%) of the wind speed (Brown, 1991) so a gale force wind (34 knots or 17.2 m/s) would drive a surface water current of about 1 knot or 0.5 m/s. Therefore strong winds can significantly alter the pattern of surface currents. Strong winds also have the potential to affect tide height depending on wind direction and local hydrodynamics of the site. A strong wind combined with a spring tide may result in higher than usual tides, which will carry any accumulated faecal matter at and above the normal high water mark into the fishery area.

10. Classification Information

Loch Kanaird is a new production area so has no classification history.

11. Historical *E. coli* Data

11.1 Validation of historical data

Results for all samples assigned against Loch Kanaird for the period 01/01/2012 to 07/01/2014 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. The data was extracted from the database on 07/01/2014. All *E. coli* results were reported as most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

All sample results reported as <20 *E. coli* MPN/ 100 g were reassigned a value of 10 *E. coli* MPN/ 100 g for the purposes of statistical evaluation and graphical representation.

All ten sample results were reported as valid in the dataset and were received at the laboratory within 48 hrs of collection

11.2 Summary of microbiological results

Table 11.1 Summary of historical sampling and results

Sampling Summary	
Production area	Loch Kanaird
Site	Ardmair
Species	Pacific oysters
SIN	RC-625-1233-13
Location	Various
Total no of samples	10
No. 2012	1
No. 2013	9
Minimum	<20
Maximum	3500
Median	50
Geometric mean	94
90 percentile	3229
95 percentile	3500
No. exceeding 230/100g	4
No. exceeding 1000/100g	1
No. exceeding 4600/100g	0
No. exceeding 18000/100g	0

One sample result was found for 2012. More regular sampling began in 2013. Four of the 10 results were greater than 230 *E. coli* MPN/100 g.

11.3 Overall geographical pattern of results

All samples had recorded grid references within <10 m of the RMP trestle at NH 1179 9918. The RMP is located higher up the intertidal zone, approximately 50 m east of the main oyster farm location to facilitate regular access for sampling. Therefore, as all

monitoring results have come from the same location it is not possible to assess spatial variation using these. Three Pacific oyster samples were taken on 5 November 2013, when the hygiene monitoring sample was taken on the same day as samples were taken for the shoreline survey. These results are listed in Table 11.2 and shown mapped in Figure 11.1.

Table 11.2 Summary of historical sampling and results

Sample source	Date	Eastings	Northings	*E. coli*
Monitoring programme	05/11/2013	211792	899172	<20
Shoreline survey	05/11/2013	211746	899167	50
Shoreline survey	05/11/2013	211752	899175	130

All results were below 230 MPN/100 g, with the highest result coming from the inshore corner of the oyster farm. Unfortunately, no samples were taken from the northern end of the oyster farm and therefore it is not possible to assess whether oysters at that end of the farm, nearer to the main flow of the River Canaird, would have had higher results.

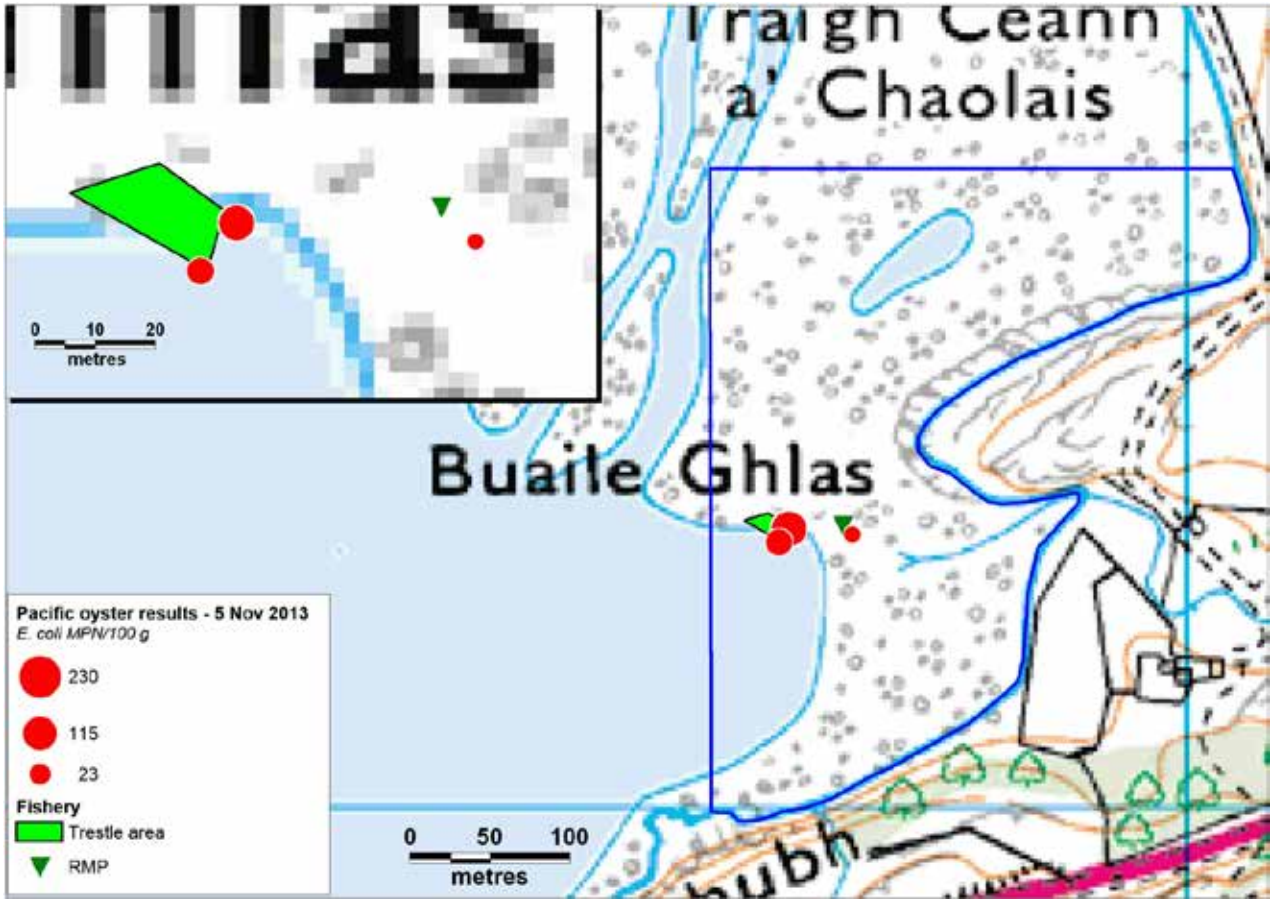


Figure 11.1 Map of reported sampling locations for Pacific oysters at Loch Kanaird

11.4 Overall temporal pattern of results

A scatterplot of *E. coli* results against date for Loch Kanaird is presented in Figure 11.2.

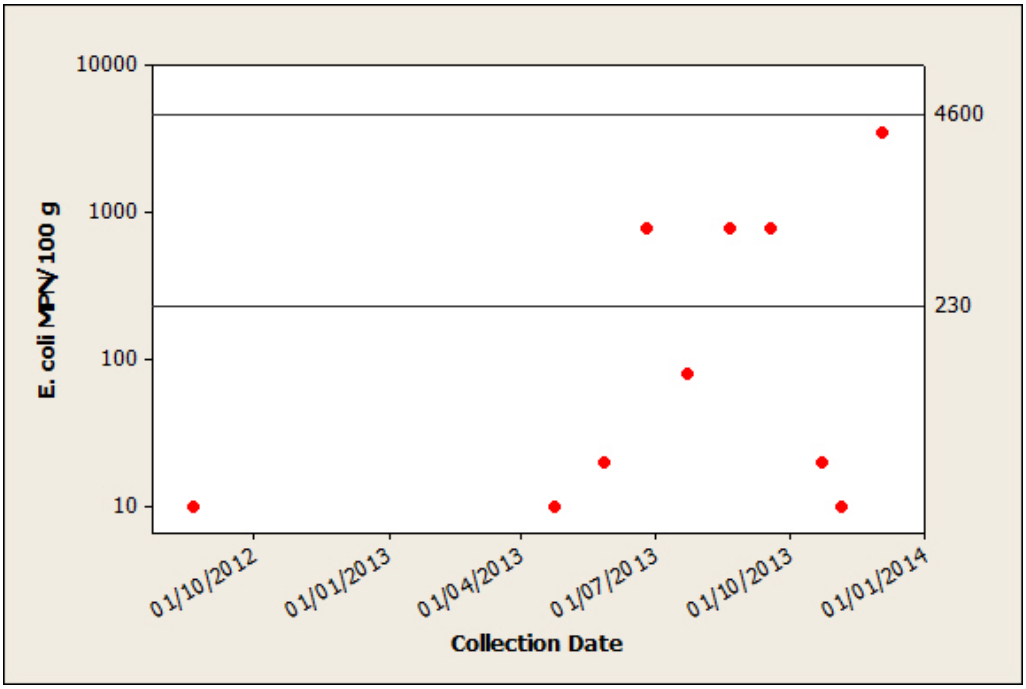


Figure 11.2 Scatterplot of *E. coli* results by collection date at Loch Kanaird

No samples were taken between 20/08/2012 and 22/4/2013. The highest result occurred in December. A single sample was submitted in August 2012, 8 months before regular sampling commenced in late April 2013. At the time of writing this report, a year's worth of continual monitoring data had not yet been completed. Due to the gap in the data, and the limited period of the data, it was not yet possible to determine whether there was any clear temporal pattern in the results.

11.5 Summary and conclusions

A significant proportion of the sample results submitted to date were greater than 230 *E. coli* MPN/ 100 g. All monitoring samples have been taken from the RMP trestle, which plots 50 m east of the recorded oyster farm location. On the day of shoreline survey, two samples taken on the oyster farm itself returned higher results that the monitoring sample taken on the same date. All three results from the same date were below 230 *E. coli* MPN/100 g, though the sample taken from the RMP trestle returned a result below the limit of detection. This suggests that the results at the monitoring trestle may underrepresent contamination levels present at the oyster farm.

12. Designated Waters Data

The Loch Kanaird fishery area does not coincide with either a designated shellfish water protected area or a designated bathing water.

13. Hydrographic Section

13.1 Introduction

13.1.1 The Study Area

Outer Loch Broom is situated in the Highland District of the west coast of Scotland. It lies in a region away from industrial activities. Outer Loch Broom is surrounded by mountains and there is very little agricultural or forest activity in the area. The main township is Ullapool which lies to the southeast of the study area in Loch Broom. The area around the Outer Loch is sparsely populated.

The assessment area lies to the north and west of the entrance to Loch Broom. The western boundary of the study area opens into the Minch. There is one island within the study area, Isle Martin. Loch Kanaird is bounded by Isle Martin to the west and the mainland to the east. There is a shallow sill between Isle Martin and the mainland between Rubha Beag and Aird nah-Eighe on the southern entrance into Loch Kanaird. There is no sill at the northern entrance.

Coordinates for Outer Loch Broom:

57°56.64'N 005° 17.69'W

OS Grid Reference NH 050 995

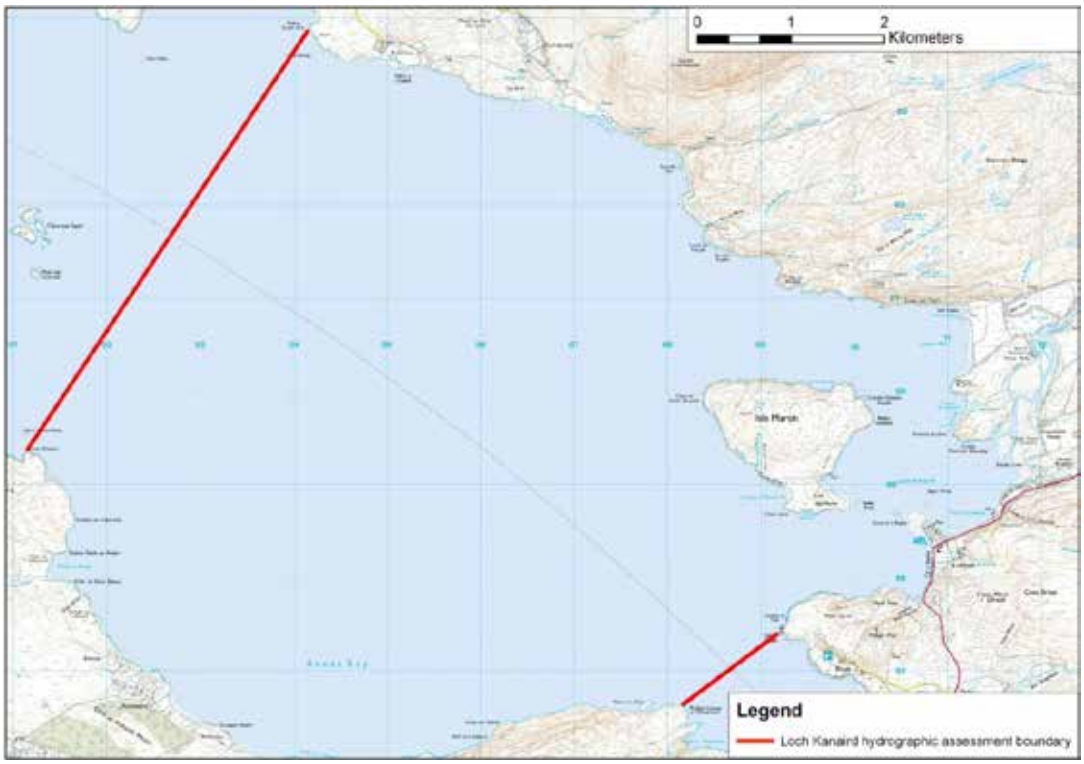


Figure 13.1 Extent of the hydrographic study area

13.2 Bathymetry and Hydrodynamics

13.2.1 Bathymetry

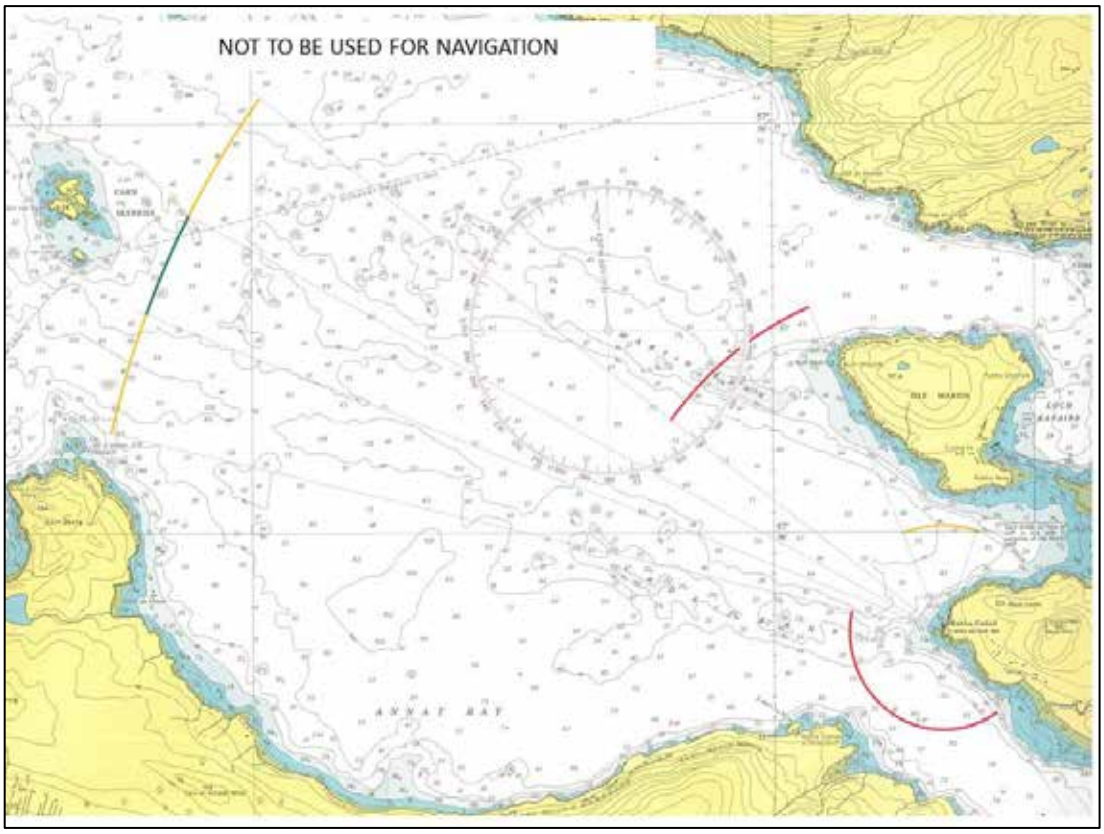


Figure 13.2 Admiralty chart (2500) extract for Loch Kanaird.

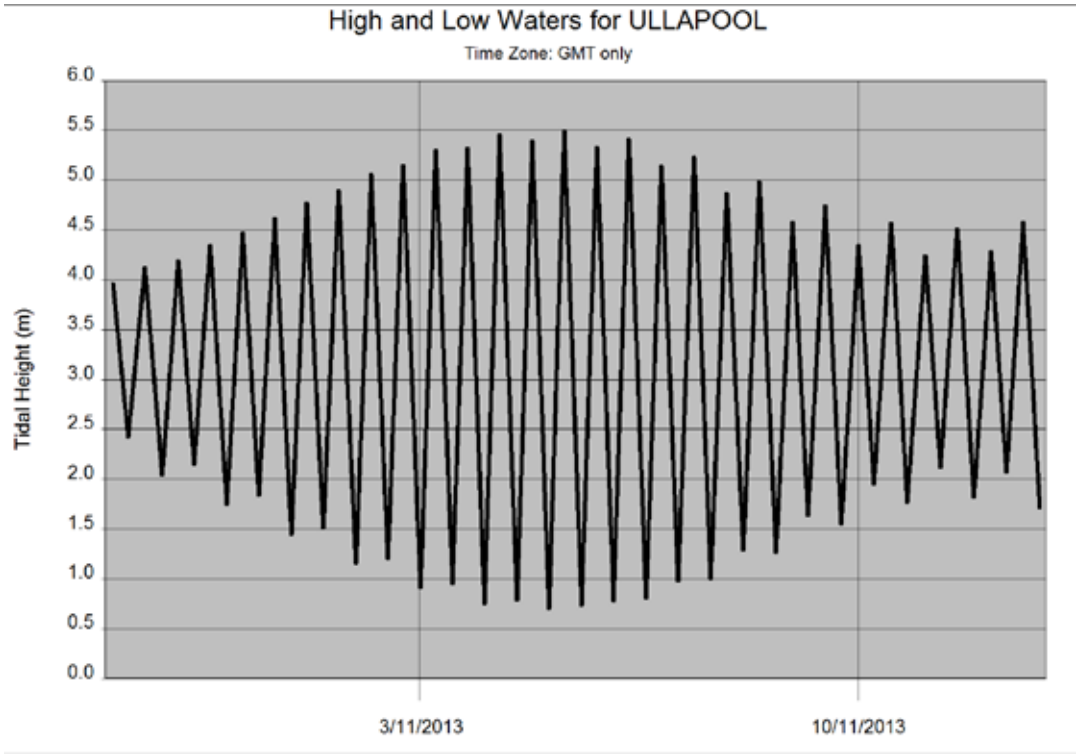
Figure 13.2 shows the bathymetry of Outer Loch Broom. The Outer Loch is divided into three basins, separated by two banks, the northern, Martin bank and the southern bank, the Cadail bank. Martin bank runs WNW from Isle Martin and extends out of the study area with the shallowest depth of 14m. The southern bank, Cadail bank, runs parallel to Martin bank and runs from the mainland at Rubha Cadail. The shallowest part of Cadail bank is 16m and Cadail bank extends to W005º 17.0'.

The maximum depths of the northern, middle & southern basins are 96m, 80m & 67m respectively. To the west where the middle and southern basins meet is the deepest part of Outer Loch Broom, 111m. This is part of a deep water channel which extends to the west into the Minch.

13.2.2 Tides

Loch Kanaird has a typical semi-diurnal tidal characteristic. Data on tidal information is given from charted information. The nearest location for tidal predictions is Ullapool, Loch Broom [http://easytide.ukho.gov.uk].

Standard tidal data for Ullapool, Loch Broom, centred around the survey date of 5th November 2013, is shown in Figure 13.3.



Reproduced from Poltips3 [www.pol.ac.uk/appl/poltips3]

Figure 13.3 Two week tidal curve for Ullapool, Loch Broom.

Tidal Heights at Ullapool, Loch Broom:

Mean High Water Springs = 5.18 m
Mean Low Water Springs = 1.01 m
Mean High Water Neaps = 4.02 m
Mean Low Water Neaps = 2.18 m

Tidal Ranges:

Mean Spring Range = 4.17 m
Mean Neap Range = 1.84 m

This gives a tidal volume of water within the assessment area during each tidal cycle of approximately:

Springs: 1.8×10^8 m^3
Neaps: 8.1×10^7 m^3

13.2.3 Tidal Streams and Currents

There are no published tidal diamonds for this area. Enhancement of tidal streams caused by straights and shallow areas in the inner part around Isle Martin will be important.

There are three sites with current meter data available from previous surveys. Current meter data were obtained from SEPA which were collected from a site in Loch Kanaird (Anderson, 2009). Figure 13.4 shows the location of this site. The hydrographic survey spans 15 days; this being the half-lunar period to capture a spring-neap cycle. Current meter data was also obtained from SEPA from two sites in Annat Bay, north & south.

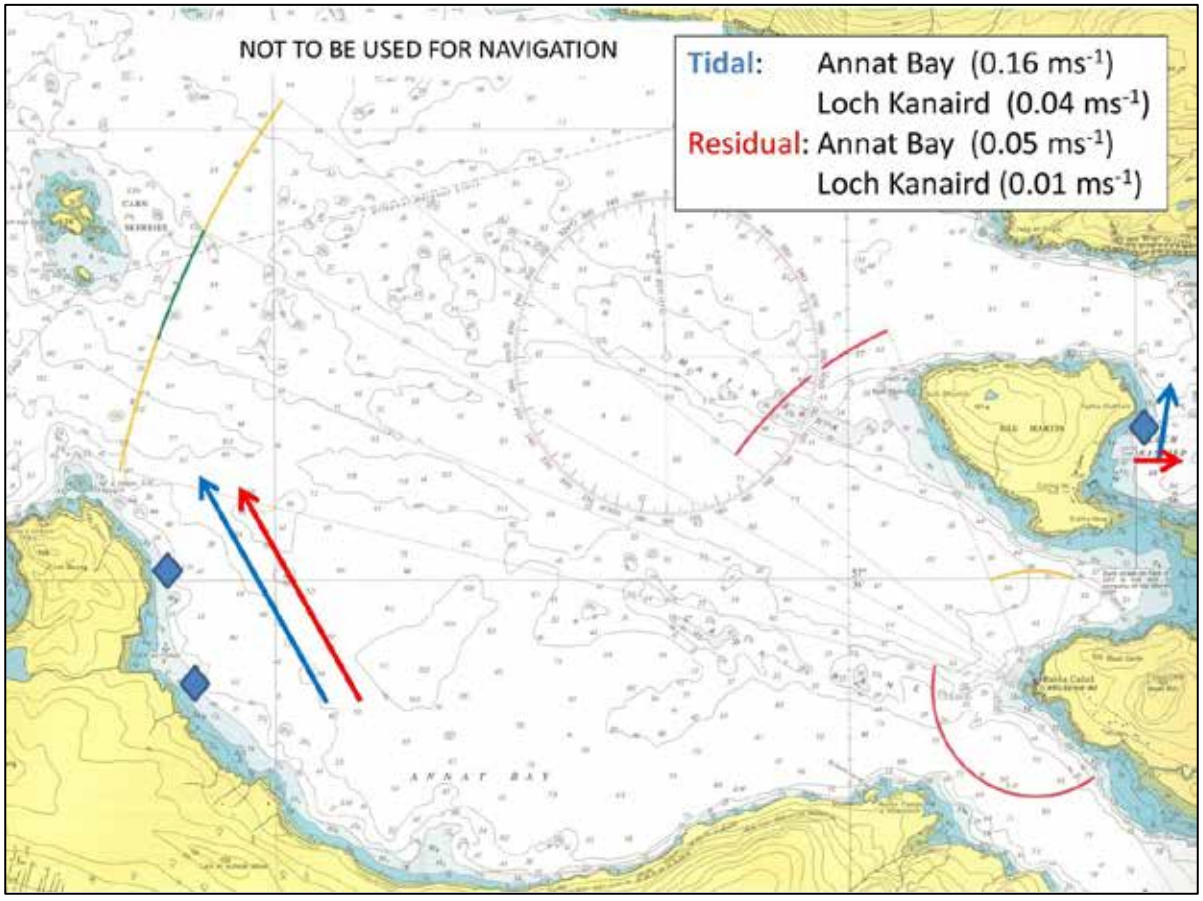


Figure 13.4 Map showing Outer Loch Broom sample sites.

Net cumulative displacement by tidal flow (ebb) and the estimated cumulative displacement through residual flow over a full tidal cycle in Annat Bay and Loch Kanaird are shown.

Data from Loch Kanaird, N57º 56.65' W005º 12.273' were collected between 23rd June and 8th July 2009 and are summarised in Table 13.1. In general, the currents were of a moderately low speed. Whilst the tabulated mean velocities are greatest in the sub-surface measurements, the report states that overall there was "similarity" between current velocity and direction throughout the water column (Anderson, 2009). The record of current speed showed a clear semi-diurnal periodicity but there was no clear spring-neap variation. Current meters were deployed in Loch Kanaird between 23rd March and 12th April 1999. No positional data is available for these data but we assume they are in a similar location to the 2009 deployment. Analysis shows the flows to be strongly non-tidal with <15% of the variability in the record explained by standard tidal constituents. As

such we have not attempted to report any tidal parameters for this deployment. We do provide summary statistics and information on residual flow in Table 13.2. The currents show very little vertical structure.

Table 13.1 Loch Kanaird current data measured in 2009

Height above seabed	Near-bed (3.1 m)	Mid (21.5 m)	Sub-surface (26.2 m)
Mean Speed (ms^{-1})	0.030	0.029	0.033
Maximum Speed (ms^{-1})	0.134	0.107	0.108
Principal Axis Amp & Dir (ms^{-1}) & (^oM)	0.036 (040º)	0.036 (195º)	0.043 (015º)
Residual speed (ms^{-1})	0.010	0.007	0.006
Residual direction (^oM)	096º	184º	057º

Table 13.2 Loch Kanaird current data measured in 2009

	Near-bed	Mid	Sub-surface
Mean Speed (ms^{-1})	0.07	0.06	0.07
Maximum Speed (ms^{-1})	0.238	0.217	0.290
Residual speed (ms^{-1})	0.018	0.019	0.013
Residual direction (^oM)	100º	112º	080º

Current speeds in Loch Kanaird were moderately low, with a maximum recorded near-bed velocity of 0.24 m/s. Current directions were only slightly asymmetric at all depths, with the major axes orientated SW-NE. Consistent with this, cumulative current vectors were weak and generally orientated towards the east. The surface residual flow of typically 0.01 m/s toward the east may indicate an anti-cyclonic gyre behind Isle Martin driven by freshwater flow from the river Kanaird. Alternatively it may be a response of the surface to west/southwest wind forcing, although no wind directions are reported with the data.

Data from Annat Bay (north), N57º 56.03' W005º 21.0', were collected between 14th September and 4th October 2001 and are summarised in Table 13.3. Mean and residual speeds decreased with depth. The semi-diurnal tides were the dominant tidal component and these showed little vertical variation with depth. Tidal currents were orientated in a ~NW/SE direction consistent with the direction of the coastline. Surface and mid-water residual currents flowed in a NNW direction; the near-bed residual currents flowed in the opposite direction.

Table 13.3 Annat Bay North current data measured in 2001

Height/Depth	Near-bed (2m above bottom)	Mid (14m below surface)	Sub-surface (2m below surface)
Mean Speed (ms^{-1})	0.04	0.06	0.1
Principal Axis Amp (ms^{-1}) & Dir	0.15 (280°)	0.16 (310°)	0.16 (340°)
Residual speed (ms^{-1})	0.008	0.02	0.10
Residual direction (^oM)	147	335	335

Data from Annat Bay (south), N57º 55.49' W005º 20.58', were collected between 11th and 29th September 2001 and are summarised in Table 13.4. Mean, tidal and residual currents decreased with depth. The semi-diurnal tides were the dominant tidal component. Tidal currents were orientated in a ~NW/SE direction, consistent with the direction of the coastline. The surface residual current flowed in a NNW direction, the mid-water & near-bed residual currents flowed in the opposite direction.

Table 13.4 Annat Bay South current data measured in 2001

Height/Depth	Near-bed (2m above bottom)	Mid (14.0 below surface)	Sub-surface (2.0 below surface)
Mean Speed (ms^{-1})	0.02	0.04	0.08
Principal Axis Amp (ms^{-1}) & Dir	0.06(300°)	0.10 (330°)	0.16 (340°)
Residual speed (ms^{-1})	0.005	0.018	0.04
Residual direction (^oM)	150	115	335

Assuming a uniform sinusoidal tide, the cumulative transport that might be expected during each phase of the tide (approximately 6 hours) has been estimated for each site as: Loch Kanaird; approximately 0.5 km (based on a principal current amplitude of 0.04 m/s); Annat Bay sites; approximately 2.1 km (based on a principal current amplitude of 0.16 m/s). No distinction is made here for springs and neaps.

Dispersion is an important property of a water body with respect to redistribution of contaminants over time. There are no measurements or published data relating to dispersion in Outer Loch Broom. Without such data it is difficult to judge what the dispersive environment might be like. However, flow round Isle Martin at the east of the assessment area, and around the islands at the entrance might enhance dispersion.

Dispersion of surface contaminants may be enhanced by wave energy within Outer Loch Broom. Sources of wave energy are from both short period waves that are created within the Loch itself and from The Minch.

13.2.4 River/Freshwater Inflow

There is one main river flowing directly into the study area. The River Canaird flows into Loch Kanaird on the eastern side of loch. There are numerous smaller rivers flowing from the Coigach Ridge to the north of the study area. These include Allt a Choire Reidh, Allt nan Coisiche and Garbh Allt. There are a number of small burns entering Annat Bay from the south. There are a number of rivers draining into Loch Broom which itself drains into the study area.

An additional contribution to the freshwater distribution in the surface layer will come from outflow from Loch Broom. The runoff into Loch Broom is 529.2 M m^3 / year (Edwards & Sharples, 1986) and annual precipitation in the Loch Broom area is approximately 1750 mm.

13.2.5 Meteorology

The nearest weather station for which a near complete rainfall data set was available is located at Aultbea No. 2, situated ~28 kms to the west. These records spanned the time frame from January 2007 – December 2012.

The year with the highest rainfall was 2011 and the least rain fell in 2010. Two years, 2007 and 2012 saw rather extreme rainfall events of nearly 50 mm/day occurring but generally high rainfall values (>30 mm/d) were rather uncommon. The highest daily rainfall values occurred throughout the autumn and winter seasons where rainfall increased from August onwards. Rainfall was lower in the months May to July. For the duration of the data set, daily rainfall of below 1 mm occurred 42% of the time and daily rainfall of above 10 mm occurred 11% of the time.

It can be surmised from these data that run-off due to rainfall is expected to be higher in the autumn and winter months but it must also be noted that high rainfall and consequently high run-off can occur in most months. This is important for the stratification and circulation in the restricted area of Loch Kanaird.

Wind data was collected from Stornoway Airport. The airport is ~75 km northwest of the study site. The predominant wind direction was from the SW. There was no marked change in wind direction throughout the months; however winds were much stronger in the winter months than in the summer months. It is highly likely that the wind direction will be strongly influenced in Outer Loch Broom by the morphology of the surrounding high ground, particularly in the inner, eastern part.

13.2.6 Model Assessment

Whilst there was some in situ data for this location, it was not appropriate to set up a box model run for the assessment area due to its coastal setting and a rather unconstrained nature.

As far as we are aware there has been no previously published modelling effort for this region.

Simple assessment of exchange using the tidal prism method has been done for Loch Broom giving an exchange time of 4 days (Edwards & Sharples, 1986; Marine Scotland, 2012). In general the tidal prism method tends to under-estimate the time for exchange due to mixing and recirculation processes not represented in the tidal prism method which tends to retain water behind the shallow sills. Nevertheless, one might expect Loch Kanaird to have an exchange time that is less than the adjacent Loch Broom.

13.3 Hydrographic Assessment

13.3.1 Surface Flow

The site maps indicate that the freshwater discharge into the surface waters is likely to be concentrated at the eastern end of Outer Loch Broom with some additional freshwater outflow in the surface waters of Loch Broom. It is anticipated that during periods of high run-off there will be rather strong stratification, certainly at the east of the study area. The meteorological data indicate a moderate seasonal variation in freshwater discharge.

Outer Loch Broom is relatively wide (~ 7km) such that there may be variations in the speed and direction of flows across the area. However, without more distributed data it is hard to assess this.

The current meter records are from quite distinct parts of the assessment area. From the current meter records in Annat Bay the tidal flow appears to be aligned with the shore. The tidal flow would be similar on the east side, flowing into Outer Loch Broom on the flood and out on the ebb, though there may also be some degree of cyclonic circulation with the flow adopting a counter-clockwise flow pattern. In Loch Kanaird, the measured flows are weaker and can show rather strong non-tidal features; probably due to friction effects in the shallower water. The weak tidal flow is has a broadly N/S orientation of the loch at that location.

The cumulative transport distance on each phase (flood/ebb) of the tide has been estimated for Annat Bay at around 2.1 km using a current amplitude of 0.16 ms^{-1} and net transport for Loch Kanaird of around 500 m using a current amplitude of 0.04 ms^{-1}. These transport vectors are presented in Figure 2.3.1.

From the current meter measurements in Outer Loch Broom it is likely that the transport path of any surface contaminant would primarily follow the shoreline. Once beyond the entrance there is likely to be effective transport and dispersal into The Minch, except in periods of onshore winds.

Surface flows would be enhanced/retarded by winds blowing out of/into the loch. Winds will also further enhance the mixing of the waters through the full depth.

Net transport of contaminants is related to the residual flow documented in Tables 13.1-4. The residual flow measured in the surface waters of the assessment area is highly variable and likely related to variation in the local wind and freshwater conditions. In general the residual flow is greater in Annat Bay than in Loch Kanaird. Using the range of

residual flow speeds at the surface (0.006 m/s to 0.1 m/s) we see that the net transport over a tidal cycle of approximately 12 hours would be between 250 m and 4 km, a 16-fold spread. The net transport in Annat Bay over a tidal cycle of approximately 12 hours using a surface residual of order 0.05 m/s would be around 2 km. In Loch Kanaird the net transport would be approximately 0.4 km with a surface residual of 0.01 m/s. The implication is that the cumulative transport over a tidal cycle can be highly variable throughout this system.

The dispersive characteristics of the site are unknown but there will be enhanced dispersion as the flow encounters islands along the path of the flow and in periods of strong wind.

13.3.2 Exchange Properties

A simple tidal prism modelling study (Marine Scotland, 2012) indicates a flushing time for the adjacent Loch Broom of around 4 days. Given the relatively big tidal range in the assessment area it is likely that the exchange of waters in the Outer Loch Broom is principally a tidally driven process. Hence there is likely to be rather little seasonal variation in the flushing time of the Loch. Closer to the eastern end of the loch, where there River Canaird discharges, we would expect there to be reduced flushing time for the surface waters due to run off.

Although Outer Loch Broom is comprised of a three distinct basins, one might describe the flushing characteristics in the surface waters as being ‘moderately flushed’, with the potential for additional enhancement from the fresh water discharge and from winds. The relatively deep water channel at the mouth means that subsurface exchange in much of the loch will probably have similar exchange characteristics as the surface water.

Although it would appear that Outer Loch Broom is a simple tidal system, and there is a patch distribution of current meter data available there is a paucity of any measured hydrographic data by which to check the assessment. The inner part around Loch Kanaird is a rather complex estuarine arrangement and may not respond in a simplified manner with uncertain flows around Isle Martin. Further, there is no published scientific literature for this location to aid the assessment. Therefore the confidence level of this assessment is LOW.

14. Shoreline Survey Overview

The shoreline survey at Loch Kanaird was conducted on the 5th November 2013. The prevailing weather was sunny, with cloud and rain in the afternoon and wind stated at N/NW F1-2. There was no information regarding rainfall during the 48 hour period prior to survey.

Pacific oyster cultivation was undertaken on the intertidal foreshore on the east shore of the loch. Oysters are grown in bags and baskets on trestles, which at present are located at the lower intertidal area and only fully accessible on spring tides. The RMP is situated further up the shoreline. Current stock was medium in size (approximately 45-65 mm in length) and the harvester (Mr Hayes) anticipated harvesting would commence in June 2014. He intends to sell his oysters to another local producer and in the future plans to market some of the stock locally. This would depend upon depuration facilities being placed on site or nearby.

Several isolated houses were observed set back from the shoreline to the north of the oyster farm. Ardmair Point Holiday Centre (camping/caravan park) and chalets are also located at Ardmair Point, though it was closed for winter. A laundrette and a chemical toilet disposal facility were associated with the park. Immediately below the park were a number of discharge pipes along the shore, with an associated smell of sewage. A seawater sample taken close to these discharges returned a result of 77 *E. coli* cfu/100 ml. A seawater sample was also taken from the northern side of Ardmair Point, adjacent to the slipway and pier close to a group of chalets and it returned a result of 19 *E. coli* cfu/100 ml. A suspected discharge pipe was observed on shore below Keanchulish House but was not sampled as it was only seen at low tide after the completion of the survey.

Infrastructure related to boating activity was seen in Ardmair, where there were 10 boats on offshore moorings and at Ardmair Point, with two production rafts moored at two of the four offshore moorings. An unoccupied mooring buoy was also observed south of the oyster trestles and three boats seen on the shoreline along south of the fishery.

Very few livestock were seen. Three sheep were observed on the shoreline immediately above the oyster trestles and sheep droppings were seen around Keanchulish House and on the shoreline southwest of North Keanchulish. Farm machinery was seen at Keanchulish House. Crofts were present above the shore at Ardmair. The majority of the surrounding land was noted to be rural, with areas of grass around Keanchulish and Ardmair Point.

A water sample taken from the River Canaird returned a result of 60 *E. coli* cfu/100 ml. Smaller streams were also present at regular intervals along the eastern shoreline, with *E. coli* levels varying between <10 and 460 *E. coli* cfu/100 ml.

Birds and seals were observed around the survey area.

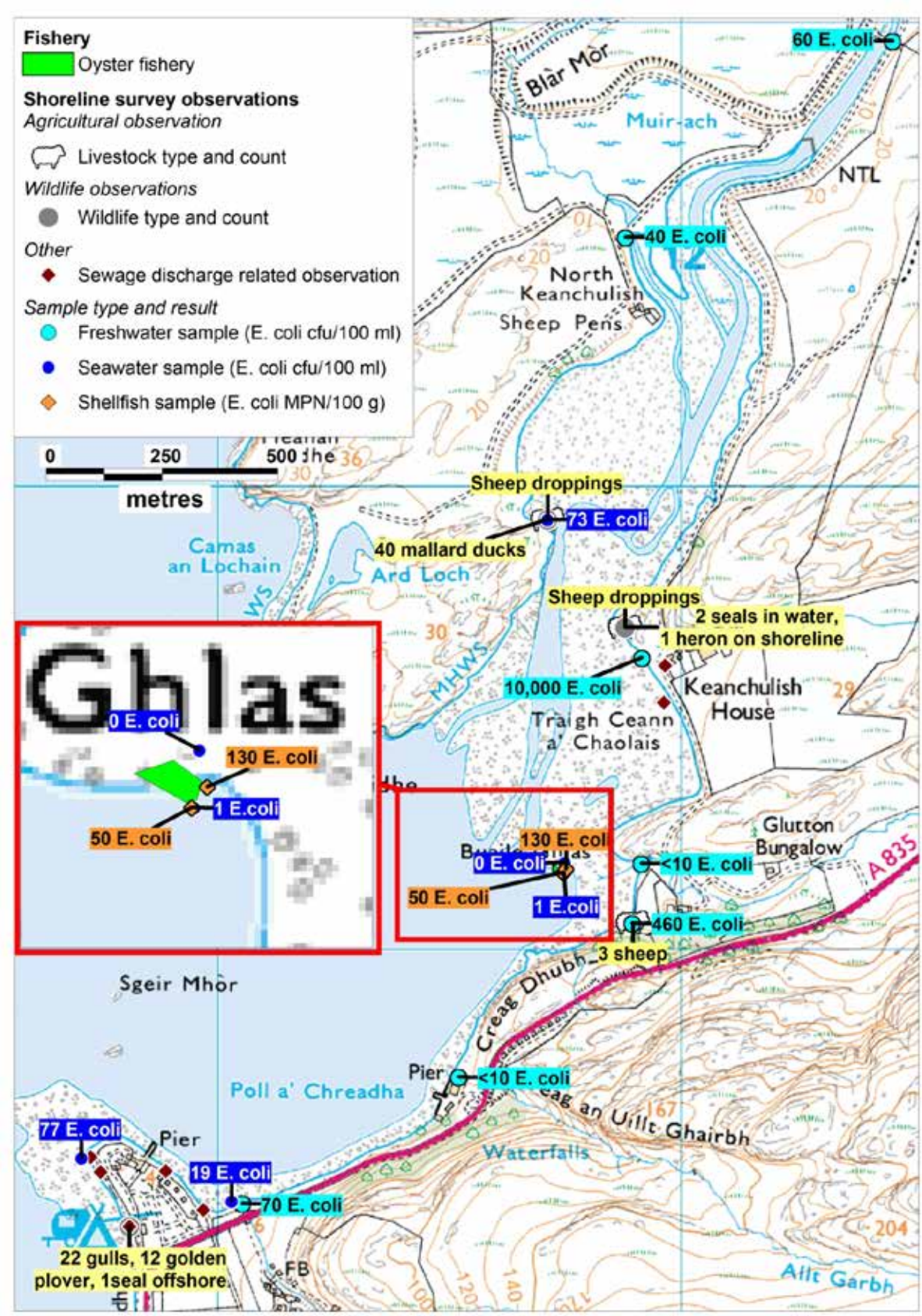


Figure 14.1 Map of shoreline survey observations at Loch Kanaird

15. Bacteriological Survey

As the area has had 9 recent samples, and covers a very small geographic area, no bacteriological survey was conducted.

16. Overall Assessment

Human sewage impacts

Although the largest potential sources of human sewage are from the public WWTW at Ullapool, these lie over 7 km away from the oyster farm. In light of the relatively short predicted transport distances, it is considered unlikely that the Ullapool discharges will have a significant impact on water quality at the oyster farm in Loch Kanaird.

The nearest community septic tank is the small tank located at Ardmair, approximately 2km south of the oyster farm. As the septic tank outfall is approximately 2 km from the oyster farm, it is considered unlikely to significantly impact the fishery due to the relatively low predicted transport distances.

Of greater significance are the private septic tank discharges located north of Ardmair Point and along watercourses discharging to the fishery. A seawater sample taken from the west side of Ardmair Point, near a series of observed outfall pipes, returned a result of 77 *E. coli* cfu/100 ml, indicating significant faecal contamination at this location.

The closest septic outfall to the fishery is that from Keanchulish House which discharges approximately 250 m north of the oyster farm. This discharges to sea and would be expected to contribute at least to background contamination levels at the oyster trestles.

SEPA identified 13 consents for discharges along the River Canaird, all but one of which were reported to discharge to soakaway and one to a tributary of the river. Although most of the identified private septic tanks are consented to discharge to soakaway, any of these that are malfunctioning or diverted to watercourses will be more likely to have an impact on water quality in the area.

Agricultural impacts

There is likely to be significant agricultural diffuse pollution, mainly from sheep and any wastes applied to arable fields used for growing silage. Sheep and sheep droppings were observed on the shoreline adjacent to the fishery, and it is likely that agricultural activity arising around Keanchulish as well as along the Allt Glutton will have the most immediate impact at the oyster farm. Impact from agricultural sources is also likely to be carried via the River Canaird, where there are areas of improved grazing and/or silage upriver. Diffuse contamination arising at Ardmair is considered to be less significant, as most of these sources lie outwith the predicted tidal excursion for the area. These sources could potentially reach the fishery, however, under certain conditions and may contribute to background contamination levels in the loch. Any contamination arising from crofts at Rhue are even further from the fishery and are not expected to have a significant impact on water quality there.

Wildlife impacts

Very little information was found on wildlife populations present in the area. There is a significant amount of intertidal area around the mouth of the River Canaird, which is likely

to attract some wading birds. There is local anecdotal evidence of other birds, otters, deer and seals, however only birds were seen during the shoreline survey. There are seabird breeding colonies on Isle Martin, and these animals are likely to contribute to background contamination levels in the loch, particularly during the summer nesting season when they are present in larger concentrations nearby. There are likely to be seasonally variable populations of other birds in the area, though there was insufficient information on which to base an assessment of these. It is expected that wildlife will contribute to faecal contaminant loadings found in watercourses in the area.

Seasonal variation

Seasonal variation in human population, and thence sewage impacts, is expected due to the relatively large amount of seasonal accommodation near the fishery. The campsite at Ardmair Point is seasonal, though the cottages are available for hire year round. Yachting use of the local anchorages is also expected to be seasonal, with highest use in summer. The resident population density is very low and therefore seasonal increases in population are likely to be proportionally significant. However, even with the identified visitor accommodation in full use, the overall population in the area will be relatively quite small.

Seasonal variation in livestock numbers and agricultural practices is also anticipated, as sheep production usually means higher numbers of animals in summer, when lambs are present.

Seasonal variation in rainfall is expected, with overall drier conditions occurring in early summer. Episodes of very high rainfall, however, were found to occur in most months of the year and therefore rainfall-associated runoff may occur whenever high rainfall events occur. Higher daily rainfall is generally expected in autumn and winter.

Although there was insufficient monitoring history on which to assess any observed seasonal variation in shellfish *E. coli* results, the anticipated seasonal variation in sources suggests that seasonal variation in results is also likely.

Rivers and streams

The oyster farm lies at the mouth of the River Canaird, which is largest source of freshwater to Loch Kanaird. At the time of shoreline survey, it carried an estimated loading of 7.4×10^{11} *E.coli*/day. This river receives diffuse faecal contamination from agricultural, human and wildlife sources. In addition to the main flow of the river, three smaller tributaries were found discharging to the lower river above the location of the oyster farm. The most significant of these in terms of contamination was the unnamed watercourse north of Keanchulish House, which carried an estimated spot loading of 9.1×10^{10} *E.coli*/day. The water sample taken from this watercourse returned a result of 10000 *E. coli* cfu/100 ml, which was consistent with significant faecal contamination. The source of this contamination was not clear.

Although the Allt Glutton discharges to shore approximately 130 m southeast of the oyster farm, the water sample taken during the shoreline survey returned a result below the limit of detection and therefore this was not a significant source of contamination at the time. Two further watercourses south of the fishery carried only low to moderate loadings and therefore whilst they may contribute to the overall contamination levels within the loch they are much less significant sources than the River Canaird.

Movement of contaminants

The oyster farm at Loch Kanaird is situated between the mouth of the River Canaird and Isle Martin, where predicting flows is complicated by the high freshwater influx over the site and the constrictions of Ardmair Point and Isle Martin. Some evidence was found of an anti-cyclonic flow in this area, with a net transport eastwards. The estimated surface transport distance at Loch Kanaird was approximately 500 m, based on tidal flow alone. There was some evidence to suggest that wind-driven flow could alter this substantially.

Faecal contaminants arising in freshwater flows to the north of the fishery are likely to be the most significant sources of contamination to the oyster farm, with smaller relative contributions coming from sources within 500 m of the trestles.

Temporal and geographical patterns of sampling results

There was insufficient monitoring history on which to base an assessment of temporal and geographic trends in sampling results. However, the shoreline survey sampling was undertaken on the same date as the classification sampling, and therefore three results from different locations on the same date were available for consideration. Results from the two samples taken on the oyster farm returned slightly higher *E. coli* results than that obtained from the RMP. This may have been due to their location lower down the shoreline, and closer to the main flow of the river and where they would be filtering for a longer proportion of the tidal cycle. However it may also have been due to natural variation and therefore results should be interpreted with caution. Oysters placed at the RMP trestle are higher on the shoreline and will have had less time to filter feed per tidal cycle than those on the oyster farm. Therefore this location may not be representative of conditions on the oyster farm itself.

Conclusions

The main sources of contamination to the fishery are:

- Diffuse livestock, human and wildlife source faecal contamination carried via the River Canaird.
- Discharges from private septic tanks along the shoreline northeast, east, and south of the oyster farm.
- Faecal contamination of the watercourse north of Keanchulish House.

Any overboard discharges from yachts anchored north of Ardmair.

The main transport mechanism is likely to be freshwater flow from the river, which would flow north to south across the mussel farm and carry with it other sources arising north of the fishery. An anti-cyclonic flow within Loch Kanaird could potentially carry contamination from boats anchored at Isle Martin eastward toward the fishery, however it is not clear how strong and under what conditions such a flow would operate.

17. Recommendations

Production area

It is recommended that the provisional production area boundary (the area bounded by lines drawn from NH 1170 9900 to NH 1170 9940 to NH 1203 9940 and extending to MHWS) be retained. This encompasses the active fishery and excludes sources further up the River Canaird and at Ardmair.

RMP

Ideally, the RMP should be located on the oyster farm in order to represent likely contamination levels in stock harvested from the site. It is understood that this may pose challenges in terms of access, particularly during summer when there is more frequent sampling for biotoxins. It is recommended that the RMP for this site be moved onto the main trestle area, to NH 1174 9918.

Depth of sampling

As this is an intertidal fishery, sampling depth is not applicable.

Tolerance

Due to the small size of the site, sampling tolerance of 20 m is recommended.

Frequency

As seasonal variation is anticipated, monthly sampling is recommended.

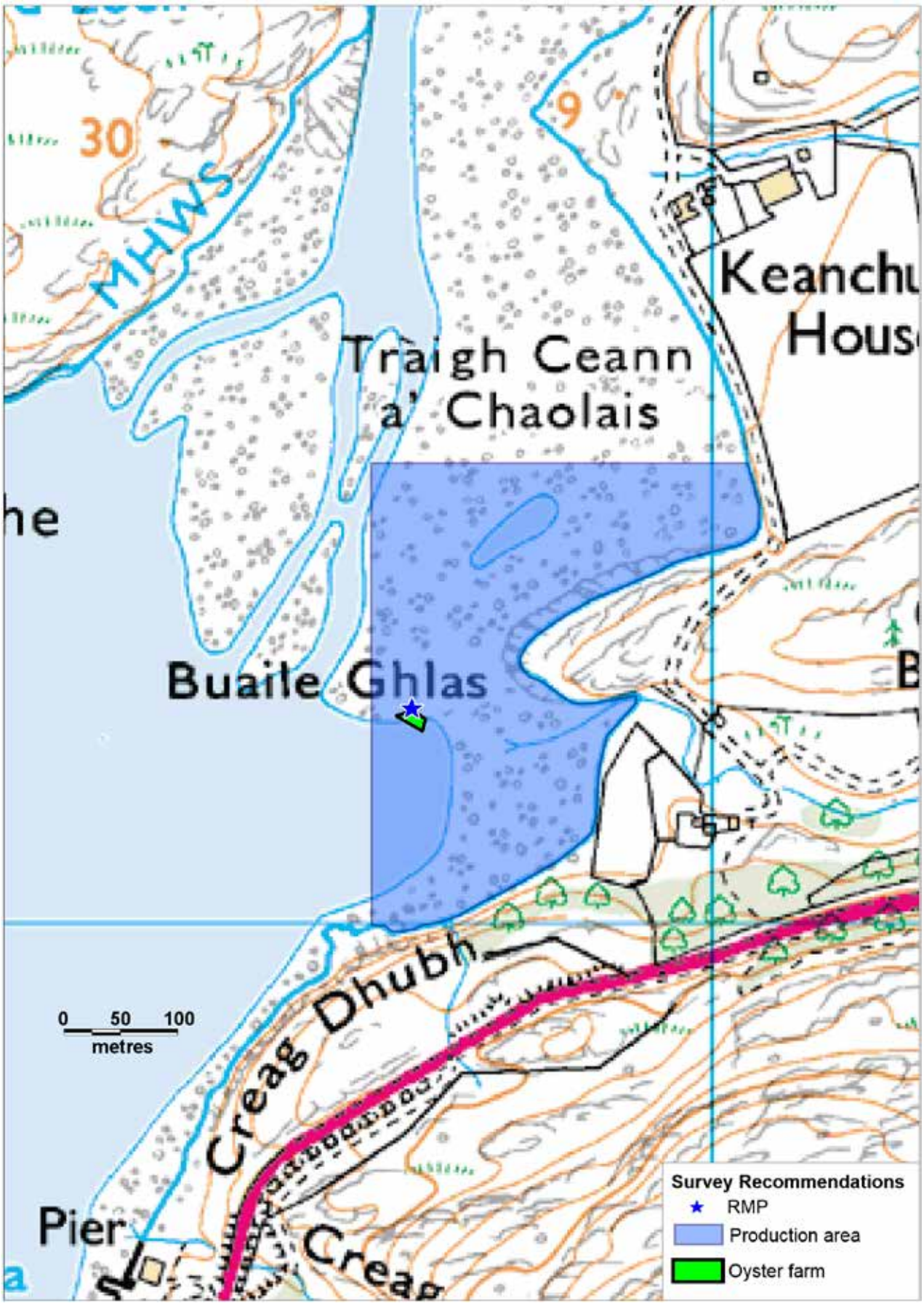


Figure 17.1 Map of recommendations at Loch Kanaird

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2. **Tables of Typical Faecal Bacteria Concentrations**
3. **Hydrographic Section Glossary**
4. **Shoreline Survey Report**
5. **SEPA Discharge Consents**

1. General Information on Wildlife Impacts

Pinnipeds

Two species of pinniped (seals, sea lions, walruses) are commonly found around the coasts of Scotland: These are the European harbour, or common, seal (*Phoca vitulina vitulina*) and the grey seal (*Halichoerus grypus*). Both species can be found along the west coast of Scotland.

Common seal surveys are conducted every 5 years and an estimate of minimum numbers is available through Scottish Natural Heritage.

According to the Scottish Executive, in 2001 there were approximately 119,000 grey seals in Scottish waters, the majority of which were found in breeding colonies in Orkney and the Outer Hebrides.

Adult Grey seals weigh 150-220 kg and adult common seals 50-170 kg. They are estimated to consume between 4 and 8% of their body weight per day in fish, squid, molluscs and crustaceans. No estimates of the volume of seal faeces passed per day were available, though it is reasonable to assume that what is ingested and not assimilated in the gut must also pass. Assuming 6% of a median body weight for harbour seals of 110kg, that would equate to 6.6kg consumed per day and probably very nearly that defecated.

The concentration of *E. coli* and other faecal indicator bacteria contained in seal faeces has been reported as being similar to that found in raw sewage, with counts showing up to 1.21×10^4 CFU (colony forming units) *E. coli* per gram dry weight of faeces (Lisle *et al* 2004).

Both bacterial and viral pathogens affecting humans and livestock have been found in wild and captive seals. *Salmonella* and *Campylobacter* spp., some of which were antibiotic-resistant, were isolated from juvenile Northern elephant seals (*Mirounga angustirostris*) with *Salmonella* found in 36.9% of animals stranded on the California coast (Stoddard, et al., 2005) *Salmonella* and *Campylobacter* are both enteric pathogens that can cause acute illness in humans and it is postulated that the elephant seals were picking up resistant bacteria from exposure to human sewage waste.

One of the *Salmonella* species isolated from the elephant seals, *Salmonella typhimurium*, is carried by a number of animal species and has been isolated from cattle, pigs, sheep, poultry, ducks, geese and game birds in England and Wales. Serovar DT104, also associated with a wide variety of animal species, can cause severe disease in humans and is multi-drug resistant (Poppe, et al., 1998)

Cetaceans

As mammals, whales and dolphins would be expected to have resident populations of *E. coli* and other faecal indicator bacteria in the gut. Little is known about the concentration of indicator bacteria in whale or dolphin faeces, in large part because the animals are widely dispersed and sample collection difficult.

A variety of cetacean species are routinely observed around the west coast of Scotland. Where possible, information regarding recent sightings or surveys is gathered for the production area. As whales and dolphins are broadly free ranging, this is not usually possible to such fine detail. Most survey data is supplied by the Hebridean Whale and Dolphin Trust or the Shetland Sea Mammal Group and applies to very broad areas of the coastal seas.

It is reasonable to expect that whales would not routinely affect shellfisheries located in shallow coastal areas. It is more likely that dolphins and harbour porpoises would be found in or near fisheries due to their smaller physical size and the larger numbers of sightings near the coast.

Birds

Seabird populations were surveyed all over Britain as part of the SeaBird 2000 census. These counts are investigated using GIS to give the numbers observed within a 5 km radius of the production area. This gives a rough idea of how many birds may be present either on nests or feeding near the shellfish farm or bed.

Further information is gathered where available related to shorebird surveys at local bird reserves when present. Surveys of overwintering geese are queried to see whether significant populations may be resident in the area for part of the year. In many areas, at least some geese may be present year round. The most common species of goose observed during shoreline surveys has been the Greylag goose. Geese can be found grazing on grassy areas adjacent to the shoreline during the day and leave substantial faecal deposits. Geese and ducks can deposit large amounts of faeces in the water, on docks and on the shoreline.

A study conducted on both gulls and geese in the northeast United States found that Canada geese (*Branta canadiensis*) contributed approximately 1.28×10^5 faecal coliforms (FC) per faecal deposit and ring-billed gulls (*Larus delawarensis*) approximately 1.77×10^8 FC per faecal deposit to a local reservoir (Alderisio & DeLuca, 1999). An earlier study found that geese averaged from 5.23 to 18.79 defecations per hour while feeding, though it did not specify how many hours per day they typically (Gauthier & Bedard, 1986)

Waterfowl can be a significant source of pathogens as well as indicator organisms. Gulls frequently feed in human waste bins and it is likely that they carry some human pathogens.

Deer

Deer are present throughout much of Scotland in significant numbers. The Deer Commission of Scotland (DCS) conducts counts and undertakes culls of deer in areas that have large deer populations.

Four species of deer are routinely recorded in Scotland, with Red deer (*Cervus elaphus*) being the most numerous, followed by Roe deer (*Capreolus capreolus*), Sika deer (*Cervus nippon*) and Fallow deer (*Dama dama*).

Accurate counts of populations are not available, though estimates of the total populations are >200,000 Roe deer, >350,000 Red deer, < 8,000 Fallow deer and an unknown number of Sika deer. Where Sika deer and Red deer populations overlap, the two species interbreed further complicating counts.

Deer will be present particularly in wooded areas where the habitat is best suited for them. Deer, like cattle and other ruminants, shed *E. coli*, *Salmonella* and other potentially pathogenic bacteria via their faeces.

Other

The European Otter (*Lutra lutra*) is present around Scotland with some areas hosting populations of international significance. Coastal otters tend to be more active during the day, feeding on bottom-dwelling fish and crustaceans among the seaweed found on rocky inshore areas. An otter will occupy a home range extending along 4-5km of coastline, though these ranges may sometimes overlap (Scottish National Heritage, n.d.). Otters primarily forage within the 10 m depth contour and feed on a variety of fish, crustaceans and shellfish (Paul Harvey, Shetland Sea Mammal Group, personal communication).

Otters leave faeces (also known as spraint) along the shoreline or along streams, which may be washed into the water during periods of rain.

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2. Tables of Typical Faecal Bacteria Concentrations

Summary of faecal coliform concentrations (cfu $100ml^{-1}$) for different treatment levels and individual types of sewage-related effluents under different flow conditions: geometric means (GMs), 95% confidence intervals (CIs), and results of t-tests

Indicator organism	**Base-flow conditions**				**High-flow conditions**			
Treatment levels and specific types: Faecal coliforms	n^c	Geometric mean	Lower 95% CI	Upper 95% CI	n^c	Geometric mean	Lower 95% CI	Upper 95% CI
Untreated	252	1.7×10^{7} * (+)	1.4×10^{7}	2.0×10^{7}	282	2.8×10^{6} * (-)	2.3×10^{6}	3.2×10^{6}
Crude sewage discharges	252	1.7×10^{7} * (+)	1.4×10^{7}	2.0×10^{7}	79	3.5×10^{6} * (-)	2.6×10^{6}	4.7×10^{6}
Storm sewage overflows					203	2.5×10^{6}	2.0×10^{6}	2.9×10^{6}
Primary	127	1.0×10^{7} * (+)	8.4×10^{6}	1.3×10^{7}	14	4.6×10^{6} (-)	2.1×10^{6}	1.0×10^{7}
Primary settled sewage	60	1.8×10^{7}	1.4×10^{7}	2.1×10^{7}	8	5.7×10^{6}		
Stored settled sewage	25	5.6×10^{6}	3.2×10^{6}	9.7×10^{6}	1	8.0×10^{5}		
Settled septic tank	42	7.2×10^{6}	4.4×10^{6}	1.1×10^{7}	5	4.8×10^{6}		
Secondary	864	3.3×10^{5} * (-)	2.9×10^{5}	3.7×10^{5}	184	5.0×10^{5} * (+)	3.7×10^{5}	6.8×10^{5}
Trickling filter	477	4.3×10^{5}	3.6×10^{5}	5.0×10^{5}	76	5.5×10^{5}	3.8×10^{5}	8.0×10^{5}
Activated sludge	261	2.8×10^{5} * (-)	2.2×10^{5}	3.5×10^{5}	93	5.1×10^{5} * (+)	3.1×10^{5}	8.5×10^{5}
Oxidation ditch	35	2.0×10^{5}	1.1×10^{5}	3.7×10^{5}	5	5.6×10^{5}		
Trickling/sand filter	11	2.1×10^{5}	9.0×10^{4}	6.0×10^{5}	8	1.3×10^{5}		
Rotating biological contactor	80	1.6×10^{5}	1.1×10^{5}	2.3×10^{5}	2	6.7×10^{5}		
Tertiary	179	1.3×10^{3}	7.5×10^{2}	2.2×10^{3}	8	9.1×10^{2}		
Reed bed/grass plot	71	1.3×10^{4}	5.4×10^{3}	3.4×10^{4}	2	1.5×10^{4}		
Ultraviolet disinfection	108	2.8×10^{2}	1.7×10^{2}	4.4×10^{2}	6	3.6×10^{2}		

comparing base- and high-flow GMs for each group and type.

Source: (Kay, et al., 2008b)

Table 3 – Geometric mean (GM) and 95% confidence intervals (CIs) of the GM faecal indicator organism (FIO) concentrations (cfu/100ml) under base- and high-flow conditions at the 205 sampling points and for various subsets, and results of paired t-tests to establish whether there are significant elevations at high flow compared with base flow

FIO	*n*	**Base Flow**			**High Flow**		
Subcatchment land use		Geometric mean	Lower 95% CI	Upper 95% CI	Geometric mean[a]	Lower 95% CI	Upper 95% CI
Total coliforms							
All subcatchments	205	5.8×10^{3}	4.5×10^{3}	7.4×10^{3}	7.3×10^{4}**	5.9×10^{4}	9.1×10^{4}
Degree of urbanisation							
Urban	20	3.0×10^{4}	1.4×10^{4}	6.4×10^{4}	3.2×10^{5}**	1.7×10^{5}	5.9×10^{5}
Semi-urban	60	1.6×10^{4}	1.1×10^{4}	2.2×10^{4}	1.4×10^{5}**	1.0×10^{5}	2.0×10^{5}
Rural	125	2.8×10^{3}	2.1×10^{3}	3.7×10^{3}	4.2×10^{4}**	3.2×10^{4}	5.4×10^{4}
Rural subcatchments with different dominant land uses							
≥75% Imp pasture	15	6.6×10^{3}	3.7×10^{3}	1.2×10^{4}	1.3×10^{5}**	1.0×10^{5}	1.7×10^{5}
≥75% Rough Grazing	13	1.0×10^{3}	4.8×10^{2}	2.1×10^{3}	1.8×10^{4}**	1.1×10^{4}	3.1×10^{4}
≥75% Woodland	6	5.8×10^{2}	2.2×10^{2}	1.5×10^{3}	6.3×10^{3}*	4.0×10^{3}	9.9×10^{3}
Faecal coliform							
All subcatchments	205	1.8×10^{3}	1.4×10^{3}	2.3×10^{3}	2.8×10^{4}**	2.2×10^{4}	3.4×10^{4}
Degree of urbanisation							
Urban	20	9.7×10^{3}	4.6×10^{3}	2.0×10^{4}	1.0×10^{5}**	5.3×10^{4}	2.0×10^{5}
Semi-urban	60	4.4×10^{3}	3.2×10^{3}	6.1×10^{3}	4.5×10^{4}**	3.2×10^{4}	6.3×10^{4}
Rural	125	8.7×10^{2}	6.3×10^{2}	1.2×10^{3}	1.8×10^{4}**	1.3×10^{4}	2.3×10^{4}
Rural subcatchments with different dominant land uses							
≥75% Imp pasture	15	1.9×10^{3}	1.1×10^{3}	3.2×10^{3}	5.7×10^{4}**	4.1×10^{4}	7.9×10^{4}
≥75% Rough Grazing	13	3.6×10^{2}	1.6×10^{2}	7.8×10^{2}	8.6×10^{3}**	5.0×10^{3}	1.5×10^{4}
≥75% Woodland	6	3.7×10	1.2×10	1.2×10^{2}	1.5×10^{3}**	6.3×10^{2}	3.4×10^{3}
Enterococci							
All subcatchments	205	2.7×10^{2}	2.2×10^{2}	3.3×10^{2}	5.5×10^{3}**	4.4×10^{3}	6.8×10^{3}
Degree of urbanisation							
Urban	20	1.4×10^{3}	9.1×10^{2}	2.1×10^{3}	2.1×10^{4}**	1.3×10^{4}	3.3×10^{4}
Semi-urban	60	5.5×10^{2}	4.1×10^{2}	7.3×10^{2}	1.0×10^{4}**	7.6×10^{3}	1.4×10^{4}
Rural	125	1.5×10^{2}	1.1×10^{2}	1.9×10^{2}	3.3×10^{3}**	2.4×10^{3}	4.3×10^{3}
Rural subcatchments with different dominant land uses							
≥75% Imp. pasture	15	2.2×10^{2}	1.4×10^{2}	3.5×10^{2}	1.0×10^{4}**	7.9×10^{3}	1.4×10^{4}
≥75% Rough Grazing	13	4.7×10	1.7×10	1.3×10^{2}	1.2×10^{3}**	5.8×10^{2}	2.7×10^{3}
≥75% Woodland	6	1.6×10	7.4	3.5×10	1.7×10^{2}**	5.5×10	5.2×10^{2}
[a] Significant elevations in concentrations at high flow are indicated: **po0.001, *po0.05.							
[b] Degree of urbanisation categorised according to percentage built-up land: 'Urban' (X10.0%), 'Semi-urban' (2.5–9.9%) and 'Rural' (o2.5%).							

Source: (Kay, et al., 2008a)

Table 4 - Comparison of faecal indicator concentrations (average numbers/g wet weight) excreted in the faeces of warm-blooded animals

Animal	Faecal coliforms (FC) number	Excretion (g/day)	FC Load (numbers/day)
Chicken	1,300,000	182	2.3×10^8
Cow	230,000	23,600	5.4×10^9
Duck	33,000,000	336	1.1×10^{10}
Horse	12,600	20,000	2.5×10^8
Pig	3,300,000	2,700	8.9×10^8
Sheep	16,000,000	1,130	1.8×10^{10}
Turkey	290,000	448	1.3×10^8
Human	13,000,000	150	1.9×10^9

Source: (Gauthier & Bedard, 1986)

References

Gauthier, G. & Bedard, J., 1986. Assessment of faecal output in geese. *Journal of Applied Ecology,* 23(1), pp. 77-90.

Kay, D. et al., 2008a. Faecal indicator organism concentrations and catchment export coefficients in the UK. *Water Research,* 42(10/11), pp. 2649-2661.

Kay, D. et al., 2008b. Faecal indicator organism in concentration sewage and treated effluents. *Water Research,* 42(1/2), pp. 442-454.

3. Hydrographic Assessment Glossary

The following technical terms may appear in the hydrographic assessment.

Bathymetry. The underwater topography given as depths relative to some fixed reference level e.g. mean sea level.

Hydrography. Study of the movement of water in navigable waters e.g. along coasts, rivers, lochs, estuaries.

MHW. Mean High Water, The highest level that tides reach on average.

MHWN. Mean High Water Neap, The highest level that tides reach on average during neap tides.

MHWS. Mean High Water Spring, The highest level that tides reach on average during spring tides

MLW. Mean Low Water, The lowest level that tides reach on average.

MLWN. Mean Low Water Neap, The lowest level that tides reach on average during neap tides.

MLWS. Mean Low Water Spring, The lowest level that tides reach on average during spring tides.

Tidal period. The dominant tide around the UK is the twice daily one generated by the moon. It has a period of 12.42 hours. For near shore so-called rectilinear tidal currents then roughly speaking water will flow one way for 6.2 hours then back the other way for 6.2 hours.

Tidal range. The difference in height between low and high water. Will change over a month.

Tidal excursion. The distance travelled by a particle over one half of a tidal cycle (roughly~6.2 hours). Over the other half of the tidal cycle the particle will move in the opposite direction leading to a small net movement related to the tidal residual. The excursion will be largest at Spring tides.

Tidal residual. For the purposes of these documents it is taken to be the tidal current averaged over a complete tidal cycle. Very roughly it gives an idea of the general speed and direction of travel due to tides for a particle over a period of several days.

Tidal prism. The volume of water brought into an estuary or sea loch during half a tidal cycle. Equal to the difference in estuary/sea loch volume at high and low water.

Spring/Neap Tides. Spring tides occur during or just after new moon and full moon when the tide-generating force of the sun acts in the same direction as that of the moon, reinforcing it. The tidal range is greatest and tidal currents strongest during spring tides.

Neap tides occur during the first or last quarter of the moon when the tide-generating forces of the sun and moon oppose each other. The tidal range is smallest and tidal currents are weakest during neap tides.

Tidal diamonds. The tidal velocities measured and printed on admiralty charts at specific locations are called tidal diamonds.

Wind driven shear/surface layer. The top metre or so of the surface that generally moves in the rough direction of the wind typically at a speed that is a few percent (~3%) of the wind speed.

Return flow. A surface flow at the surface may be accompanied by a compensating flow in the opposite direction at the bed.

Stratification. The splitting of the water into two layers of different density with the less dense layer on top of the denser one. Due to either temperature or salinity differences or a combination of both.

4. Shoreline Survey Report

Report Title	Loch Kanaird Shoreline Survey Report
Project Name	Shellfish Sanitary Surveys
Client/Customer	Cefas
SRSL Project Reference	00561_B0067

Document Number	B0067_Shoreline 0024

Revision History

Revision	Changes	Date
A	Issue for internal review	11/11/2013
B	Issue incorporating comments from Draft A	13/11/2013
01	First formal issue to Cefas	22/11/2013
02	Second issue to Cefas incorporating comments in issue 01	11/12/2013

	Name & Position	Date
Author	Lars Brunner and Debra Brennan	08/11/2013
Checked	Andrea Veszelovszki	10/12/2013
Approved	Andrea Veszelovszki	11/12/2013

SRSL, Scottish Marine Institute, Oban, Argyll, PA37 1QA, tel 01631 559 470, www.samsrsl.co.uk

Shoreline Survey Report

Production area:	Loch Kanaird
Site name:	Ardmair
SIN:	RC-625-1233-13
Species:	Pacific oyster (*Crassostrea gigas*)
Harvester:	Mr Joe Hayes
Local Authority:	Highland Council – Ross & Cromarty
Status:	New application
Date Surveyed:	5th November 2013
Surveyed by:	Debra Brennan & Lars Brunner
Existing RMP:	NH 1179 9918
Area Surveyed:	**1**. Ardmair peninsula to Isle Martin fish farm base at NH 1177 9900 **2**. Bay east of Creag Dhubh to immediately north of Keanchulish House **3**. From the bridge at NC 1245 0095 to North Keanchulish Farm

Weather

5th November: Wind N/NW F1-2. 45% cloud cover, sea state calm. Weather sunny, changing later to cloudy with rain.

Stakeholder engagement during the survey

Contact was made with both the harvester and the local authority sampling officer prior to the survey, and both were very helpful with information about the history of the site, and practicalities of access.

On the day of survey, we met the harvester, Mr Joe Hayes, as well as the sampling officer, Mr Hamish Spence, at the production site.

Fishery

The fishery in Loch Kanaird consists of cultivation of Pacific oyster (*Crassostrea gigas*) in bags & baskets located on trestles in an intertidal area on the eastern shore of the loch. Work on the site commenced in August 2012, with full planning permission granted in April 2013. Regular monitoring of the site commenced when the planning permission was granted. There has been no previous cultivation of oysters in the loch.

The current stock on site has been there since the site's inception, and is of medium size (~45-65mm). The trestles present are situated quite far down the tidal range of the area, and are only easily accessible on a spring tide. The

site of the RMP is approximately 50m further up the shore from the main area of trestles, and is located there to provide easier access for the local authority sampling officer. Both Mr Hayes and Mr Spence expressed a concern that the current siting of the RMP is less than ideal, and may be providing erroneous readings due to the higher level of freshwater run-off further up the shoreline.

Mr Hayes has not harvested any oysters to date but anticipated he would commence harvesting in June 2014. He will be selling his oysters to another producer, although he hopes in the future to market some of the stock locally, however this would depend on the presence of depuration facilities. At present there are no depuration facilities on site or locally.

Sewage Sources

The survey area is rural in nature, with a small collection of houses at Ardmair, and isolated single houses through the rest of the survey area. There are no public facilities such as cafes or public toilets in the area, although Ardmair Point camping and caravan park (see also below) has chemical toilet disposal facilities. Immediately on the shore below the park, discharge pipes were noted. In addition, what appeared to be a discharge pipe was noted on the shore below Keanchulish House, but it was only observable at the lowest state of the tide, a photograph was taken of the pipe (Fig 14).

Seasonal Population

A caravan and camping site is present in Ardmair (Ardmair Point Holiday Centre), although signage was present indicating that the site was closed for the winter. We noted no B&Bs in the survey area, although chalets were available for hire in Ardmair.

Boats/Shipping

A pier and slipway are present in Ardmair, and ten boats were noted on moorings offshore (2 yachts, 1 small fishing vessel and 7 small pleasure craft). In addition a slipway and small pier were present at the fish farm base at NH 1151 9872, and there were also four moorings offshore with two occupied by production rafts. One mooring buoy was observed off the site of the production area, which was unoccupied. On the shore immediately above the south end of the production area there were three boats stored, a small fishing vessel, and two yachts.

No boats were observed transiting, or working on the loch on the day of survey.

Farming and Livestock

The only livestock directly observed were three sheep on the shoreline immediately above the production area. Evidence of sheep presence (in the form of fresh droppings) was noted around Keanchulish House and on the shoreline to the SW of North Keanchulish. Farm machinery was also present at Keanchulish House, and a cattle grid was noted next to Glutton Bungalow. Crofting fields were present above the shore at Ardmair, but no livestock was observed.

Land Use

The Ardmair area features industry in the form of tourism at Ardmair Point Holiday Centre, aquaculture (fish farm base) and crofting. Land use on the remainder of the survey use is more rural in nature with small scale farming and crofting being the predominant land use in the mid-survey area, and the land largely reverting to wild usage in the northernmost survey area.

Land Cover

In the Ardmair area land cover consists of grassland in the caravan and camping park. A mixture of crofting, grazing and wild land surrounded the loch area. In the mid and northern section of the survey areas, the land cover comprises moor and heath, with some small areas of native woodland and improved grazing around the properties at Keanchulish.

Watercourses

The largest watercourse in the area is the River Canaird, which discharges into Loch Kanaird in a wide delta to the north of the survey area. Smaller streams are also present, including the Allt Garbh discharging at NH 1150 9873, the Allt Glutton at NH 1193 9918 and the Allt Bealach at NC 1189 0052.

Wildlife/Birds

Birds seen on the survey were:

- 22 gulls and 12 Golden Plover at Ardmair
- 40 Mallard ducks near North Keanchulish
- 1 Heron at Keanchulish House

In addition two Common Seals were seen on the shore below Keanchulish House, and one at Ardmair.

Specific observations made during the survey are mapped in Figure 1 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figure 2. Bacteriology results are given in Tables 2 and 3. Photographs are presented in Figures 3-14.

Shoreline Survey Maps

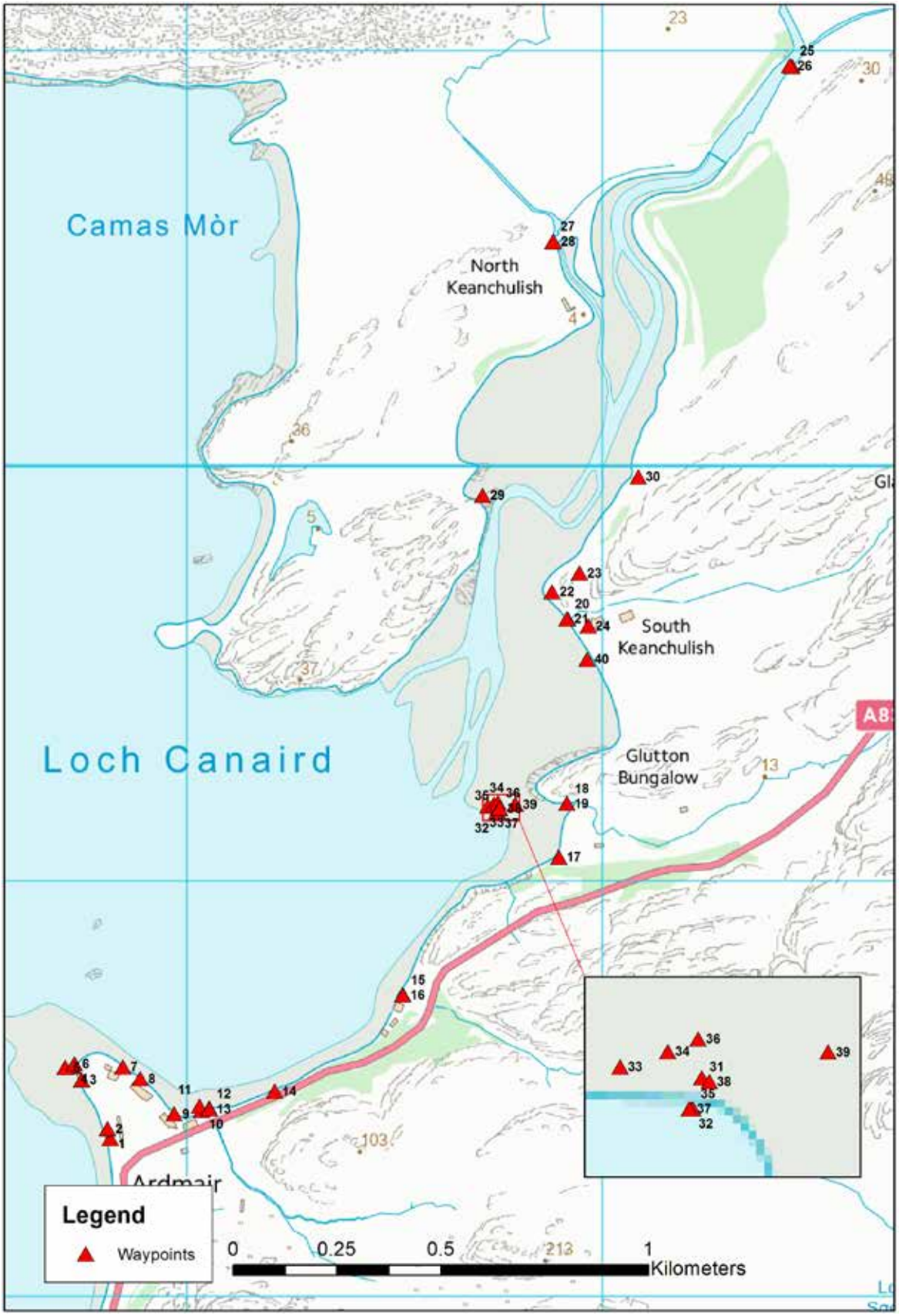

Figure 1. Loch Kanaird waypoints

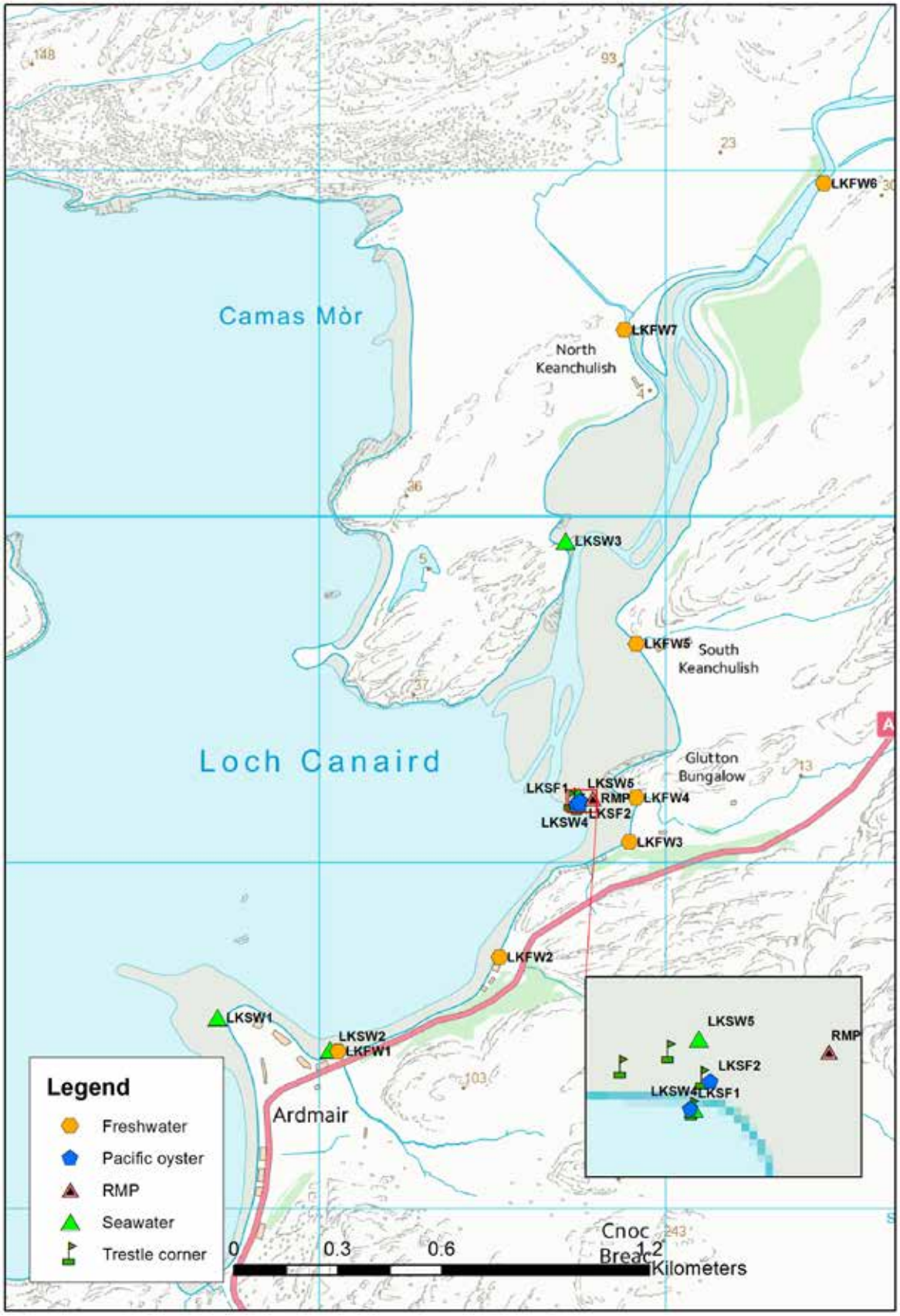

Figure 2. Loch Kanaird samples

Table 1 Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	05/11/2013	9:09	NH 10815 98380	210815	898380	Fig 3		Start of survey (section 1) Ardmair Point caravan and camping park above beach closed for winter.
2	05/11/2013	9:13	NH 10808 98404	210809	898404			Two raised pipes on beach - no manholes observed in caravan park above. 22 gulls & 12 golden plover seen. One seal observed offshore.
3	05/11/2013	9:17	NH 10746 98521	210747	898522			Manhole on shore immediately below chemical toilet emptying point & laundrette on campsite. Discharge pipe visible on shore (10cm uPVC), but disappears below tide line.
4	05/11/2013	9:21	NH 10725 98554	210725	898554	Fig 4		Second discharge pipe running from caravan site, smell of sewage present in the air. This pipe connects with the pipe seen in waypoint 3 on the lower shore - still not possible to see the discharge due to the state of the tide.
5	05/11/2013	9:25	NH 10706 98551	210707	898552		LKSW1	Extra seawater sample taken due to smell and discharge pipes. LKSW1
6	05/11/2013	9:28	NH 10728 98560	210729	898561	Fig 5		Third pipe running onto foreshore - several broken sections present, with no flow observed in broken sections. Fish farm noted, and photographed on opposite side of bay.
7	05/11/2013	9:32	NH 10845 98552	210845	898553			Concrete pier with ten boats at anchor (two yachts, one small fishing vessel & seven small pleasure craft). Seven additional empty buoys.
8	05/11/2013	9:35	NH 10887 98524	210888	898524			Manholes (two) noted on shoreline below chalet style dwellings - no pipes visible on foreshore.
9	05/11/2013	9:39	NH 10969 98439	210969	898440	Fig 6		A third manhole cover (concrete) below chalet style buildings - no pipe visible on foreshore.
10	05/11/2013	9:41	NH 11035 98448	211035	898448			Small slipway north of chalet buildings.
11	05/11/2013	9:43	NH 11030 98458	211031	898458		LKSW2	Planned seawater sample LKSW2.
12	05/11/2013	9:46	NH 11053 98453	211054	898454		LKFW1	Planned freshwater sample LKFW1.
13	05/11/2013	9:46	NH 11053 98451	211054	898452			Observations associated with sample from waypoint 12 Width 75cm; Depth 9cm; Flow 0.361m/s SD 0.009

14	05/11/2013	9:54	NH 11210 98494	211211	898494	Fig 7		Shoreline from this point further north difficult to access due to state of tide and rocky shoreline. Roadside has no walkway and fast traffic prevented continuation off the survey alongside the road. No outfalls or watercourses were visible along short length, (binoculars were used to survey the remaining area), so returned to van to drive to access pier at end of section 1.
15	05/11/2013	10:17	NH 11520 98726	211520	898726		LKFW2	Planned freshwater sample LKFW2.
16	05/11/2013	10:17	NH 11519 98726	211520	898726			Observations associated with sample from waypoint 15. Width 1.4m; Depth 24cm; Flow 0.386m/s SD 0.042. Stream running adjacent to fish farm pier and buildings, but no discharges noted running into stream or onto shore. Four moorings in bay.
17	05/11/2013	10:36	NH 11895 99058	211896	899059	Fig 8 & 9	LKFW3	Site of expected stream difficult to access due to steep cliff at edge of loch, there was a flow of water running from upper beach on large area of upper shoreline. Sample LKFW3 was taken from this, but flow measurement impossible as flow is very diffuse across rocky beach. Three boats (one fishing boat, two yachts) on shoreline above beach, three sheep in field. One mooring in bay.
18	05/11/2013	10:44	NH 11914 99187	211915	899187		LKFW4	Planned freshwater sample LKFW4.
19	05/11/2013	10:44	NH 11914 99187	211914	899187			Observations associated with sample from waypoint 18. Width 3.5m; Depth (1) 14cm; Flow (1) 0.461 m/s, SD 0.012. Depth (2) 14cm; Flow (2) 0.501 m/s, SD 0.013.
20	05/11/2013	11:02	NH 11916 99631	211916	899632	Fig 10	LKFW5	Planned freshwater sample LKFW5.
21	05/11/2013	11:02	NH 11914 99631	211915	899632			Observations associated with sample from waypoint 20. Width 55cm; Depth 15cm; Flow 0.128 m/s SD 0.008.
22	05/11/2013	11:09	NH 11879 99697	211879	899697			Two seals noted in water, one heron on shoreline. Sheep droppings present.
23	05/11/2013	11:11	NH 11945 99742	211945	899742			Shed (broken windows, appears unused) above shoreline.
24	05/11/2013	11:13	NH 11965 99615	211966	899615			Manhole on road next to Keanchulish House. No discharge pipe visible on shoreline.
25	05/11/2013	11:36	NC 12457 00962	212457	900962	Fig 11	LKFW6	Planned freshwater sample LKFW6.

26	05/11/2013	11:36	NC 12451 00963	212451	900964			River Canaird observations associated with sample from waypoint 25. Width 27.5m. Too deep to wade for flow measurements, but estimates for depth of river vary from 0.5 - 1m for most of the channel, with some deeper channels of up to 3m. Flow measurements made by timing travel of wooden floats over bridge width of 4.9m; (1) 10.85 sec; (2) 8.32 sec; (3) 8.99 sec. Average time 9.39 seconds.
27	05/11/2013	11:54	NC 11880 00538	211881	900539		LKFW7	Planned freshwater sample LKFW7.
28	05/11/2013	11:54	NC 11882 00541	211882	900541			Observations associated with sample from waypoint 27. A 1m diameter culvert with one-way storm-valve on sea end of pipe. Discharge runs into cascade with a width of 1.5m; Depth 6cm; Flow 1.397 m/s SD 0.041
29	05/11/2013	12:13	NH 11712 99929	211712	899929		LKSW3	Planned seawater sample LKSW3. Not taken at location noted on survey plan, as tide was falling, so taken at closest available point. Evidence of sheep droppings in area. Forty mallard ducks observed.
30	05/11/2013	12:34	NH 12086 99973	212087	899974			Stream running off hillside into bay - not noted on sample plan, and not sampled as running off hillside with no housing or source of contamination nearby.
31	05/11/2013	14:13	NH 11750 99176	211750	899177			NE corner of oyster trestles.
32	05/11/2013	14:14	NH 11746 99167	211747	899167			SE corner of oyster trestles.
33	05/11/2013	14:15	NH 11724 99180	211724	899180			SW corner of oyster trestles.
34	05/11/2013	14:15	NH 11739 99185	211739	899185			NW corner of oyster trestles.
35	05/11/2013	14:17	NH 11747 99167	211747	899167		LKSW4	Planned seawater sample.
36	05/11/2013	14:18	NH 11749 99189	211749	899189	Fig 13	LKSW5	Planned seawater sample.
37	05/11/2013	14:20	NH 11746 99167	211746	899167		LKSF1	Planned shellfish sample.
38	05/11/2013	14:25	NH 11752 99175	211753	899176		LKSF2	Planned shellfish sample.
39	05/11/2013	14:29	NH 11790 99185	211790	899185	Fig 12		RMP trestle.
40	05/11/2013	15:43	NH 11963 99534	211963	899535	Fig 14		Photo taken of outflow pipe at low tide at Keanchulish House. Pipe was only visible at low tide after finishing the survey.

Photographs referenced in the table can be found attached as Figures 3-14.

Sampling

Water samples were collected at the sites marked on the Loch Kanaird samples map shown in Figure 2.

An additional seawater sample was taken LKSW1 as there was a strong smell of sewage from the vicinity of the discharge pipes from Ardmair Point campsite.

All the samples were transferred to a Biotherm 30 box with ice packs and posted to the Glasgow Scientific Services (GSS) for E.coli analysis. The samples were posted on the day of collection and all the samples were received the following day. The sample temperatures on arrival at the laboratory were recorded as 4.2 °C.

Seawater samples were tested for salinity by GSS and the results were reported in mg Chloride per litre. These results have been converted to parts per thousand (ppt) using the formula:

$$\text{Salinity (ppt)} = 0.0018066 \times \text{Cl (mgl)}$$

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100ml)	Salinity (ppt)
1	05/11/2013	LKSW1	NH 10706 98551	Seawater	77	33.78
2	05/11/2013	LKSW2	NH 11030 98458	Seawater	19	24.21
3	05/11/2013	LKFW1	NH 11053 98453	Freshwater	70	
4	05/11/2013	LKFW2	NH 11520 98726	Freshwater	<10	
5	05/11/2013	LKFW3	NH 11895 99058	Freshwater	460	
6	05/11/2013	LKFW4	NH 11914 99187	Freshwater	<10	
7	05/11/2013	LKFW5	NH 11916 99631	Freshwater	10,000	
8	05/11/2013	LKFW6	NC 12457 00962	Freshwater	60	
9	05/11/2013	LKFW7	NC 11880 00538	Freshwater	40	
10	05/11/2013	LKSW3	NH 11712 99929	Seawater	73	9.94
11	05/11/2013	LKSW4	NH 11747 99167	Seawater	1	11.71
12	05/11/2013	LKSW5	NH 11749 99189	Seawater	0	28.36

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	Sample depths	E. coli (MPN/100g)
1	05/11/2013	LKSF1	NH 11746 99167	Pacific oyster	n/a	50
2	05/11/2013	LKSF2	NH 11752 99175	Pacific oyster	n/a	130

Photographs

Please note time annotated on the photographs does not match waypoint time as the camera settings had not been adjusted to GMT.

Fig 3. Ardmair peninsula from the SW. Taken at beginning of survey (waypoint 1). Toilet block (with chemical toilet emptying facilities) is the building in centre right of photo. Discharge pipe noted in Fig. 4 is by rocks immediately below building.

Fig 4. Joint discharge pipe running into water below site of Caravan Park (waypoint 4)

Fig 5. Fish farm cages on opposite side of bay. Photo taken from waypoint 6 looking NW.

Fig 6. View looking NE from waypoint 9 showing concrete manhole cover in foreground, slipway in middle distance, and fish farm in far distance on upper left.

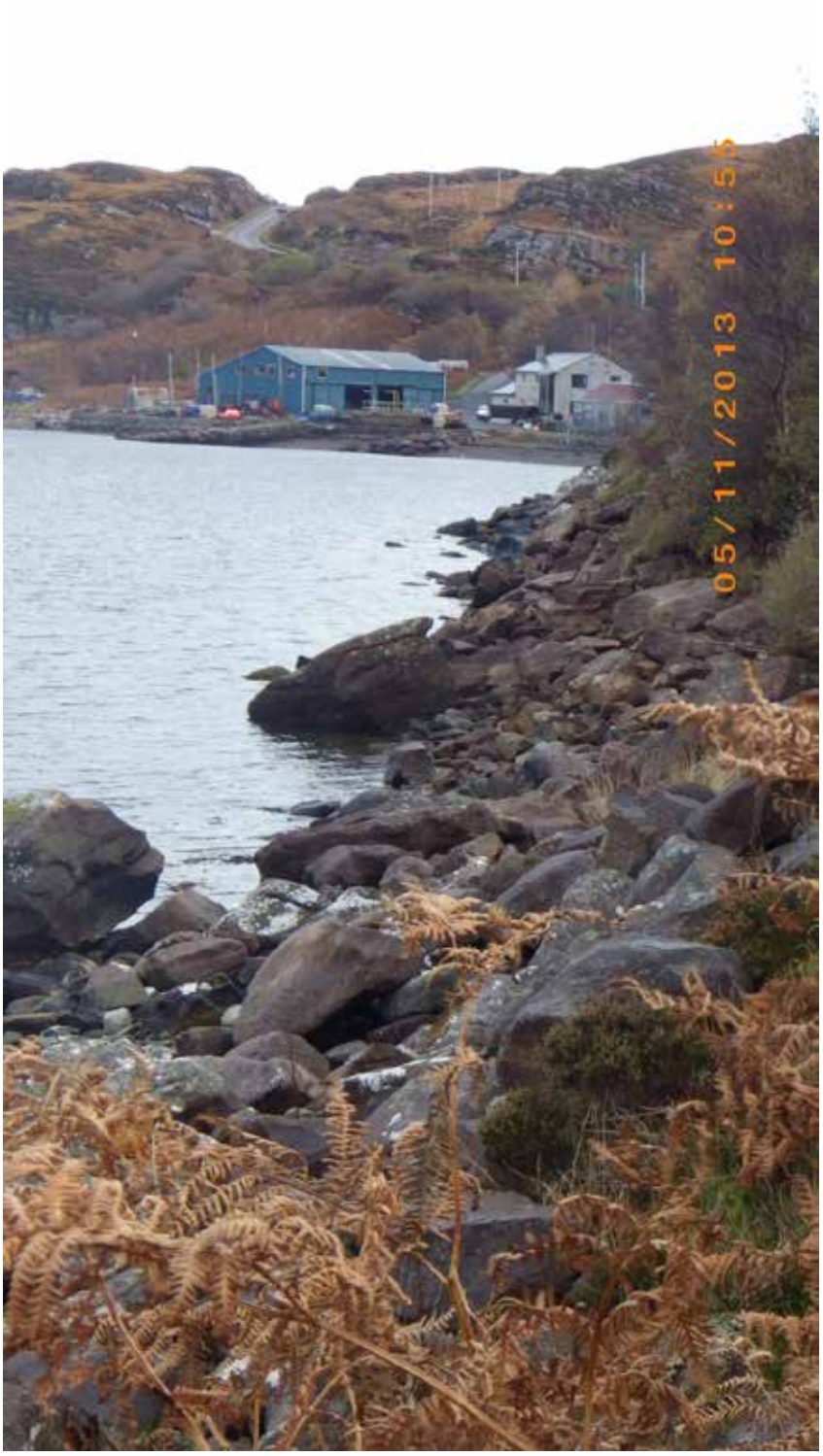

Fig 7. Closer view of fish farm base, and short section of shoreline that proved too difficult to traverse, taken from waypoint 14. Location of stream sampled in waypoint 15 is immediately behind large blue shed.

Fig 8. Looking SW from corner of S end of production area (waypoint 17). Shoreline proved difficult to access on centre left for planned water sample, so replacement sample was taken from small inflow on beach to immediate left of photo.

Fig 9. Looking up the shore above at the south end of the production area (waypoint 17) showing vessels stored ashore.

Fig 10. Stream running onto shore below Keanchulish House (waypoint 20), Site of freshwater sample LKFW5.

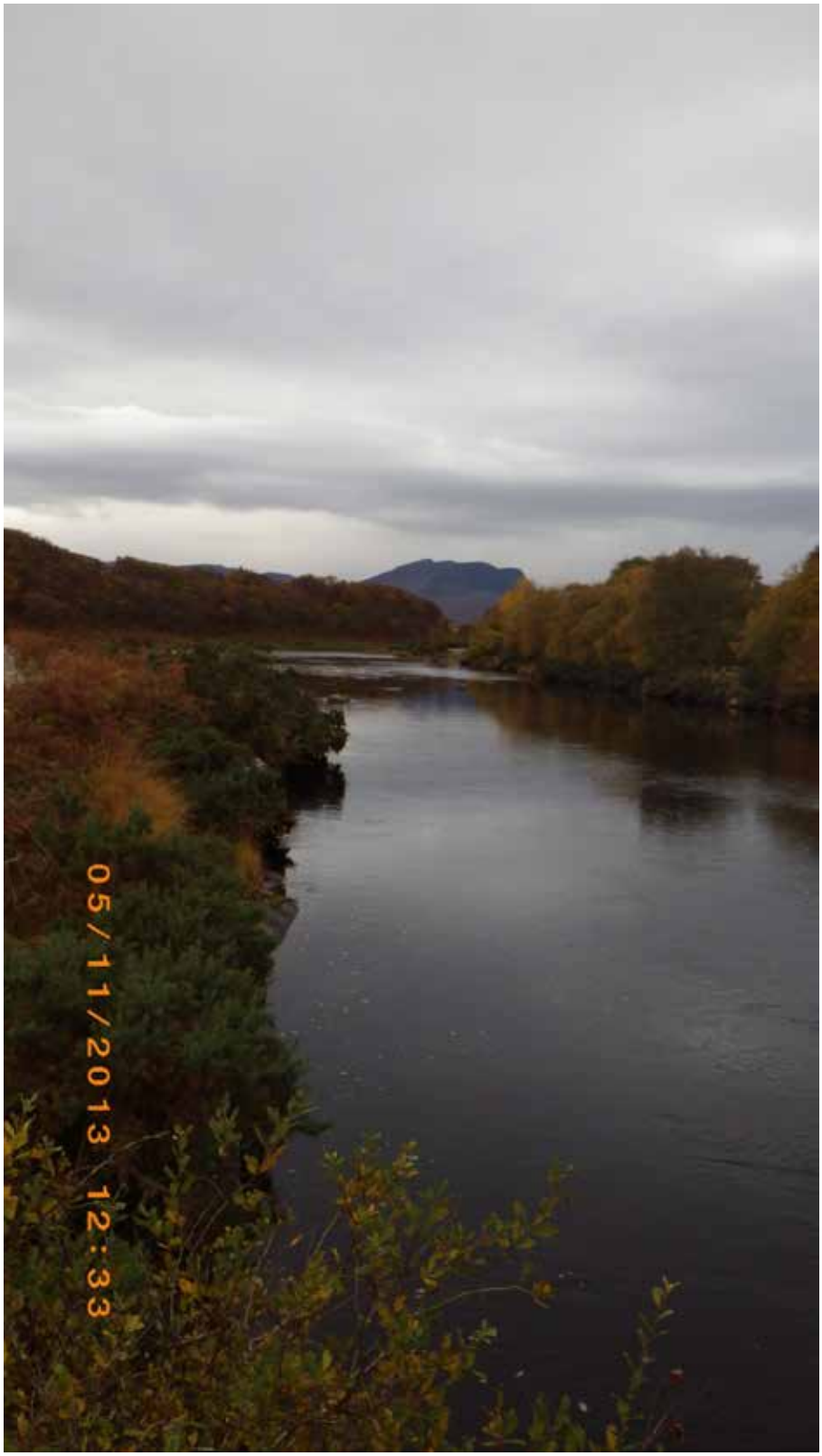

Fig 11. River Canaird, looking downstream from bridge at NC 1245 0095 (waypoint 25).

Fig 12. RMP site (foreground, waypoint 39), with main oyster trestles in distance (boundaries marked as waypoints 31-34)

Fig 13. Main oyster cultivation site, looking W. Photo taken from waypoint 36.

Fig 14. Discharge pipe noted below Keanchulish house at location NH 11926 99459, no waypoint was taken for this. Photo taken at waypoint 40.

5. Consented discharges - SEPA

Licence No.	NGR	Site Name	Discharge Type	Site Description	Discharges to	PE
CAR/L/1003889	NH 10152 99453	Isle Martin MCFF, Loch Kanaird	MCFF	Loch Kanaird MCFF, Isle Martin, Ullapool		
CAR/R/1073897	NH 14830 92740	Dwelling	Sewage (Private) Primary		Allt an Tota	5
CAR/R/1042997	NC 15266 02092	Dwelling	Sewage (Private) Primary	STE to land, Ullapool	Land	5
CAR/R/1043613	NC 15221 02048	Dwelling	Sewage (Private) Primary	STE to land, Ullapool	Land	7
CAR/R/1017243	NC 14870 01690	Dwelling	Sewage (Private) Secondary	STW FE to Land, Strathcanarid, Ullapool	Land	5
CAR/R/1064435	NH 11790 95390	Dwelling	Sewage (Private) Primary		Loch Broom	5
CAR/R/1064368	NH 09515 97174	Dwelling	Sewage (Private) Primary	7 Properties STE to Loch Broom, Ullapool	Loch Broom	5
CAR/R/1076801	NH 09957 97079	Dwelling	Sewage (Private) Primary		Loch Broom	5
CAR/R/1010197	NH 11703 93014	Dwelling	Sewage (Private) Primary	STE to Loch Broom	Loch Broom	5
CAR/R/1064529	NH 09680 97320	Dwelling	Sewage (Private) Primary		Loch Broom	5
CAR/R/1032573	NH 09950 97020	Dwelling	Sewage (Private) Secondary		Loch Broom	5
CAR/R/1093206	NH 11140 95790	Dwelling	Sewage (Private) Secondary		Loch Broom	12
CAR/R/1066365	NH 10818 98144	Dwelling	Sewage (Private) Primary	STE to Loch Kanaird, Ullapool	Loch Kanaird	5
CAR/R/1076831	NH 11761 99548	Dwelling	Sewage (Private) Primary	STE to Loch Kanaird, Ullapool	Loch Kanaird	12
CAR/R/1036938	NH 10630 97780	Dwelling	Sewage (Private) Secondary	STW FE to Loch Kanaird, Ullapool	Loch Kanaird	6
CAR/R/1036935	NH 10630 97780	Dwelling	Sewage (Private) Secondary	STW FE to Loch Kanaird, Ullapool	Loch Kanaird	6
CAR/R/1082126	NH 10630 97780	Dwelling	Sewage (Private) Secondary	STE to Loch Kanaird, Ullapool	Loch Kanaird	6
CAR/R/1042939	NH 11801 95390	Dwelling	Sewage (Private) Primary	STE to soakaway, Ullapool	Soakaway	5
CAR/R/1077961	NC 15428 02039	Dwelling	Sewage (Private) Primary		Soakaway	5
CAR/R/1067045	NC 13674 01102	Dwelling	Sewage (Private) Primary		Soakaway	5
CAR/R/1080523	NH 11720 95685	Dwelling	Sewage (Private) Primary		Soakaway	8
CAR/R/1041172	NC 14680 01400	Dwelling	Sewage (Private) Primary	STE to soakaway, Ullapool	Soakaway	5
CAR/R/1073892	NH 14810 93030	Dwelling	Sewage (Private) Primary	STE to soakaway, Braes	Soakaway	5
CAR/R/1077074	NC 15036 01908	Dwelling	Sewage (Private) Primary	STE to soakaway, Ullapool	Soakaway	10
CAR/R/1034446	NH 11980 98510	Dwelling	Sewage (Private) Primary		Soakaway	7
CAR/R/1021422	NC 17300 02850	Dwelling	Sewage (Private) Primary	STE to soakaway	Soakaway	15
CAR/R/1021421	NC 17280 02830	Dwelling	Sewage (Private) Primary		Soakaway	15
CAR/R/1021423	NC 17330 02879	Dwelling	Sewage (Private) Primary		Soakaway	15
CAR/R/1073880	NH 15865 95853	Dwelling	Sewage (Private) Primary		Soakaway	5
CAR/R/1076839	NH 12190 99160	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ardmair	Soakaway	5
CAR/R/1053906	NH 14168 92933	Dwelling	Sewage (Private) Primary	STE to soakaway, Ullapool	Soakaway	5
CAR/R/1011609	NH 11473 98650	Dwelling	Sewage (Private) Primary	STE to soakaway	Soakaway	6
CAR/R/1021458	NC 17363 02778	Dwelling	Sewage (Private) Primary		Soakaway	25
CAR/R/1064429	NH 11913 95475	Dwelling	Sewage (Private) Primary	STE to soakaway, Ullapool	Soakaway	10

Licence No.	NGR	Site Name	Discharge Type	Site Description	Discharges to	PE
CAR/R/1042846	NH 13364 95214	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ullapool	Soakaway	6
CAR/R/1043025	NC 11820 00400	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ullapool	Soakaway	5
CAR/R/1058162	NH 14153 93033	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ullapool	Soakaway	5
CAR/R/1097311	NH 14880 92620	Dwelling	Sewage (Private) Primary		Soakaway	5
CAR/R/1043097	NH 11865 95557	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ullapool	Soakaway	7
CAR/R/1067019	NH 10091 96984	Dwelling	Sewage (Private) Primary		Soakaway	6
CAR/R/1043043	NH 12110 97050	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ullapool	Soakaway	6
CAR/R/1064417	NH 12032 95438	Dwelling	Sewage (Private) Primary	STE to Soakaway, Ullapool	Soakaway	5
CAR/R/1066881	NH 09890 97200	Dwelling	Sewage (Private) Primary	STE to soakaway, Rhue, Ullapool	Soakaway	10
CAR/R/1080126	NC 14600 01322	Dwelling	Sewage (Private) Primary		Soakaway	15
CAR/R/1060997	NH 13342 94148	Dwelling	Sewage (Private) Primary		Soakaway	6
CAR/R/1069146	NH 11386 95927	Dwelling	Sewage (Private) Primary		Soakaway	5
CAR/R/1076740	NH 14067 93326	Dwelling	Sewage (Private) Primary		Soakaway	6
CAR/R/1010648	NH 11850 95600	Dwelling	Sewage (Private) Secondary	STW, FE to Soakaway, Ullapool	Soakaway	5
CAR/R/1079100	NC 15088 01874	Dwelling	Sewage (Private) Primary		U/N W/C	5