Scottish Sanitary Survey Report

Sanitary Survey Report
Loch Sligachan
SL-195
June 2015

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	Allan MacDonald	Highland Council
	Dave Oakes	Harvester

Partner Organisations

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

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Appendices

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 classified King scallop fishery at Loch Sligachan on the basis recommended in the European Union Reference Laboratory publication: "Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application" (https://eurlcefas.org/media/13831/gpg_issue-5_final_all.pdf). This areas was selected for survey at this time based on a risk-based ranking amongst those Scottish production areas that had yet to receive a survey.

Loch Sligachan is a sea loch on the east coast of the Isle of Skye, located off the west coast of Scotland.

The shellfishery at Loch Sligachan is a King scallop bed governed by a Several Order granted to the current harvester, Mr. David Oakes. The scallops are harvested by hand using divers.

The main identified sources of contamination to the shellfishery are private septic tank discharges and watercourses near to the southeastern corner of the several order area and farm animals to the northeast and southeast of the area. Sewage discharges and watercourses near the head of the loch, and immediately outside of the mouth of the loch, may also contribute to background contamination.

Transport distances over the tidal cycle may be in the order of 6 km. However, significant mixing and dispersion is expected to occur over that distance and thus the effect of sources remote from the fishery is expected to be markedly less than those in the vicinity of it.

It is recommended that the production area is constrained to encompass mainly the area defined in the several order given that this is the location of the present fishery and that there are identified sources of contamination near to, but outside, this area. It is recommend that the RMP be located at the southeastern corner of the several order area in order to reflect the effect of sources identified in that vicinity.

II. Sampling Plan

Production Area	Loch Sligachan
Site Name	Loch Sligachan
SIN	SL-195-291-07
Species	King scallops
Type of Fishery	Hand dived
NGR of RMP	NG 5216 3237
East	152160
North	832370
Tolerance (m)	40
Depth (m)	N/A
Method of Sampling	Hand
Frequency of Sampling	Monthly
Local Authority	Highland Skye & Lochalsh
Authorised Sampler(s)	Allan MacDonald
Local Authority Liaison Officer	Alan Yates
Production Area	The area between lines drawn between NG 5150 3269 and NG 5150 3186 and between NG 5225 3283 and NG 5225 3227 extending to MHWS.

III. Report

1. General Description

Loch Sligachan is a sea loch on the east coast of the Isle of Skye, located off the west coast of Scotland. This area lies within the Skye and Lochalsh district of the Highland Council.

Loch Sligachan is 4.4 km in length and has a maximum width of approximately 700 m. Its maximum depth is 25 meters. The loch has an easterly orientation and the mouth is sheltered by the islands of Raasay and Scalpay.

The area around Loch Sligachan is sparsely inhabited, with the villages of Sconser on the south shore and Penachorrain on the north shore.

A sanitary survey was undertaken on the classified fishery at Loch Sligachan 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.cefas.defra.gov.uk/nrl/information-centre/eu-good-practice-guide.aspx). This production area was selected for survey at this time based on a risk-based ranking of the area amongst those in Scotland that have yet to receive sanitary surveys.

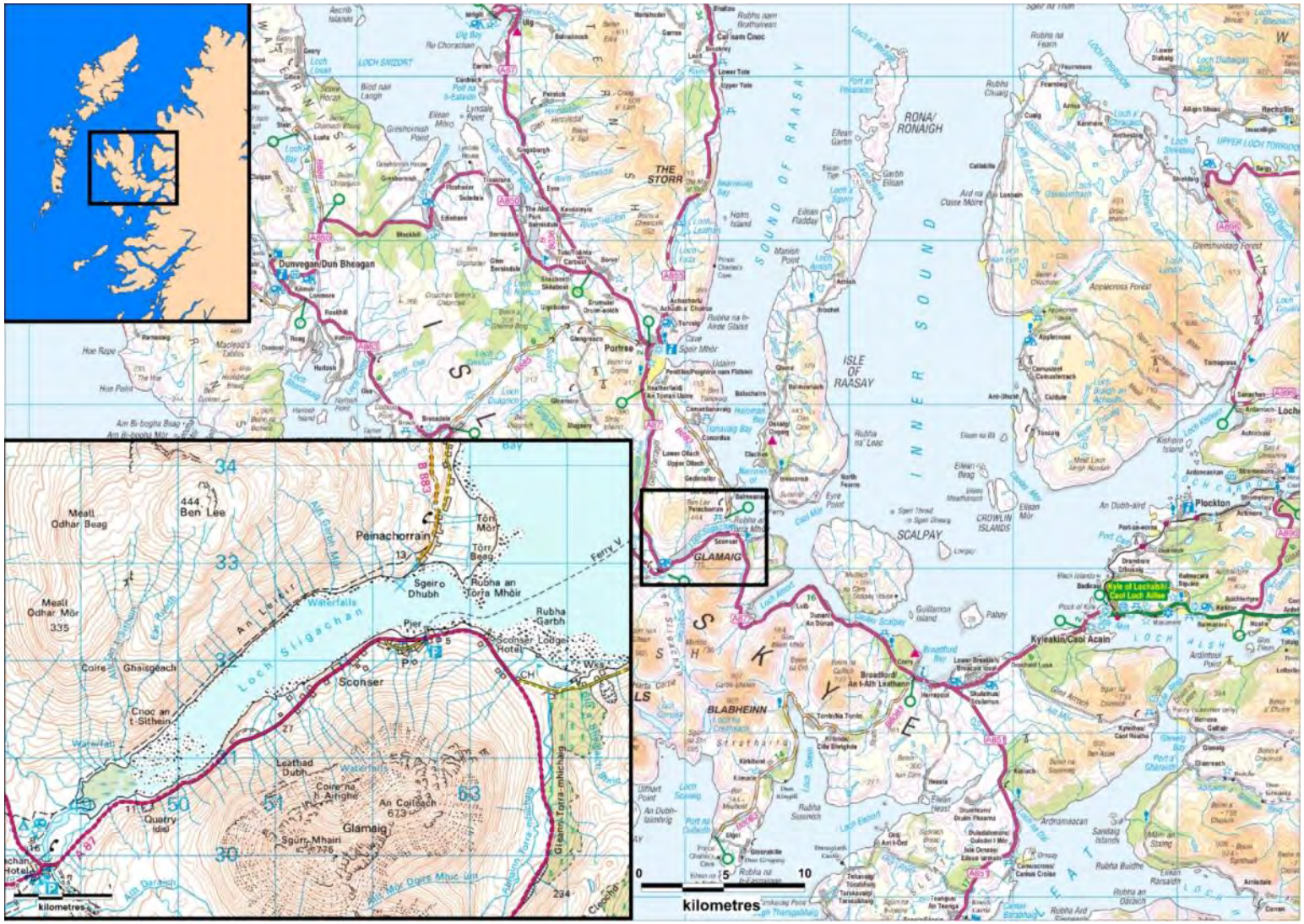


Figure 1.1 Location of Loch Sligachan

2. Fishery

At Loch Sligachan, there is a subtidal fishery for King Scallops (*Pecten maximus*), which are harvested by divers. Details of the sites given in the 2014-2015 classification documents are presented in Table 2.1.

Table 2.1 Area shellfish farms

Production area	Site	SIN	Species
Loch Sligachan	Loch Sligachan	SL-195-291-07	King Scallop
Loch Sligachan	Loch Sligachan Pier	SL-195-292-07	King Scallop

The production area is defined as the area west of a line drawn between NG 5368 3510 and NG 5500 3220 extending to MHWS. The harvester identified that he used to hold scallops in lantern nets at locations both within and outside the loch. However, he has discontinued this practice and now hand dives for scallops within the area depicted in Figure 2.1. The Loch Sligachan site given in Table 2.1 corresponds to the area in the vicinity of the RMP shown in the figure. An alternative RMP located towards the southwest corner of the present harvesting area was identified by the sampling officer. It should be noted, however, that some classification samples taken during 2014 have been reported to have been taken at the RMP rather than the alternative RMP (see Section 11 for further details).

The area is subject to a Several Fishery Order. A several order grants ownership of the shellfish specified in the order and gives the owner exclusive right to harvest the shellfish and manage the fishery. (GOV.UK, 2013).The several fishery order, laid out in Scottish Statutory Instruments 2013 N.o.280 grants these rights to Mr David Oakes, the present harvester. The several order area is defined as:

That part of the bed of the sea in Loch Sligachan, Isle of Skye, extending to 31.3 hectares or thereby and bounded as follows—

> on or towards the east by a straight line extending in a generally southerly direction from a point at 57°19.114'North latitude and 06°06.979' West longitude to a point at 57°18.864' North latitude and 06°06.948' West longitude
>
> then on or towards the south by a line extending in a generally westerly direction following the line of mean low water springs to a point at 57°18.682' North latitude and 06°07.463' West longitude;
>
> then on or towards the west by a straight line extending in a generally northerly direction to a point at 57°18.950' North latitude and 06°07.578' West longitude;
>
> then on or towards the north by a line extending in a generally easterly direction following the line of mean low water springs to the point of beginning.

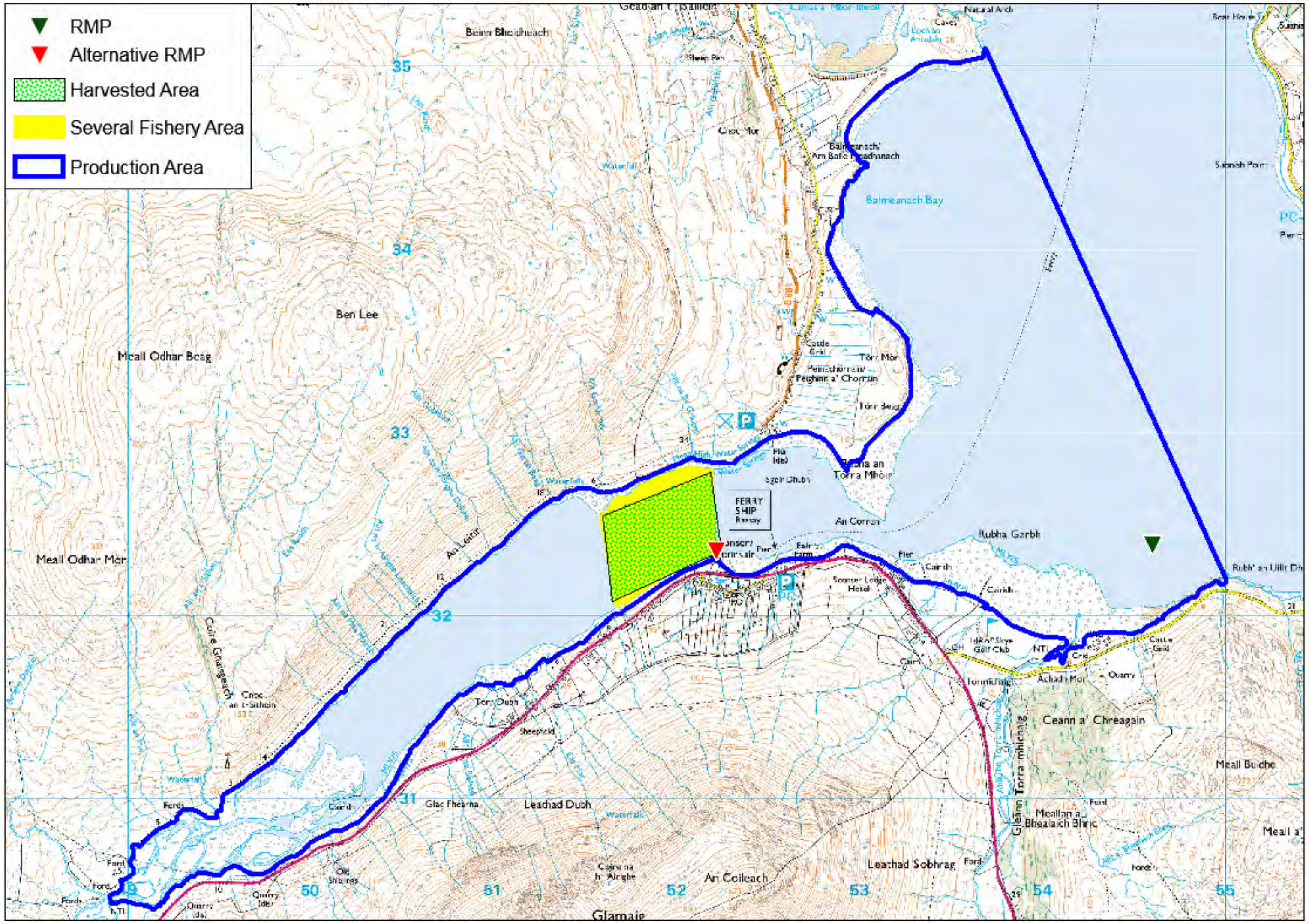


Figure 2.1 Loch Sligachan Fishery

3. Human Population

Information was obtained on the population within the vicinity of the Loch Sligachan production area from the General Register Office for Scotland. The last census was undertaken in 2011. The census output areas surrounding Loch Sligachan are shown in Figure 3.1 thematically mapped by the 2011 population densities. The population density is low overall (< 3 people per km^2) within the output areas bordering the loch. However, the output areas have vastly different land areas, and the populations within them are not evenly distributed.

Table 3.1 Census output areas and populations – Loch Sligachan

Census Output Area ID	Population	Area (km^2)
S00081086	108	45
S00081098	74	146
S00081095	81	29

The A87 runs along the southern shore, through the village of Sconser, and then heads inland at the eastern end of the loch. The northern shore is inaccessible by road and uninhabited west of the settlement of Peinachorrain. Sconser has a pier and ferry terminal, small slipway and holiday accommodation including a hotel, B&Bs and at least 4 self-catering cottages. A vehicle and passenger ferry runs daily from Sconser to the island of Raasay (CalMac Ferries Limited, 2014). During the survey, ten moorings were observed adjacent to the Sconser slipway. An anchorage is also noted to the west of the ferry slip (Clyde Cruising Club, 2007). Along the shore to the east of Sconser are a golf club and a large quarry.

Southwest of the head of the loch are a hotel (sleeps 42), a bunkhouse (sleeps 20), two self-catering cottages and a campsite. The campsite has toilet and shower facilities and is open only during the summer months. At the time of the shoreline survey, 19 tents and 6 live-in vehicles were on site and the campsite was estimated to be approximately 30% full.

Adjacent to the northern shore at the mouth of the loch, the settlement of Peinachorrain spreads out along the B883 road. There is also a pier and holiday accommodation in this area.

Although the overall population density is low, the population along the shores of the loch is concentrated around Sconser and Peniachorrain near the mouth of the loch, and next to the River Sligachan, southwest of the head of the loch. The eastern end of the shellfish several area lies nearest the main populated areas at Sconser and Peinachorrain, and therefore are likely to be more affected by contamination arising from these areas. The presence of tourist accommodation, moorings and the ferry terminal suggests that there is likely to be significant seasonal variation in human population around the loch, with greater numbers of people likely to be present during the traditional summer holiday months of July and August.

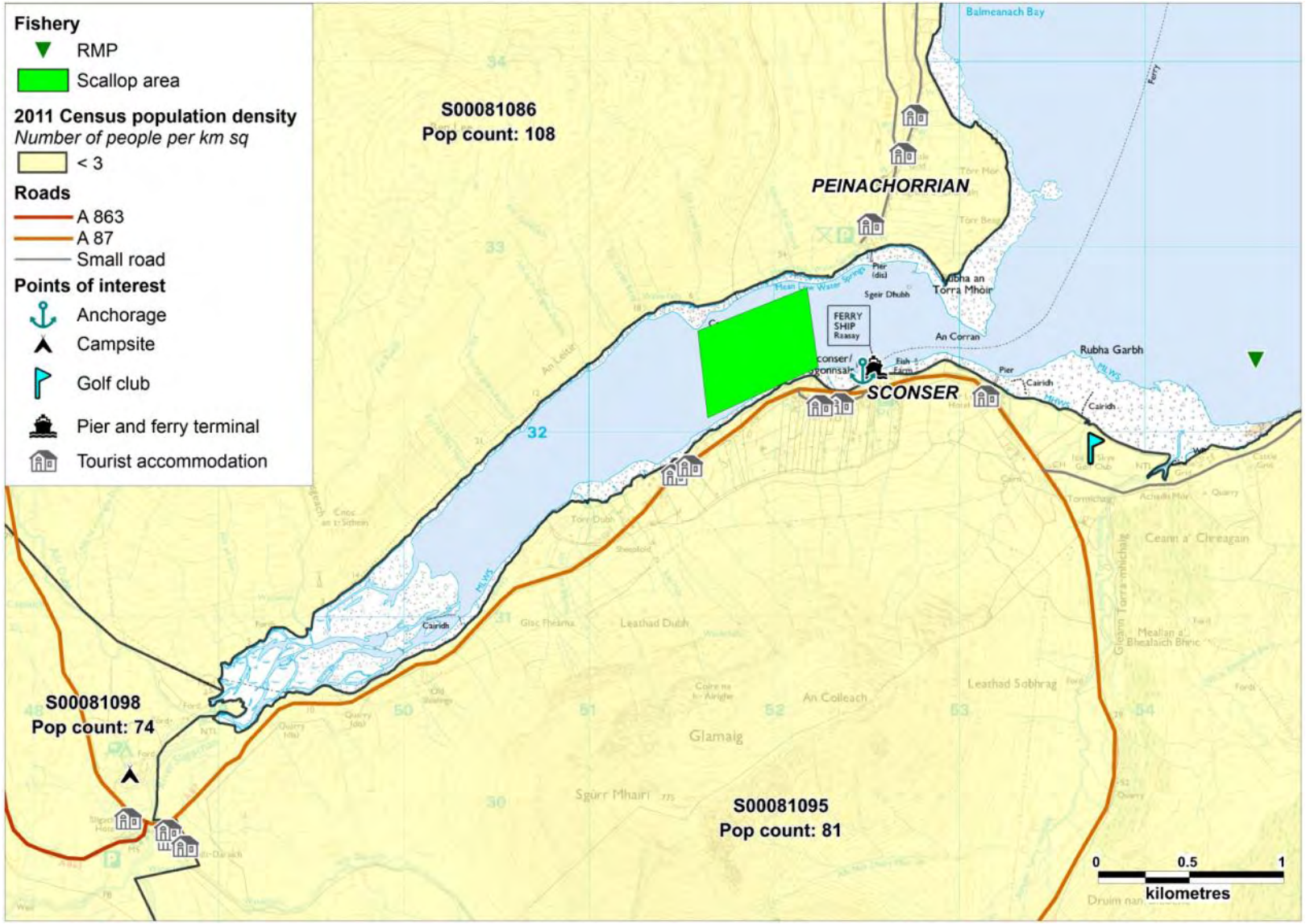


Figure 3.1 Population map of Loch Sligachan

4. Sewage Discharges

Information on sewage discharges within an area 7.5 km around the point NG 5460 3240 (the location of the RMP) 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 quality, spill frequency, discharge destination (to land, watercourse or sea), any available dispersion or dilution modelling studies, and whether improvements were in work or planned. No information was received on spill frequency, sanitary or bacteriological quality, modelling studies or planned/current improvement works.

Information on locations where sewage sludge is applied to land had been requested from SEPA: it was identified that little data was held on this and that the data that was held could not be made available for assessment within the sanitary survey programme.

4.1 Community Discharges

Scottish Water and SEPA did not report any community discharges affecting the assessment area.

4.2 Consented Private Discharges - SEPA

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 should not contribute any faecal input to the area.

Information was provided on 147 sewage discharge consents within the area requested. These discharges are located around the village of Sconser, along the road which follows the Sound of Raasay and in areas around Raasay and around the south coast of Loch Ainort. Three discharges to the Sound of Raasay to the northeast of Loch Sligachan have PEs of greater than 25 (CAR/S/1098878, CAR/S/1023437 and CAR/S/1020826).

There are also 30 discharges located around Loch Ainort, to the south of Loch Sligachan. These are small (<15 PE) domestic septic tanks discharging a minimum of 7.5 km from the fishery.

All identified sewage discharges are shown mapped in Figure 4.1 and are listed in Appendix 6.

Consented discharges to Loch Sligachan or watercourses which flow into Loch Sligachan are listed in Table 4.1 and shown in Figure 4.2.

Registration is required for all new properties and upon sale of existing properties. Information provided by SEPA is considered to be correct at the time of writing; however there may be additional discharges that have not yet been registered with SEPA.

Table 4.1 Discharges to Loch Sligachan and adjacent watercourses.

Licence Number	National Grid Reference	Site Description	Treatment Type	Discharging to	PE
CAR/L/1001917	NG 48639 29792	Hotel	Sewage (Private) Secondary	River Sligachan	100
CAR/L/1003966	NG 48642 30183	Camp Site	Sewage (Private) Primary	River Sligachan	83
CAR/R/1069299	NG 52357 32133	Dwelling	Sewage (Private) Secondary	Unnamed watercourse	5
CAR/R/1018539	NG 53250 32240	Hotel	Sewage (Public) Primary	Loch Sligachan	30
CAR/R/1045633	NG 52580 32312	Dwelling	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1045822	NG 52380 32130	Dwelling	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1064953	NG 52329 32223	Dwelling	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1067770	NG 52338 32225	Dwelling	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1079043	NG 51600 32031	Dwelling	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1104262	NG 52529 32289	Ferry Terminal	Sewage (Private) Secondary	Loch Sligachan	15

Seven septic tanks at Sconser discharge to Loch Sligachan most of which are associated with private dwellings. Two are associated with public facilities (a hotel and the ferry terminal), and these also have larger PEs and therefore larger likely discharge volumes. Two large septic tanks (CAR/L/1003966 and CAR/L/1001917) discharge to the River Sligachan at the head of the loch, approximately 4 km from the western boundary of the several order area. These are associated with the hotel and campsite located there.

4.3 Shoreline Survey Discharge Observations

Seventeen observations relating to sewage discharges or infrastructure were recorded during the shoreline survey, as shown in Table 4.2.

Table 4.2 Sewage infrastructure observed during shoreline survey

No.	Date	NGR	Associated Photograph (Appendix 5)	*E. coli* (cfu/100ml)	Description
1	15/07/2014	NG 52314 35454		-	Camus More house. Concrete area 1mx1m, suspected septic tank.
2	15/07/2014	NG 52428 35335	Fig 19	-	Concrete plinth PVC pipe air vent, suspected septic tank.
3	15/07/2014	NG 52454 35186		-	Concrete area with PVC pipe vent. Suspected septic tank.
4	15/07/2014	NG 52695 34575	Fig 18	-	Plastic green lid in field 1x1 metre, possible septic tank.
5	15/07/2014	NG 52751 34442		-	Septic tank
6	15/07/2014	NG 52770 34252		-	Septic tank cover.
7	15/07/2014	NG 52772 34234		-	Septic tank cover.
8	15/07/2014	NG 52838 33898	Fig 17	-	Manhole cover, possible soakaway.

No.	Date	NGR	Associated Photograph (Appendix 5)	*E. coli* (cfu/100ml)	Description
9	15/07/2014	NG 53250 32216	Fig 13	4500	Seawater sample. Sample taken from in front of discharge pipe. 15cm diameter PVC pipe submerged.
10	15/07/2014	NG 52660 32304		-	Discharge to sea, 15cm PVC pipe. No flow. House across road above pipe.
11	15/07/2014	NG 52589 32298	Fig 12		Discharge to seawater, 10cm PVC pipe, no flow. House just above shore.
12	14/07/2014	NG 52480 32263	Fig 9	-	Septic tank at car park level at Sconser Ferry Terminal.
13	14/07/2014	NG 52502 32289	Fig 10	20000	Water coming out underneath rock facia below car park wall. Below septic tank. Extensive green algal growth.
14	14/07/2014	NG 52518 32289	Fig 11	20000	Pipe
15	16/07/2014	NG 51242 31514		-	Vent pipe to surface in private garden. Suspected septic tank.
16	14/07/2014	NG 48505 30157		-	Manholes at [campsite] toilet block, no sign of drain.
17	14/07/2014	NG 48507 30115	Fig 8	-	Septic tank.
18	14/07/2014	NG 48600 29881		-	Large septic tank below hotel. 7x2m chamber connected to discharge pipe
19	14/07/2014	NG 48628 29879	Fig 7	33000	Discharge to river, pipe running under A863 road into river.

Observations 1-8 are located along the road towards Peinchorran and relate to septic tanks with no discharge pipes observed. Given the lack of discharge pipes it is likely these septic tanks discharge to soakaway. This matches the information provided by SEPA for discharges within the area.

Observation 9 relates to a seawater sample taken from a pipe discharging underwater. A seawater sample taken from this point returned a value of 4500 *E.coli*/100 ml. This is a high value for a seawater sample and indicative of the presence of faecal contamination.

Observation 10 and 11 both relate to presumed septic tank discharge pipes. These would discharge to the intertidal zone when operating, but were not active at the time of survey.

Observation 12 relates to the septic tank at Sconser Ferry Terminal (CAR/R/1104262) which has a PE of 15. Observation 13, taken on the shore below, reported water flowing out from under boulders with extensive algal growth (see Appendix 5 Figure 10) which is indicative of high nitrogen content associated with sewage pollution. A sample returned a value of 20000 *E.coli* cfu/100 ml, which

indicates significant faecal contamination. This gives an estimated loading, based on recorded flow, of $1.9x10^{11}$ (*E. coli*/day).

Observation 14 related to a large pipe, possibly a culvert, discharging onto the foreshore. A sample taken from this returned a value of 20000 *E. coli* cfu/100 ml. This gives a loading of $4.3x10^{10}$ (*E. coli*/day).

Observation 15 describes a vent pipe in a garden, from what is presumed to be a septic tank. Based on its geographic location, this seems to relate to a septic tank which has PE of five (CAR/R/1077746).

Observations 16 and 17 relates to sewage infrastructure and septic tanks serving the Sligachan camp site. This septic tank (CAR/L/1003966) has a consented PE of 83.

Observations 18 and 19 relate to a septic tank and outfall serving Sligachan Hotel (CAR/L/1001917). This outfall location differs from that given in the consent document provided by SEPA. A sample taken from the effluent returned a value of 33000 *E.coli*/100ml, indicating significant faecal content. The estimated loading was 7.2×10^{14} (*E. coli*/day).The consent did not specify flow values, however SEPA estimated that it had a PE of 100 with a flow of 23 m^3/day.

4.4 Summary

As there are no community discharges to the area, the main sewage inputs to the fishery come from small private discharges around the village of Sconser. Additional contamination at the southwestern end of the fishery will arise from septic tanks associated with dwellings located along the A87 southwest of Sconser. Two large septic tanks discharge to the River Sligachan, near the head of the Loch, less than 4 km from the fishery. There are also septic tank discharges to the narrows of Raasay, approximately 6 km northeast of the fishery.

List of Acronyms

MDF=	Mean daily flow	DWF=	Dry weather flow
PE=	Population Equivalent	ST=	Septic Tank
WWTW=	Wastewater Treatment Work	CSO=	Combined Sewer Overflow

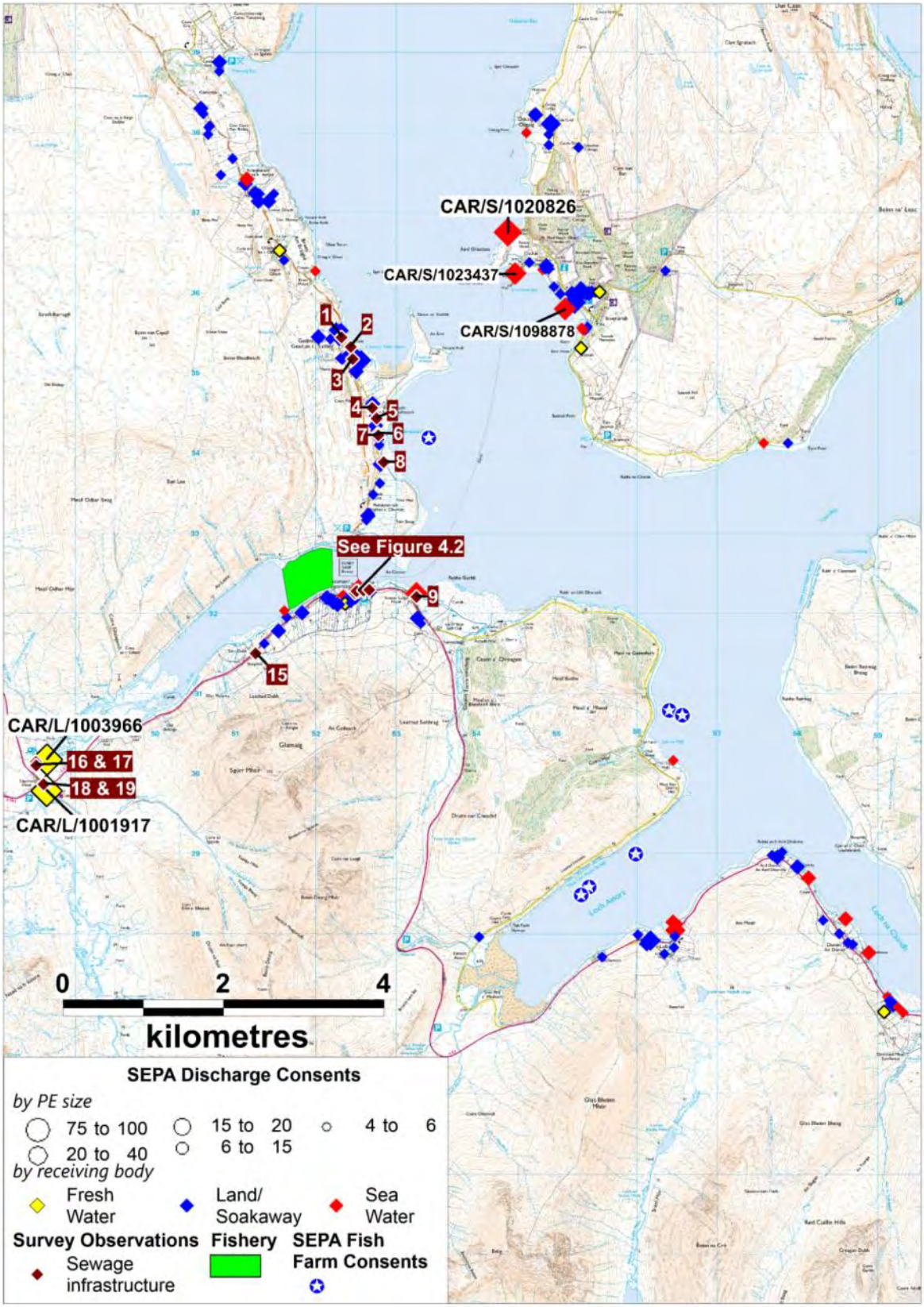


Figure 4.1 Map of discharges for the area around Loch Sligachan

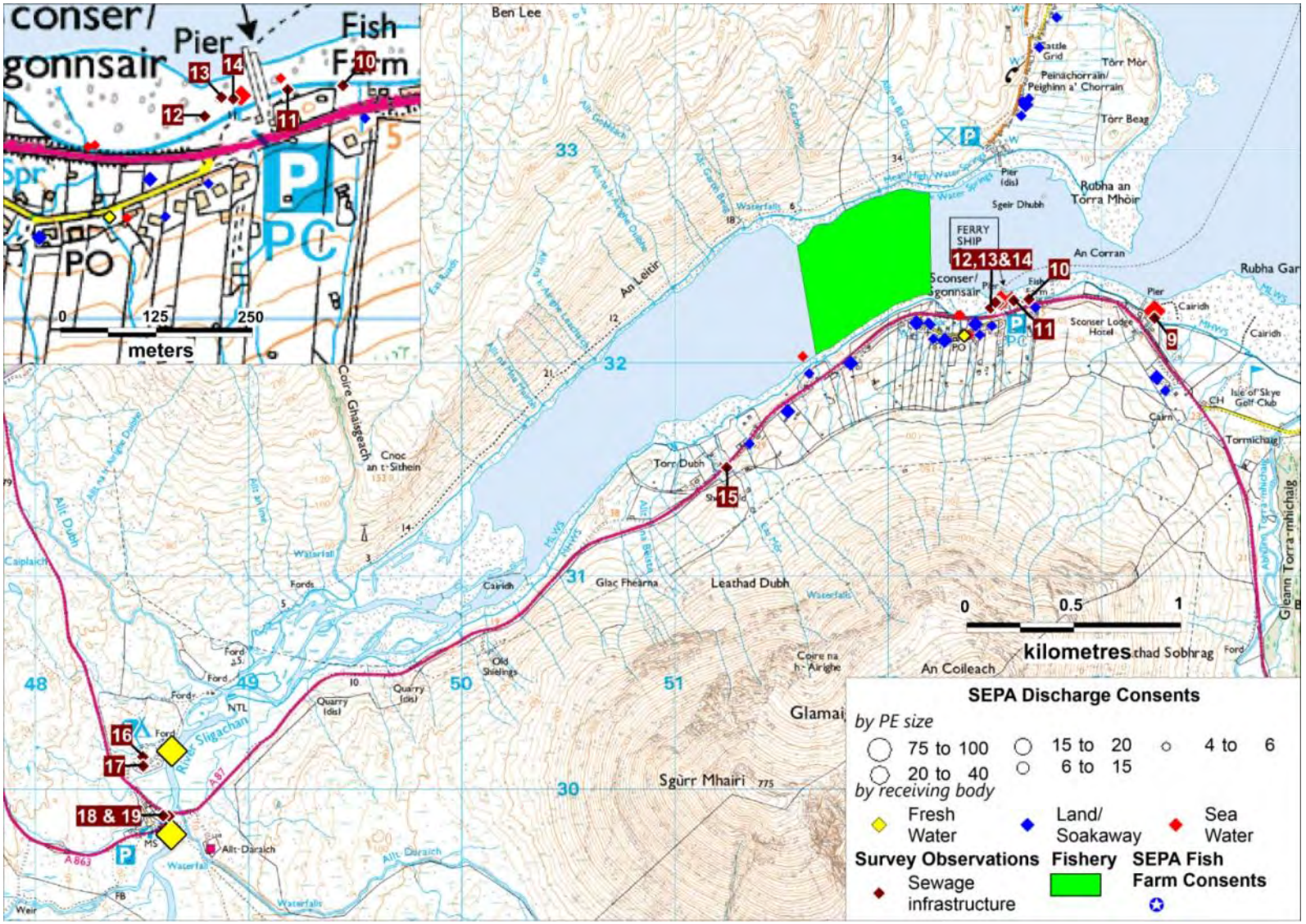


Figure 4.2 Map of discharges for Loch Sligachan

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 farm area. Agricultural census data to parish level was requested from the Scottish Government Rural Environment, Research and Analysis Directorate (RERAD) for the Portree and Bracadale parishes. Reported livestock populations for the parishes in 2013 are listed in Table 5.1. RERAD withheld data for reasons of confidentiality where the small number of holdings reporting would have made it possible to discern individual farm data. Any entries which relate to fewer than five holdings, or where two or fewer holdings account for 85% or more of the information, are replaced with an asterisk.

Table 5.1 Livestock numbers in the Portree and Bracadale agricultural parishes 2013

	Portree		Bracadale	
	228 km^2		382 km^2	
	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	*	*
Poultry	20	247	28	365
Cattle	23	489	36	1257
Sheep	66	16726	67	26100
Horses used in Agriculture	0	-	*	*
Other horses and ponies	8	15	11	27

* data withheld

The livestock census numbers for Portree and Bracadale relate to very large parish areas, therefore it is not possible to determine the spatial distribution of the livestock on the shoreline adjacent to the loch or to identify how many animals are likely to impact the catchment around the shellfish farm. Although the figures are of little use in assessing the potential impact of livestock contamination to the shellfishery, they do give an idea of the total numbers of livestock over the broader area. Sheep were reported in moderate numbers in both parishes, while poultry and cattle were reported in small numbers. No pigs were reported for either parish due the small number of holdings.

A source of spatially relevant information on the livestock population in the area was the shoreline survey (see Appendix 5), which only was undertaken on the 14th, 15th and 16th July 2014. Observations made during the survey relate only to the dates of site visit and are dependent upon the viewpoint of the observer as some animals may have been obscured by the terrain.

During the shoreline survey, a small number of sheep were observed grazing in Sconser to the southeast of the shellfish harvesting area. Further flocks of sheep were observed grazing in the area to the northeast of the harvesting area and along the coastline of Balmeanach Bay. No livestock were observed to the west of the harvesting area at the time of the survey.

Review of publicly available aerial images shows that areas likely to be improved pasture are located along the southern coastline of the loch and also along the coastline of the bay located north of the loch (Bing Maps, accessed 26/08/2014 (imaging date Apr-May 2012, http://mvexel.dev.openstreetmap.org/bing/)). These areas are shown in Figure 5.1. The 1:25000 Ordnance Survey map identified several cattle grids and a sheepfold, suggesting agricultural animals have historically been present in the area. SEPA identified four sheep dips in the area, locations of which are shown in Figure 5.1.

Numbers of sheep are expected to be approximately double during the spring and summer months when lambs are present. Any contributions of faecal contamination from livestock are expected to be low to moderate, with livestock grazing on the improved pasture to the northeast and southeast of the shellfish harvesting area potentially contributing to faecal indicator concentrations found in waters along the eastern side of the area.

Information on locations where animal slurry is stored and/or applied to land had been requested from SEPA: it was identified that little data was held on this and that the data that was held could not be made available for assessment within the sanitary survey programme.

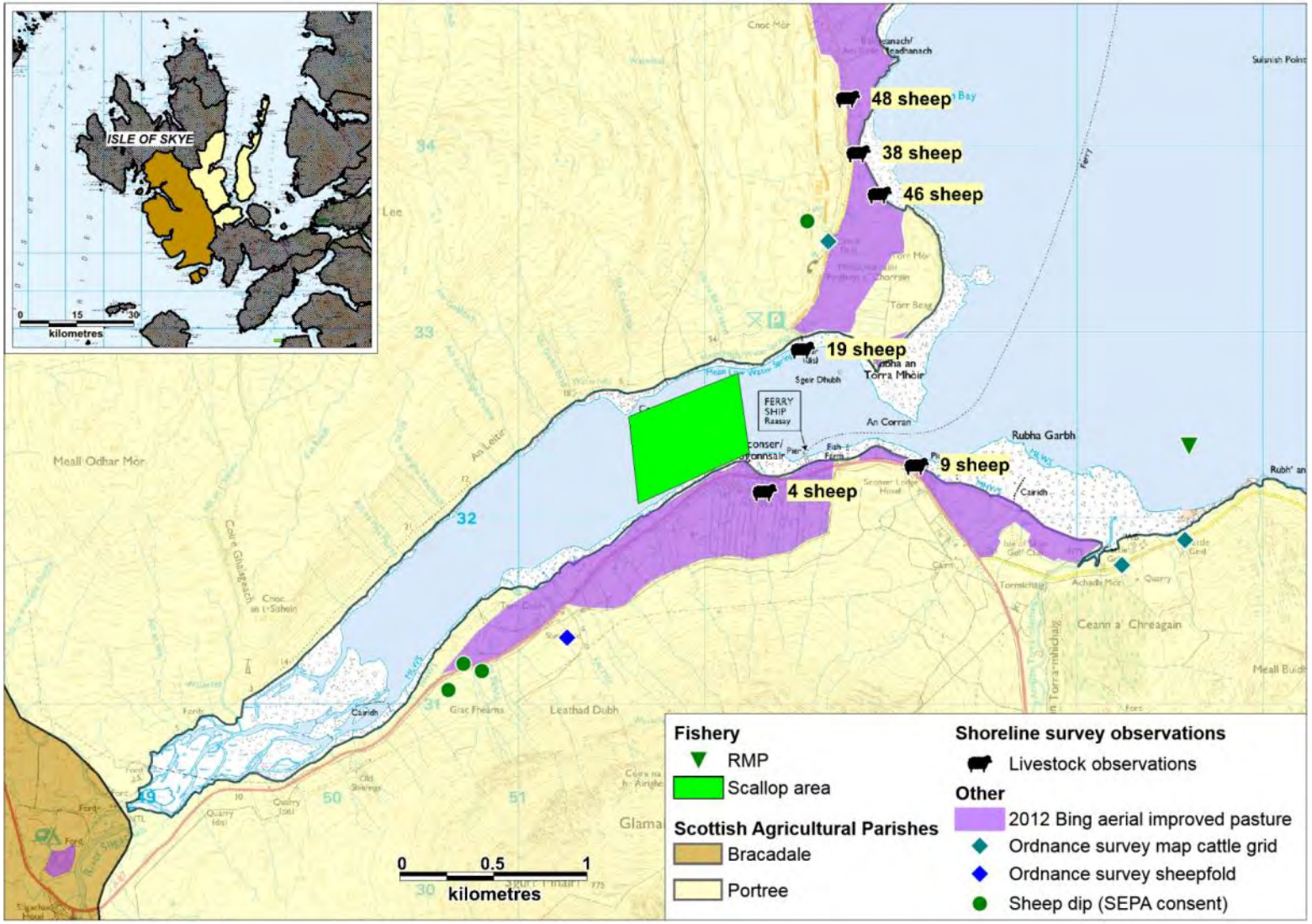


Figure 5.1 Livestock observations at Loch Sligachan

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 (pinnipeds), whales (cetaceans) and some seabirds may deposit faecal wastes directly into the sea, whilst birds and mammals present on land will contribute a proportion of any faecal indicator loading carried in diffuse run-off or watercourses.

The species for which information was potentially available and which could contribute to faecal indicator levels at Loch Sligachan are considered below.

Pinnipeds

The Special Committee on Seals 2013 Report noted that in the month of August between the years 2007 and 2011, 10 harbour seals were observed in the general area of Loch Sligachan: it should be noted that the counts relate to 10 km grids. The report also noted moderately sized harbour seal haul out sites south of the Isle of Skye, representing approximately 200 seals. During the same period, no grey seals were observed. No seals were observed during the shoreline survey.

Cetaceans

There are reports that bottlenose and common dolphins, as well as Minke whales are common in the waters around the Isle of Syke, with the later present during March and October (IsleofSkye.com, n.d.). There are also anecdotal accounts of porpoise being observed in Loch Sligachan (Jagger & Jagger, 2011). No cetaceans were observed during the shoreline survey.

Seabirds

Seabird data was downloaded from the collated JNCC dataset from the website (JNCC, 2014) in March 2014. The dataset was then manipulated to show the most recent data where repetitions of counts were present. It should be appreciated that the sources of this data are varied, with some recorded as unknown or estimated, whilst some come from reliable detailed surveys such as those carried out for the Seabird 2000 report by Mitchell *et al.*, (2004). Data applicable for the 5 km area around the fishery are listed in Table 6.1.

Table 6.1 Seabird counts within 5 km of Loch Sligachan

Common name	Species name	Count*	Method	Accuracy
Herring Gull	*Larus argentatus*	8	Occupied nests	Accurate
Great Black-Backed Gull	*Larus marinus*	2	Occupied nests	Accurate

*Counts have been doubled to represent accurate numbers of birds in occupied nest sites.

Only two bird observations were made to the area within 5 km of Loch Sligachan, both of which were located to the north of the loch, on the small island Sgeir Dhubh.

During the shoreline survey, seabirds were the only wildlife observed and included gulls and oystercatchers, with the former being most numerous. The densest aggregation of birds was noted at the fish farm located near the mouth of the loch, at the eastern end of Sconser.

No information was found on winter populations of birds, particularly wading birds and waterfowl that are likely to be present in higher numbers during the autumn and winter months.

Otters

The European otter (*Lutra lutra*) is known to be common on the Isle of Skye. However there were no specific reports of otters in Loch Sligachan, except for anecdotal accounts of them in the loch (Jagger & Jagger, 2011). No otters were observed during the shoreline survey.

Deer

Red deer are common on the Isle of Skye, and often come down from hillsides/mountains to land around the shoreline during the colder winter months (IsleofSkye.com, n.d.). No deer were observed during the shoreline survey.

Overall

Wildlife are not expected be significant source of contamination to the Loch Sligachan scallop fisheries, although they will contribute to background levels of contamination throughout the loch. The limited amount of contamination from wildlife will be mainly attributable to seabirds, including gulls and oystercatchers, and any impact will be sporadic in both spatial and temporal terms. Minor input may occur from other species such as seals, otters and deer.

Figure 6.1 Map of wildlife distributions around Loch Sligachan

7. Land Cover

The Land Cover Map 2007 data for the area is shown in Figure 7.1. There are no built up or urban areas represented. The predominant land cover types adjacent to Loch Sligachan are improved grassland, rough grassland and dwarf shrub heath. There are also scattered areas of acid grassland, bog, coniferous woodland and broad leaved woodland. No urban areas are identified . The shorelines north west and south of the shellfish harvesting area are composed of improved grassland.

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 Sligachen scallop farm is from the areas of improved grassland located to the northwest, northeast, and south of the fishery. Any impact is likely to be greatest on the southern side of the shellfish harvesting area, where there is a larger extent of grazing land directly adjacent. This contribution would be expected to increase after rainfall events.

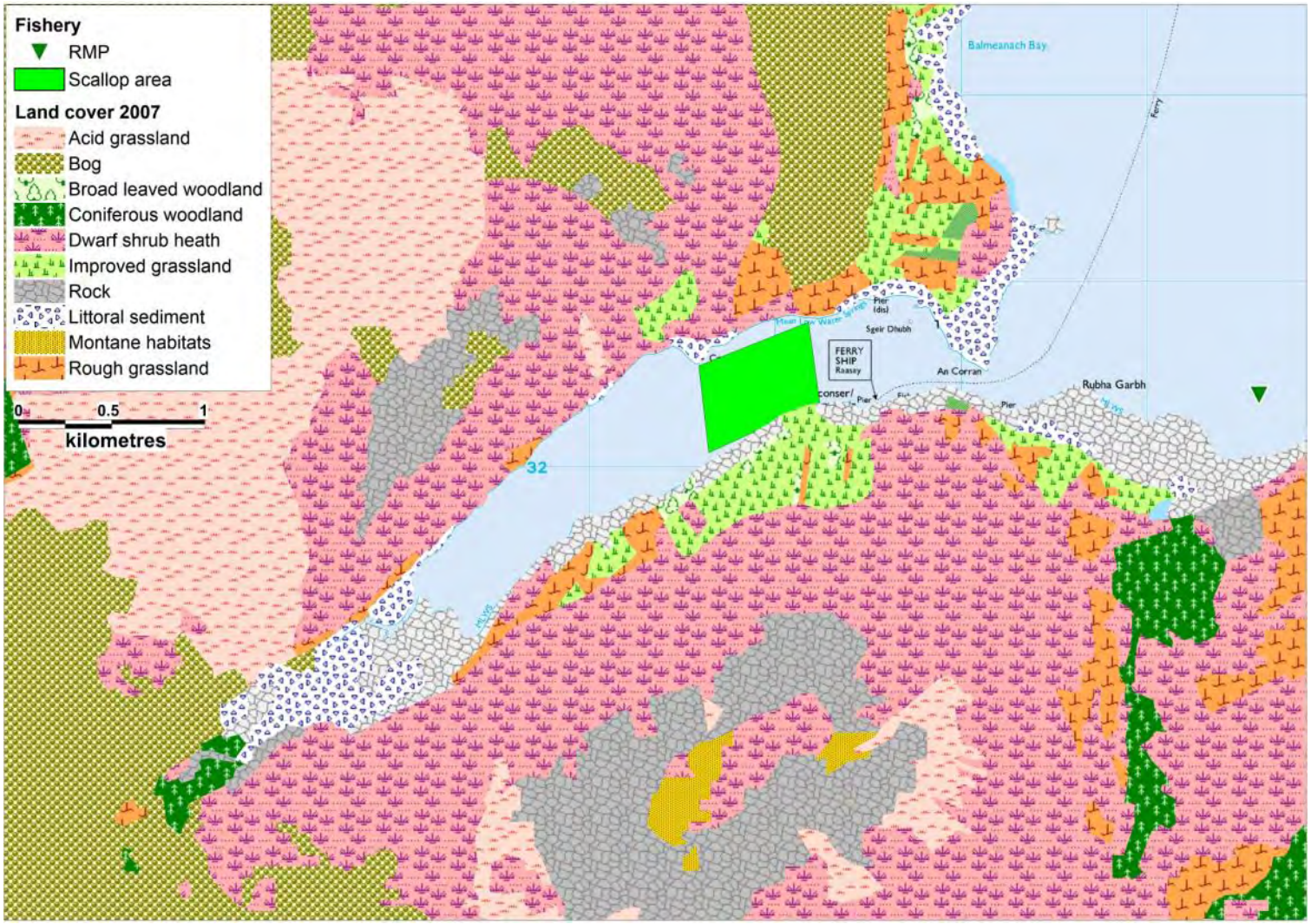


Figure 7.1 LCM2007 land cover data for the area around Loch Sligachan

8. Watercourses

There are no gauging stations on watercourses entering Loch Sligachan.

Spot measurements of flow and microbial content were obtained during the shoreline survey conducted on the 14th & 15th July 2014. Light precipitation was recorded in the 48 hrs prior to the survey. The watercourses listed in Table 8.1 are those recorded during the shoreline survey. An area of land drainage was observed north of Loch Sligachan and another area east of Sconser. The locations and loadings of measured watercourses are shown in Figure 8.1.

Table 8.1 Watercourses entering Loch Sligachan

No.	Eastings	Northings	Description	Width (m)		Depth (m)		Flow (m^3/d)		Loading (*E. coli* per day)
1	148878	830467	Allt Dubh	1.5[1]	1.35[2]	0.13[1]	0.1[2]	8360[1]	3980[2]	3.5×10^{10}
2	148924	830457	River Sligachan	9.1[1]	24[2]	0.15[1]	0.09[2]	92800[1]	75800[2]	4.7×10^{11}
3	151096	831649	Unnamed watercourse	Not measured or sampled						Not determined
4	151166	831672	Eas Mòr	1.3		0.09		4680		4.7×10^{08}
5	152340	832307	Unnamed watercourse	2.1		0.11		7110		1.4×10^{12}
6	152518	832287	Culvert	0.8		0.05		9		1.7×10^{09}
7	152683	832307	Unnamed watercourse	Not measured or sampled						Not determined
8	152995	832344	Unnamed watercourse	Not measured or sampled						Not determined
9	153140	832279	Unnamed watercourse	Not measured or sampled						Not determined
10	153247	832211	Unnamed watercourse	0.65		0.07		1050		2.2×10^{09}
11	153533	832121	Unnamed watercourse	1.6		0.12		1710		1.0×10^{12}
12	153700	832037	Unnamed watercourse	1.1		0.12		890		8.9×10^{08}
13	154176	831874	Abhuinn Torra-mhichaig	1.5		0.25		48100		2.4×10^{10}
14	154402	831916	Unnamed watercourse	0.12		0.03		142		$<1.4 \times 10^{07}$*
15	154536	831919	Unnamed watercourse	1.0		0.06		1380		8.3×10^{08}

[1] Branch 1 [2] Branch 2 (Both the Allt Dubh and River Sligachan had two branches. Loadings for each branch were estimated separately and then combined to give the overall loading.

* Where *E. coli* values were less than the limit of detection, that value was used to estimate the upper limit for the loading.

There are additional watercourses along most of the coastline of Loch Sligachan, including the northern shoreline adjacent to the harvesting area. However, the northern shoreline was largely inaccessible and therefore was not surveyed.

The largest watercourses observed entering the survey area were the River Sligachan at the western end of the loch and Abhuinn Torra-mhicaig on the eastern southern shoreline of the loch, both of which had high estimated *E. coli* loadings. Four small watercourses were recorded but not measured or sampled, the locations of which are shown in Figure 8.1. A culvert located approximately 300 m south east of the fishery had a moderate estimated *E. coli* loading. The watercourse with the highest estimated *E. coli* loading of 1.4×10^{12} discharges approximately 110 m south east of the shellfish harvesting area. The remaining watercourses recorded were located on the southern shoreline east and west of the fishery and all had moderate to high estimated *E. coli* loadings.

Overall, freshwater inputs are expected to provide moderate to high levels of contamination to the scallop fishery in Loch Sligachan, with the highest impact expected from the watercourses that discharge closest to the shellfish farm on the south eastern coastline. The inaccessible watercourses adjacent to the fishery on the northern shoreline could also potentially provide varying levels of contamination to the fishery.

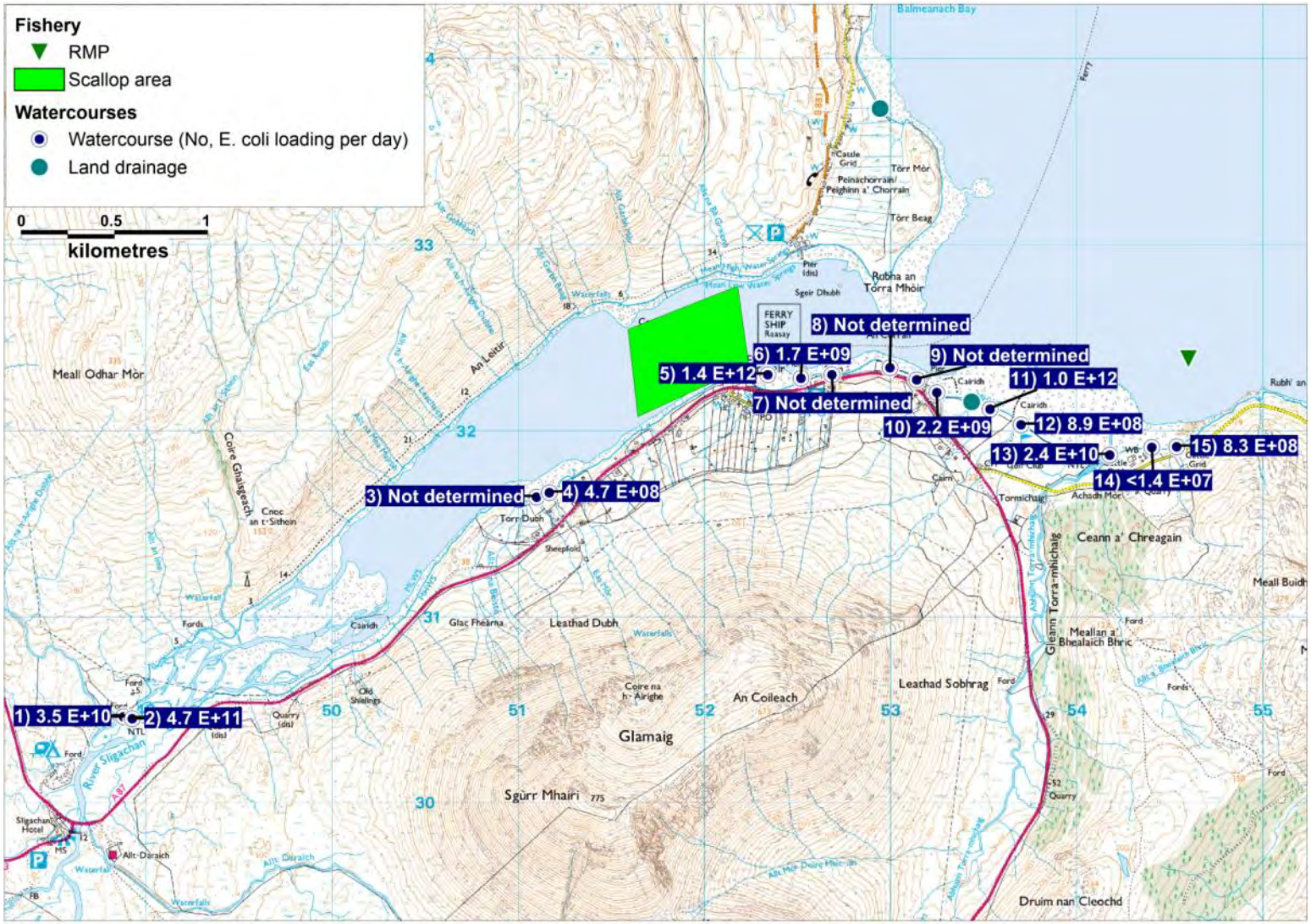


Figure 8.1 Map of watercourse loadings at Loch Sligachan

9. Meteorological Data

The nearest weather station for which a nearly complete rainfall data set was available is Skye: Lusa, situated approximately 20 km to the west of the production area. Rainfall data was available for January 2008 – December 2013 but data were excluded from assessment during validation when they were made up of accumulated or estimated values. Dates excluded are: 11/01/08-14/01/08, 31/03/08, 01/04/08, 04/06/08-05/06/08, 16/06/08-19/06/08, 04/05/09-05/05/09, 17/05/09-18/05/09, 10/08/09-11/08/09, 01/12/10-02/12/10, 16/08/11-20/08/11, 22/08/11, 29/10/11-30/10/11, 22/08/12-23/08/12 and 04/12/12-05/12/12.

The nearest wind station is situated at South Uist: Range, located 76 km west of the production area. Conditions may differ between this station and the fisheries due to the distances between them. However, this data is still shown as it can be useful in identifying seasonal variation in wind patterns.

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 Sligachan.

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 *.

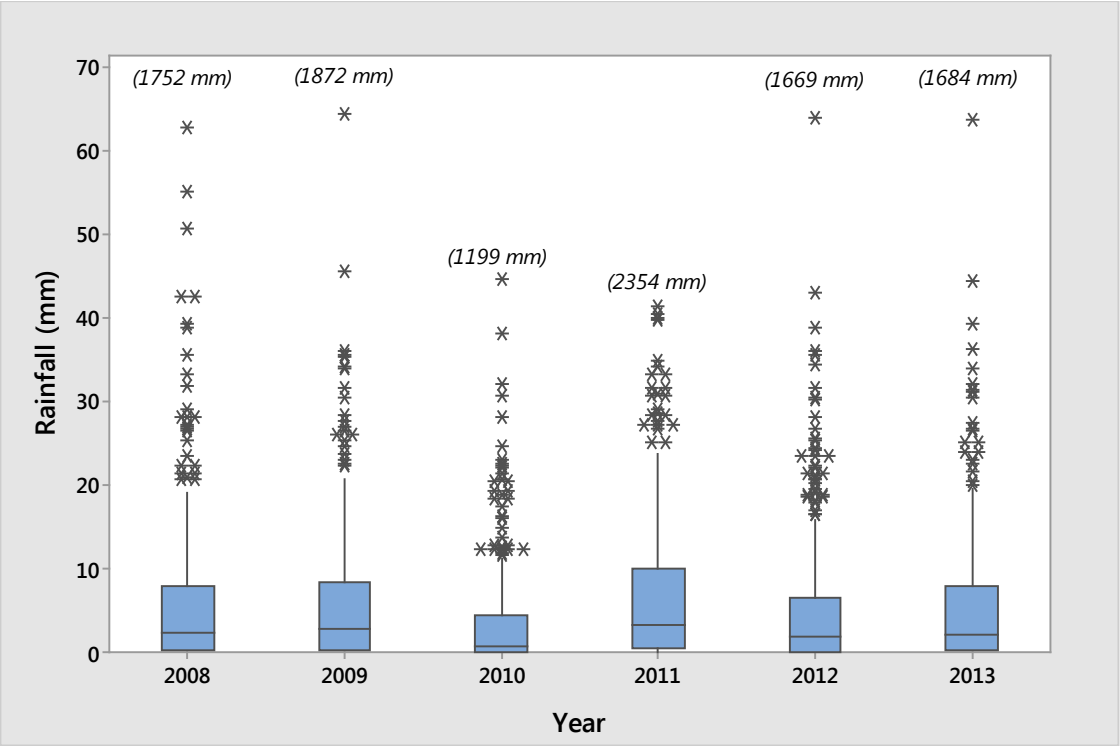


Figure 9.1 Box plot of daily rainfall values by year at Skye: Lusa (2008 – 2013)

Daily rainfall values varied from year to year, with 2010 having the lowest overall daily rainfall and the lowest total rainfall (1199 mm). The wettest year was 2011 (2354 mm). Rainfall values exceeding 40 mm/d occurred in all years, but extreme rainfall values exceeding 60 mm/d occurred in 2008, 2009, 2012 and 2013.

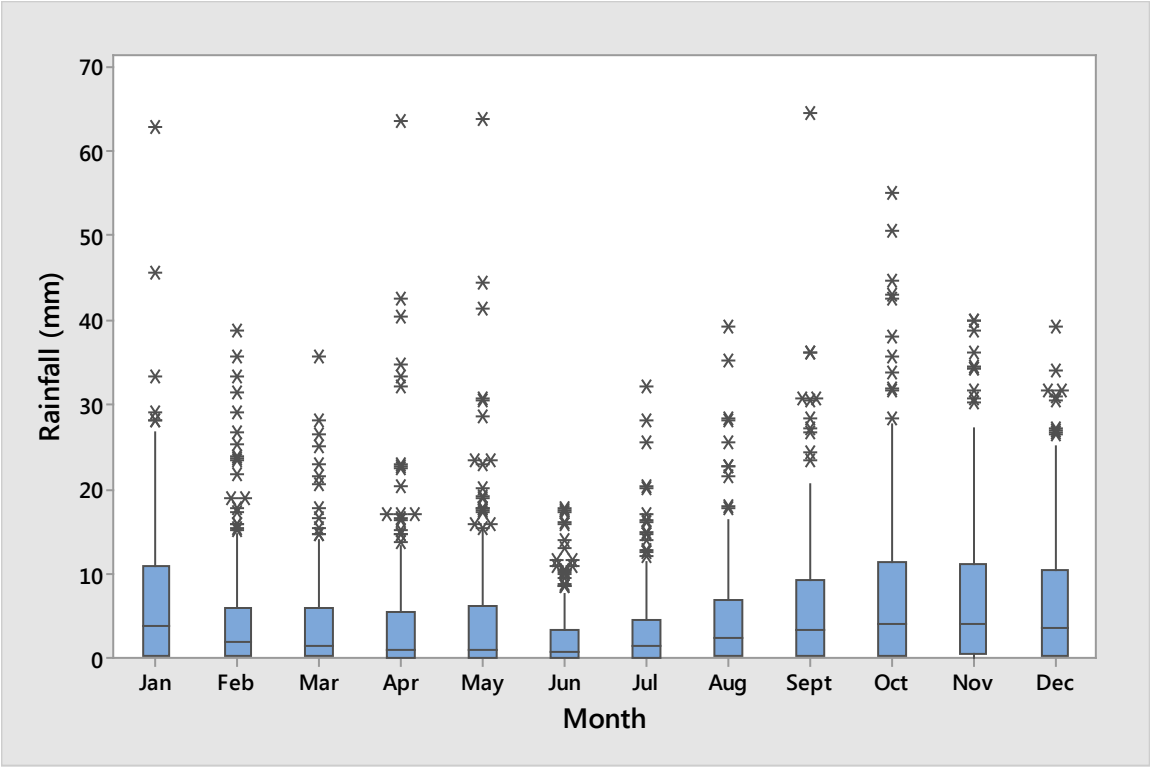


Figure 9.2 Box plot of daily rainfall values by month at Skye: Lusa (2008 – 2013)

Daily rainfall values were higher during the autumn and winter. Rainfall was greatest in October (1348 mm). Weather was driest in June (429 mm). Rainfall values exceeding 30 mm/d occurred in all months bar June and extreme rainfall values of 60 mm/d were seen in January, April, May and September.

For the period considered here (2008 – 2013) 40 % of days received daily rainfall of less than 1 mm and 19 % of days received daily rainfall of over 10 mm.

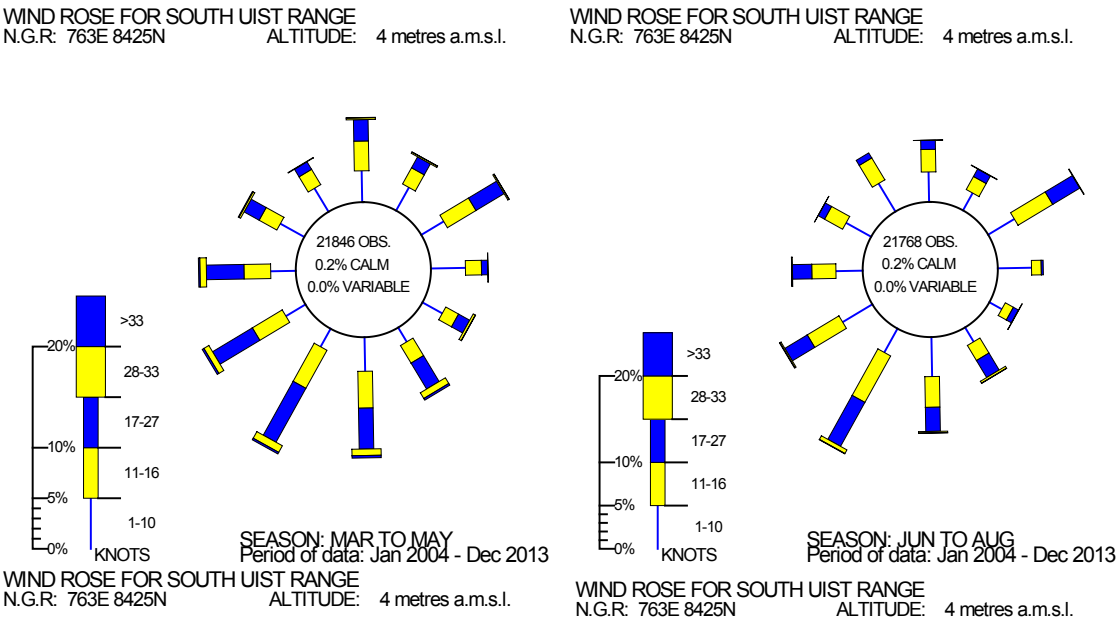
It is therefore expected that run-off due to rainfall will be higher during the autumn and winter months. However, extreme rainfall events leading to episodes of high runoff can occur in most months and when these occur during generally drier periods in late spring and summer, they are likely to carry 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 South Uist: Range and summarised in seasonal wind roses in Figure 9.3 and annually in Figure 9.4.

Overall, the strongest winds tended to come from the southwest quarter. Seasonally the strongest winds occurred during the winter with those from the south and west predominating, in the spring and summer a notable proportion of strong winds came from the east-northeast.

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 production area.



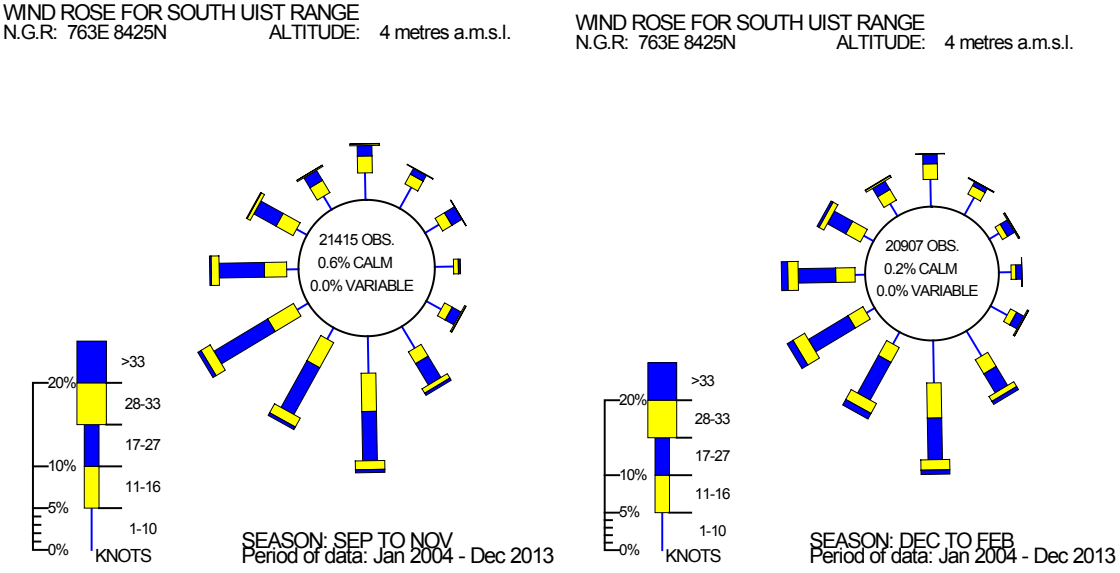


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Figure 9.3 Seasonal wind roses for South Uist: Range

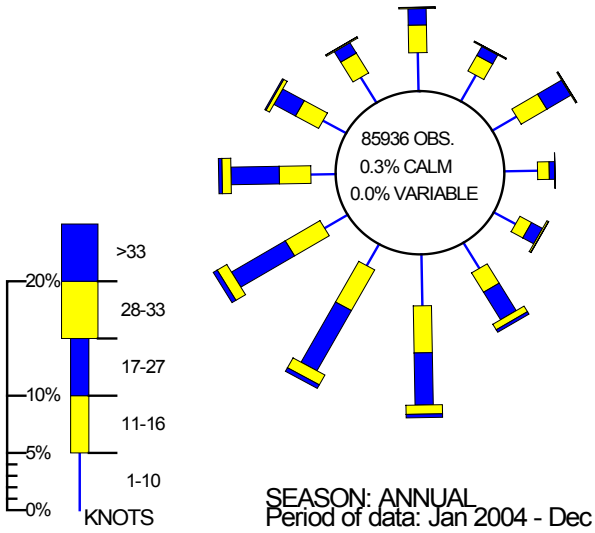

Figure 9.4 Annual wind rose for South Uist: Range

10. Classification Information

Loch Sligachan is classified for production of king scallops (*Pecten maximus*). The classification history since 2006 is listed in Table 10.1.

Table 10.1 Loch Sligachan: (king scallops) classification history

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	A	A	A	A	A	B	B	B	B	A	A	A
2007	A	A	A	A	A	B	B	A	A	A	A	A
2008	A	A	A	A	A	A	B	B	B	A	A	A
2009	A	A	A	A	A	A	A	A	A	A	A	A
2010	A	A	A	A	A	A	A	A	A	A	A	A
2011	A	A	A	A	A	A	A	A	A	A	A	A
2012	A	A	A	A	A	A	A	A	A	A	A	A
2013	A	A	A	A	A	A	A	A	A	A	A	A
2014	A	A	A	A	A	A	A	A	A	A	A	A
2015	A	A	A									

The area has been given a year-round A classification since 2009.

11. Historical *E. coli* Data

Results for all samples assigned against Loch Sligachan production area for the period 01/01/2009 to the 09/09/2014 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 on 09/09/2014. All *E. coli* results were reported as most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

Fifteen sample results reported as <18 or <20 were reassigned a value of 10 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

Four samples were recorded as rejected and were omitted from further analysis. Two samples were also omitted from further analysis as the reported sampling locations plotted >100 m outside the production area boundaries. The remaining 51 samples were all received within 48 hours of collection, with box temperatures of <8^{o}C.

11.1 Summary of microbiological results

Loch Sligachan historical sample results sampling and result summaries are displayed in Table 11.1.

Table 11.1 Summary of historical sampling and results

Sampling Summary	
Production area	Loch Sligachan
Site	Loch Sligachan
Species	King scallops
SIN	SL-195-291-07
Location	Various
Total no of samples	51
No. 2009	7
No. 2010	5
No. 2011	10
No. 2012	10
No. 2013	12
No. 2014	7
Results Summary	
Minimum	<20
Maximum	630
Median	50
Geometric mean	49
90 percentile	330
95 percentile	490
No. exceeding 230/100g	7 (14%)
No. exceeding 1000/100g	0
No. exceeding 4600/100g	0
No. exceeding 18000/100g	0

The majority of sample results have been <230 *E. coli* MPN/100 g.

11.2 Overall geographical pattern of results

Eight unverified samples, seven in 2012 and one in 2013, could not be included in the spatial assessment as sampling locations were not reported. Three samples appeared to have the correct location reported apart from the two letter prefix and these were corrected prior to assessment. The reported geographical locations of the remaining 44 samples are shown in Figure 11.1 with the symbol sizes graduated in proportion to the *E. coli* results.

Sampling has been reported at two locations: the first at the RMP located on the southern side of the mouth of the loch and the second located in the vicinity of an alternative RMP sited at the south-eastern corner of the present fishery.

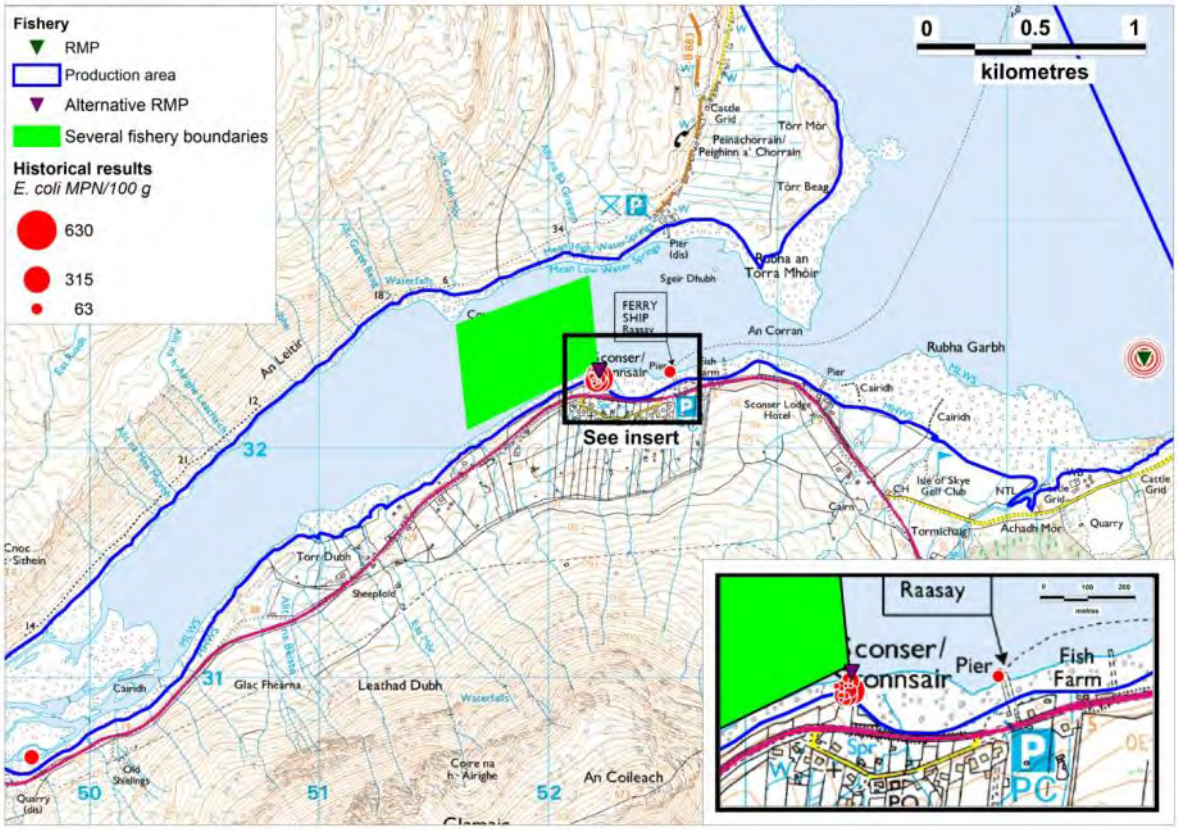

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Figure 11.1 Map of reported sampling locations for King scallops at Loch Sligachan

An unpaired t-test was carried out to determine whether there was a statistically significant difference between the geometric means of results from samples taken at the RMP and the alternative RMP. No statistically significant difference was found between sites (t-test; t = -1.14, DF = 30, p = 0.265). However, it should be noted that only one sample result exceeded 230 *E. coli* MPN/100 g at Site 1, whereas six sample results exceeded this value at Site 2. A summary of results taken at each site is listed in Table 11.2.

There has been too little variation in sampling location in the vicinity of the alternative RMP to allow any assessment of spatial variation in results across the present scallop fishery.

Table 11.2 Summary of sampling results at sites 1 and 2

Site	No. of samples	Lowest sample result	Highest sample result	Geometric mean
Current RMP	28	<20	630	60
Alternative RMP	14	<20	330	37

11.3 Overall temporal pattern of results

A scatterplot of *E. coli* results against date for Loch Sligachan is presented in Figure 11.2. The dataset is fitted with a lowess trend line. Lowess trendlines allow for locally weighted regression scatter plot smoothing. At each point in the dataset an estimated value is fitted to a subset of the data, using weighted least squares. The approach gives more weight to points near to the x-value where the estimate is being made and less weight to points further away. In terms of the monitoring data, this means that any point on the lowess line is influenced more by the data close to it (in time) and less by the data further away. A trend line helps to highlight any apparent underlying trends or cycles.

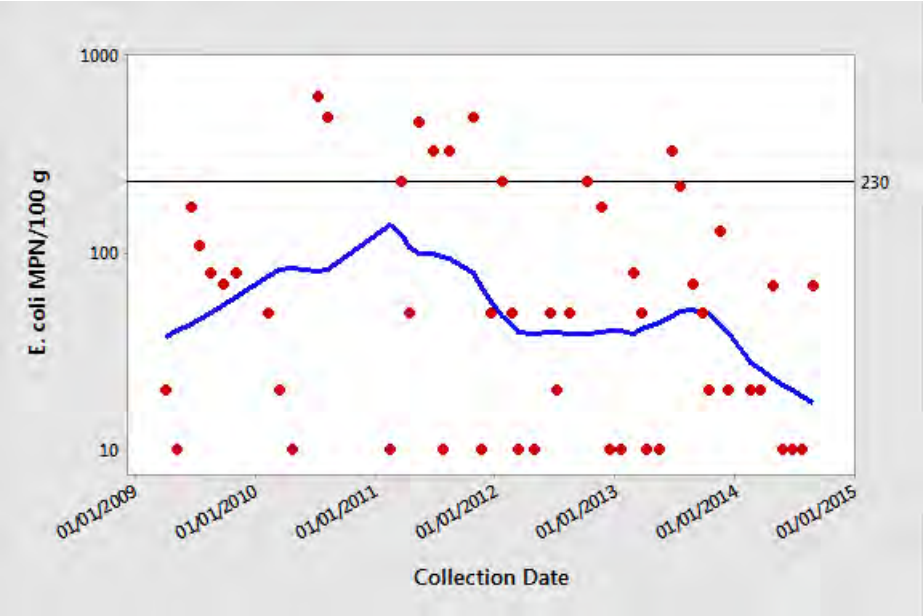


Figure 11.2 Scatterplot of E. coli results by collection date at Loch Sligachan, fitted with a lowess line

There is some indication in the trend plot of an overall decrease in contamination with time. However, it is not possible to derive any conclusions from this as the location of sampling has changed within the assessment period.

11.4 Seasonal pattern of results

Season dictates not only weather patterns and water temperature, but livestock numbers and movements, presence of wild animals and patterns in human distribution. All of these can affect levels of microbial contamination, causing seasonal patterns in results. A scatterplot of *E. coli* results by month, overlaid by a lowess line to highlight trends for Loch Sligachan is displayed in Figure 11.3. Jittering was applied at 0.02 (x-axis) and 0.001 (y-axis) respectively.

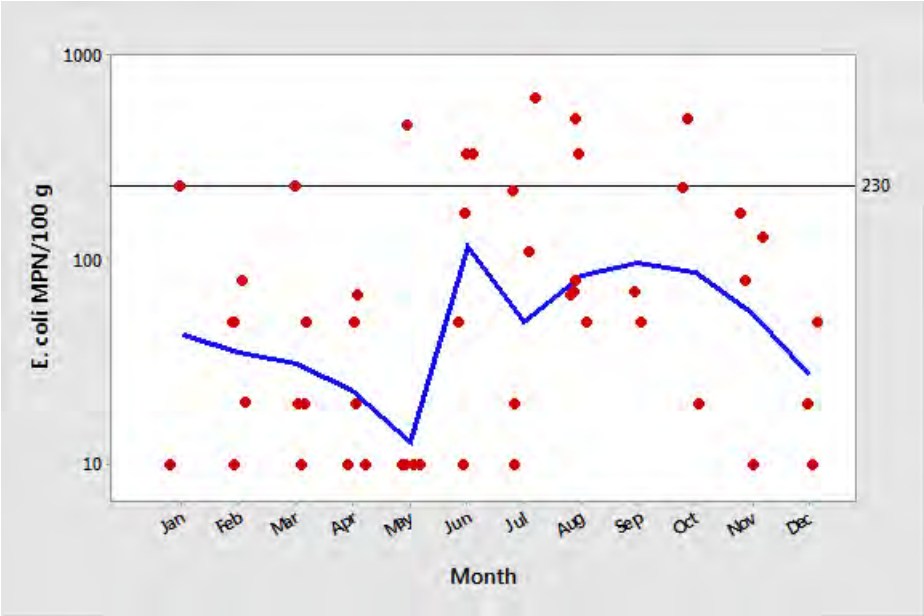


Figure 11.3 Scatterplot of *E. coli* results by month at Loch Sligachan, fitted with a lowess line

Sampling was relatively even across months. Results >230 *E. coli* MPN/100 g occurred between May and October.

For statistical evaluation, seasons were split into spring (March-May), summer (June-August), autumn (September-November) and winter (December-February). A boxplot of *E. coli* results by season for Loch Sligachan is presented in Figure 11.4.

A statistically significant difference was found between *E. coli* results for Loch Sligachan by season (one-way ANOVA, p = 0.025) (Appendix 4). Average *E. coli* results were significantly higher in summer than in spring.

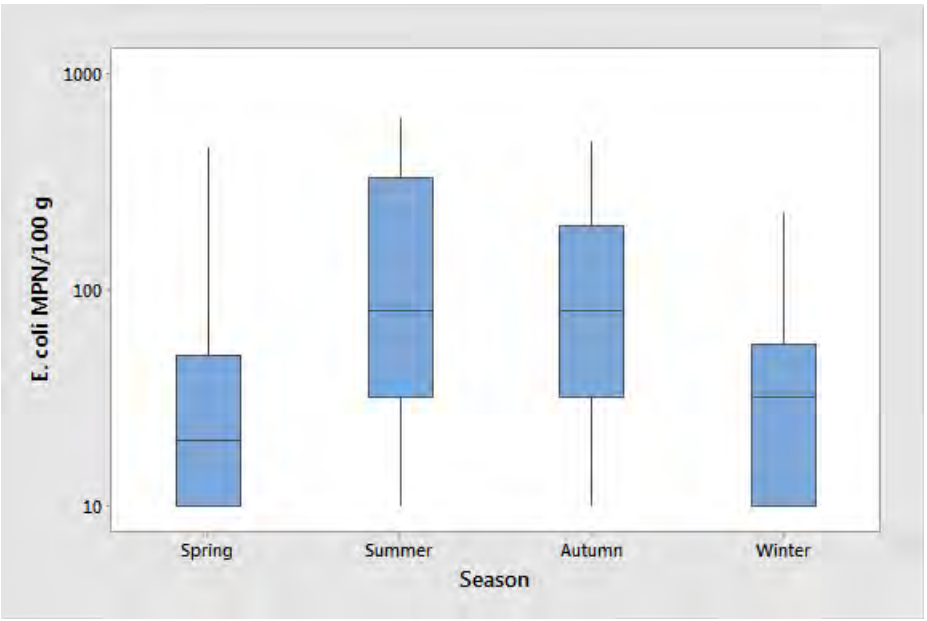


Figure 11.4 Boxplot of *E. coli* results by season at Loch Sligachan

11.5 Analysis of results against environmental factors

Environmental factors such as rainfall, tides, wind, sunshine and temperature can all influence the flux of faecal contamination into growing waters (Mallin, et al., 2001; Lee & Morgan, 2003). The effects of these influences can be complex and difficult to interpret. This section aims to investigate and describe the influence of these factors individually (where appropriate environmental data is available) on the sample results using basic statistical techniques.

11.5.1 Analysis of results by recent rainfall

The nearest weather station with available rainfall data was at Skye: Lusa approximately 20 km west of Loch Sligachan. Rainfall data was purchased from the Meteorological Office for the period of 01/01/09-31/12/2013 (total daily rainfall in mm). Data was extracted from this for all sampling occasions at Loch Sligachan between 01/01/2009-31/12/2013.

Two-day rainfall

A scatterplot of *E. coli* results against total rainfall recorded on the two days prior to sampling for Loch Sligachan is displayed in Figure 11.5. Rainfall data was available for 40 out of the 51 sample results. Jittering was applied at 0.02 (x-axis) and 0.001 (y-axis) respectively.

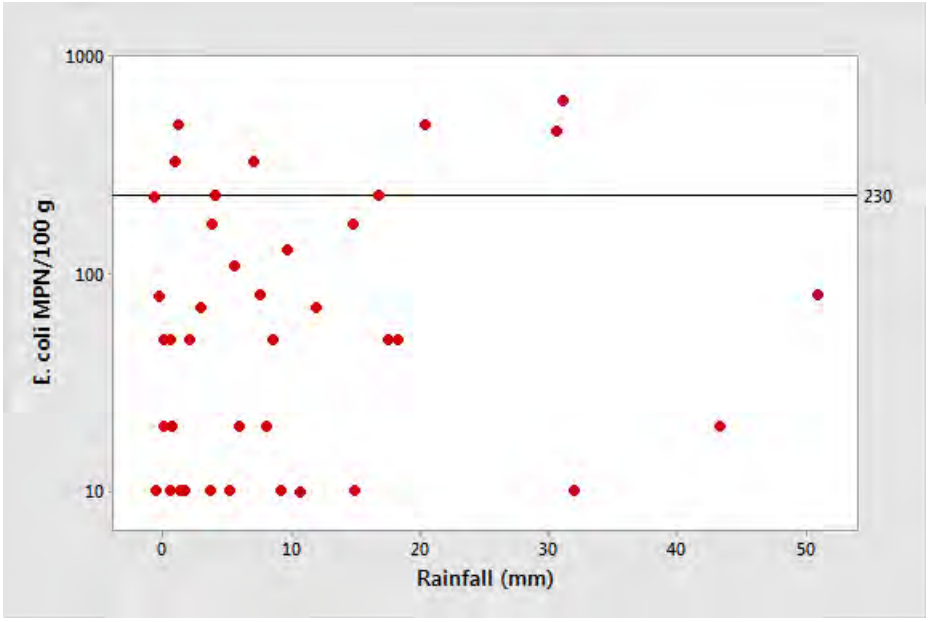


Figure 11.5 Scatterplot of *E. coli* results against rainfall in the previous two days at Loch Sligachan

No statistically significant correlation was found between *E. coli* results and the previous two day rainfall (Spearman's rank correlation r = 0.157, p = 0.333).

Seven-day rainfall

As the effects of heavy rainfall may take differing amounts of time to be reflected in shellfish sample results in different systems, the relationship between rainfall in the previous seven days and sample results was investigated in an identical manner to the above. A scatterplot of *E. coli* results against total rainfall recorded for the seven days prior to sampling at Loch Sligachan is shown in Figure 11.6. Rainfall data was available for 37 out of the 51 sample results. Jittering was applied at 0.02 (x-axis) and 0.001 (y-axis) respectively.

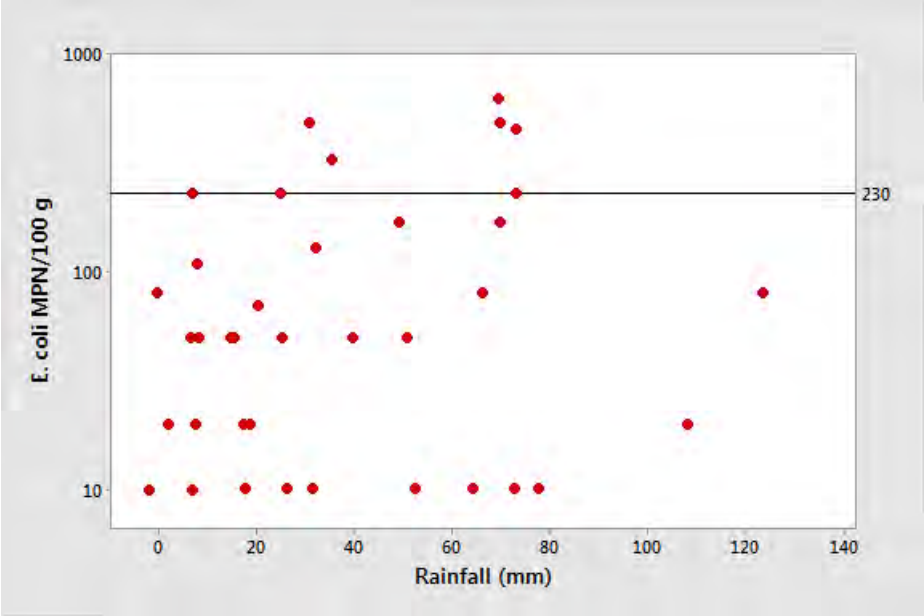


Figure 11.6 Scatterplot of *E. coli* results against rainfall in the previous seven days at Loch Sligachan

No statistically significant correlation was found between *E. coli* results and the previous seven day rainfall (Spearman's rank correlation r = 0.222, p = 0.186).

11.5.2 Analysis of results by tidal height

Spring/neap tidal cycle

Spring tides are large tides that occur fortnightly and are influenced by the state of the lunar cycle. They reach above the mean high water mark and therefore increase circulation and particle transport distances from potential contamination sources on the shoreline. The largest (spring) tides occur approximately two days after the full/new moon, at about 45º on a polar plot. The tides then decrease to the smallest (neap) tides, at about 225º, before increasing back to spring tides. A polar plot of *E. coli* results against the lunar cycle is shown for Loch Sligachan in Figure 11.7. It should be noted local meteorological conditions (e.g. wind strength and direction) can also influence tide height, but are not taken into account in this section.

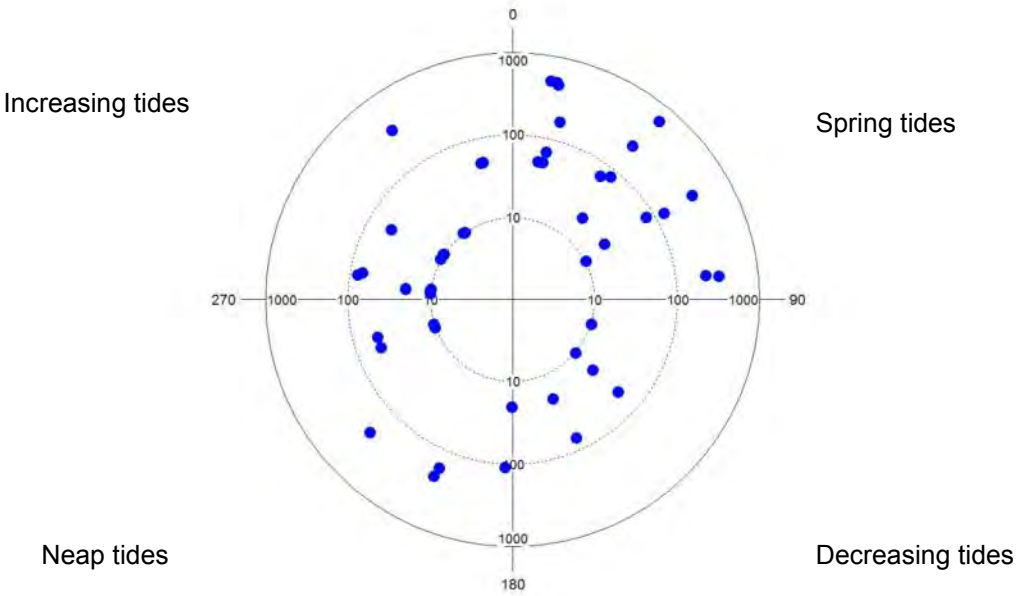


Figure 11.7 Polar plots of *E. coli* results on the spring/neap tidal cycle at Loch Sligachan

A highly significant correlation was found between $\log_{10}$ *E. coli* results and the spring/neap tidal cycle (circular-linear correlation r = 0.345, p = 0.003), with the majority of results >230 *E.coli* MPN/100 g taken on spring tides.

High/low tidal cycle

Tidal state (high/low tide) changes the direction and strength of water flow around production areas. Depending on the location of contamination sources, tidal state may cause marked changes in water quality near the vicinity of the farms. Shellfish species response time to *E. coli* levels can vary from within an hour to a few hours. A polar plot of *E. coli* results against the high/low tidal cycle for Loch Sligachan is shown in Figure 11.8. High water is located at 0º on the polar plot and low water at 180º.

High and low water data from Portree was extracted from POLTIPS-3 in September 2014. This site was the closest to the production area (approximately 11 km to the southeast) and it is assumed that the tidal state will be similar between sites.

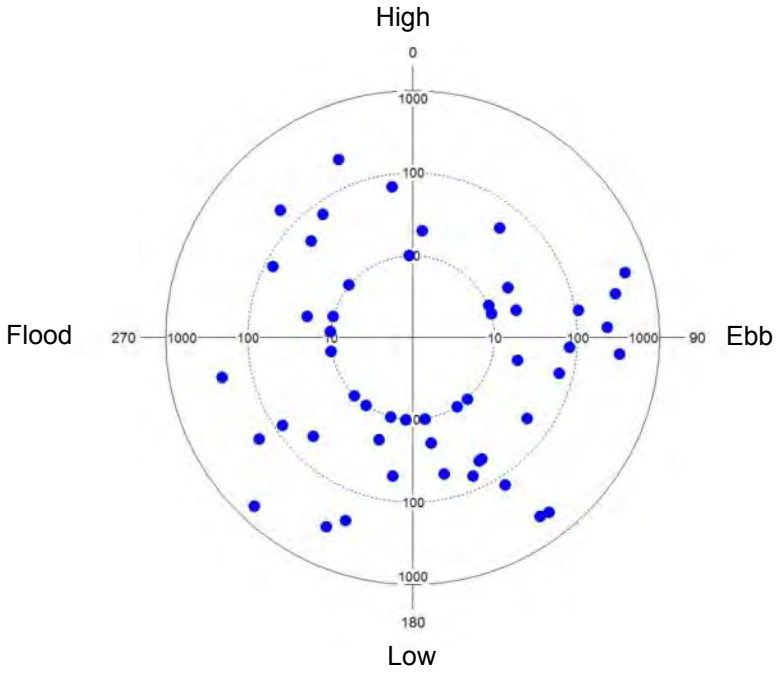


Figure 11.8 Polar plots of *E. coli* results on the high/low tidal cycle at Loch Sligachan

No statistically significant correlation was found between $\log_{10}$ *E. coli* results and the high/low tidal cycle (circular-linear correlation r = 0.128, p = 0.453).

11.5.3 Analysis of results by water temperature

Water temperature can affect survival time of bacteria in seawater (Burkhardt, et al., 2000). It can also affect the feeding and elimination rates in shellfish and therefore may be an important predictor of *E. coli* levels in shellfish flesh. Water temperature is obviously closely related to season. Any correlation between temperatures and *E. coli* levels in shellfish flesh may therefore not be directly attributable to temperature, but to the other factors e.g. seasonal differences in livestock grazing patterns. Water temperature was recorded for 47/51 Loch Sligachan samples. A scatterplot of *E. coli* results against water temperature for Loch Sligachan is shown in Figure 11.9. Jittering was applied at 0.02 (x-axis) and 0.001 (y-axis) respectively.

No statistically significant correlation was found between *E. coli* results and water temperature (Spearman's rank correlation r = 0.067, p = 0.656).

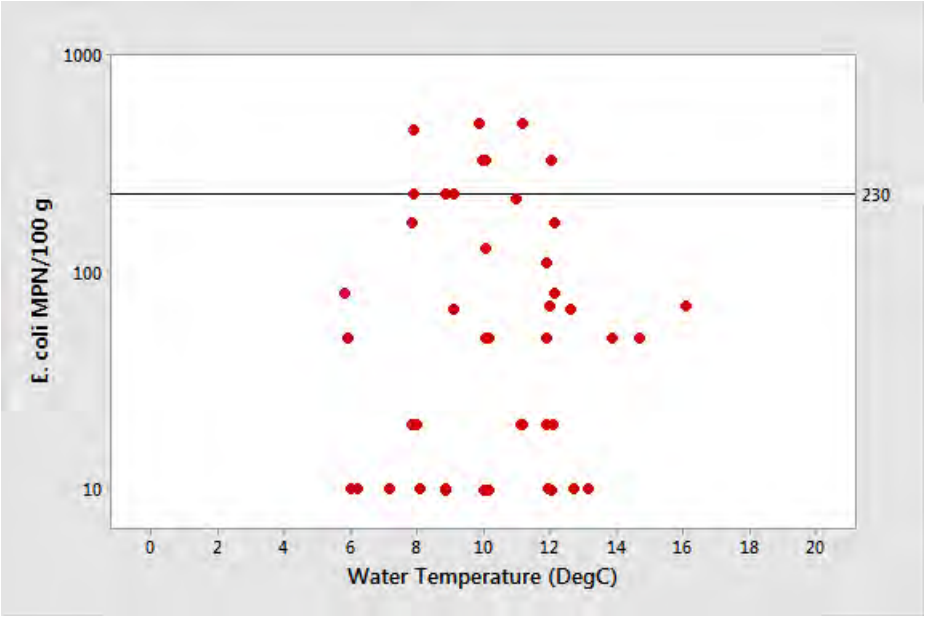


Figure 11.9 Scatterplot of *E. coli* results against water temperature at Loch Sligachan

11.5.4 Analysis of results by salinity

Salinity will give a direct measure of freshwater influence and hence freshwater borne contamination at a site. Insufficient salinity data prevented the analysis of results against salinity for this report.

11.6 Evaluation of results over 230 *E. coli* MPN/100 g

In the results from Loch Sligachan, seven King scallop samples had results >230 *E. coli* MPN/100 g. These are listed in Table 11.2.

Table 11.3 Loch Sligachan historic *E. coli* sampling results over 230 *E. coli* MPN/100 g

Collection Date	*E. coli* (MPN/ 100g)	Location	2 day rainfall (mm)	7 day rainfall (mm)	Water Temp (ºC)	Salinity (ppt)	Tidal state (spring/neap)	Tidal State (high/low)
12/07/2010	630	NG 546 324	31.1	71.7	-	-	Spring	Low
10/08/2010	490	NG 546 324	20.7	28.6	10.0	-	Spring	High
17/05/2011	460	NG 546 324	29.8	73.3	8.0	35	Spring	Ebb
28/06/2011	330	NG 546 324	7.7	33.8	10.0	-	Increasing	Low
16/08/2011	330	NG 546 324	-	-	12.0	-	Spring	High
26/10/2011	490	NG 546 324	1.3	71.8	11.0	-	Spring	Ebb
25/06/2013	330	NG 5222 3231	0.1	-	10.0	-	Spring	Ebb

-No data available

Out of the seven elevated results, four were taken in 2011, two in 2010 and one in 2013. They were attributed to months between May and October, with two noted in both June and August. Six of the seven samples were reported to have been taken at the RMP at NG 5461 3240, whilst one sample was taken close to the alternative RMP.

Rainfall over the previous two days varied between 0.1 and 31.3 mm and in rainfall over the previous seven days between 28.6 and 71.8 mm. Rainfall data for the previous two days was absent for one sample result and rainfall state for the previous seven days was absent for two of the sample results.

Six of the seven high results were taken at spring tide.

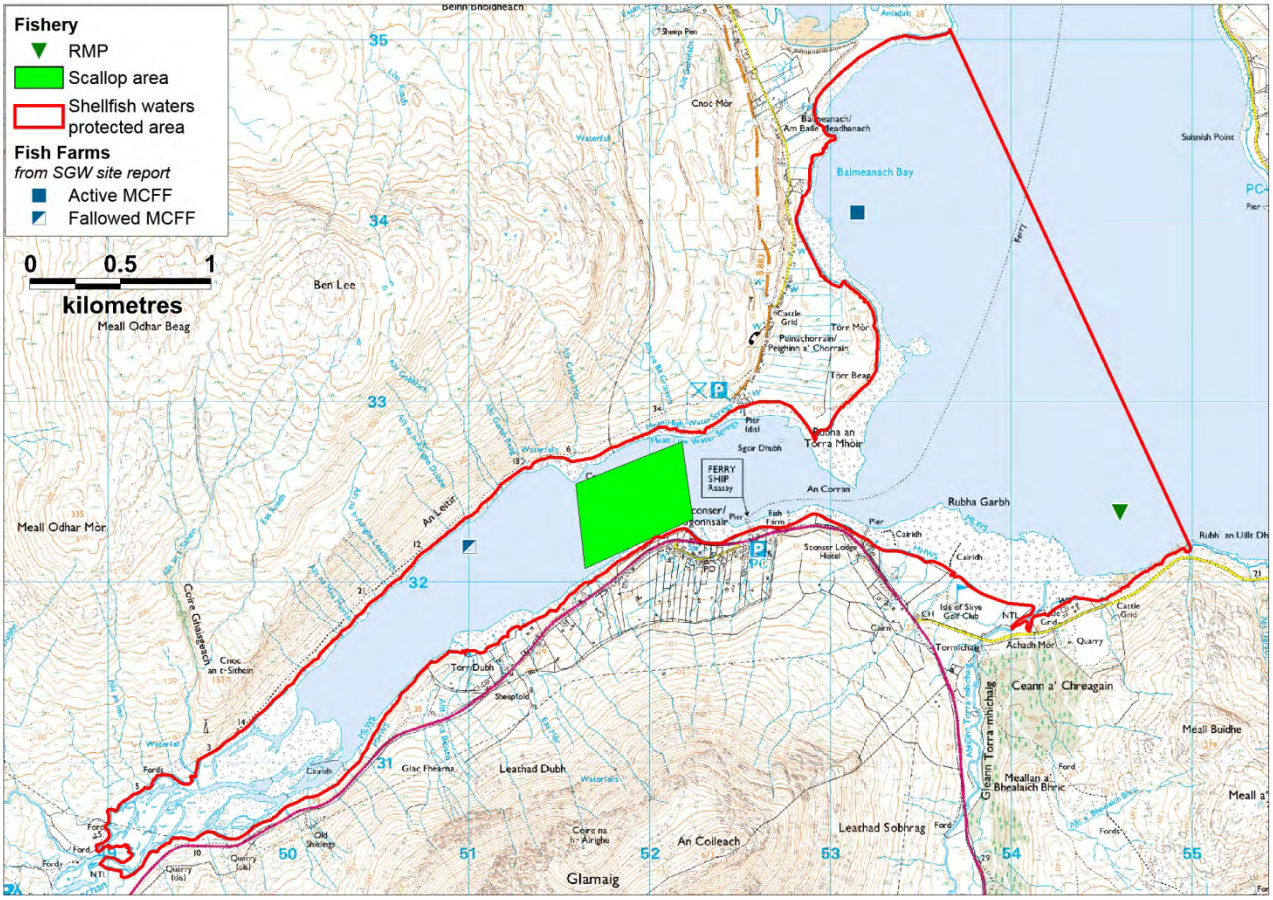
11.7 Summary and conclusions

Sampling prior to 2013 was reported to have taken place at the nominal RMP, in an area no longer used for the harvest of scallops. Since then, sampling has been reported to have been mainly undertaken in the vicinity of an alternative RMP located on the current fishery. However, nearly as many 2014 samples have been reported against the nominal RMP (3) as were reported against the alternative RMP (4). Although most of the results exceeding 230 MPN/100 g were reported against the RMP, there was no significant difference in average *E. coli* concentrations obtained at the two locations. The high results were all seen been May and October. There was a statistically significant difference in average *E. coli* between seasons, with that in summer being significantly higher than in spring. A highly statistically significant correlation was found between the spring/neap tidal cycle and *E. coli* results, with the high results mainly occurring at spring tide. No statistically significant differences were found between sample results and the high/low tidal cycle, previous two day rainfall, sample results and previous seven day rainfall, or water temperature.

12. Designated Waters Data

Shellfish Water Protected Areas

The Shellfish Waters Directive (2006/113/EC) has been repealed (as at 31 December 2013) and equivalent protection for areas previously designated under that Directive is given by The Water Environment (Shellfish Water Protected Areas: Environmental Objectives etc.) (Scotland) Regulations 2013. The Loch Sligachan Shellfish Water Protected Area (SWPA) has the same boundaries as the previous Loch Sligachan Shellfish Growing Water (SGW). The SWPA designation covers the entire loch and Baleanach Bay to the north and includes the production area and shellfish farm. The designated SWPA for Loch Sligachan is shown in Figure 12.1. Since 2007, assessment of the bacteriological status of shellfish waters has been undertaken using the shellfish hygiene *E. coli* data and this data has been reviewed in Section 11.



Produced by Cefas Weymouth Laboratory. © Crown Copyright and Database 2015. All rights reserved. Ordnance Survey licence number [GD100035675]

Figure 12.1 Designated shellfish water protected area – Loch Sligachan

The site report prepared by SEPA for this area identified that there were two marine cage fish farms within the designated area: one at Balmeanach Bay and one within the loch itself. The Loch Sligachan fish farm was identified as undergoing long term fallowing at time of the site report (2011), however it is not known for how long the site was to remain fallow.

The site report further identified that there were a number of private septic tanks around the shores and commercial discharges of sewage to the River Sligachan from a hotel and a camp site. The main source of diffuse pollution was noted to be sheep farming.

Bathing Waters

There are no designated bathing waters within Loch Sligachan.

13. Bathymetry and Hydrodynamics

13.1 Introduction

13.1.1 The Study Area

Loch Sligachan lies on the eastern coast of the Isle of Skye, within the Highland region on the west coast of Scotland. The mouth of Loch Sligachan opens to the south of the Isle of Raasay, where the Sound of Raasay meets the Inner Sound. The hydrographic assessment area for Loch Sligachan is illustrated in Figure 13.1, with the red lines demarcating the boundaries of the area. The assessment area covers the entire of Loch Sligachan, and extends beyond the mouth of the loch to the area to the south of Raasay. The northern boundary runs across the Narrows of Raasay, and the eastern boundary from Eyre Point on Raasay to Rubh' a' Chonnaidh on Scalpay. The southern limit extends from Scalpay to Maol na Gainmhich on Skye.

One large stream and several other smaller streams join the River Sligachan before it empties into the head of Loch Sligachan. The landscape around the loch is characterised by low hills, and numerous other streams flow into the loch along its whole length from both the northern and southern sides.

The total length of Loch Sligachan is 4.4 km. The loch has a relatively consistent width, being slightly narrower at the head and mouth, and with a maximum width of approximately 700 m towards the eastern end of the loch by Sconser. A spit of sand runs out from the headland at Rubha an Tòrra Mhòir at the mouth of the loch.

Figure 13.1 Extent of the hydrographic study area

Coordinates for Loch Sligachan:
57°18.780875 N 006°7.751338 W
OSGB36 National Grid 151451.062 832265.81

13.2 Bathymetry and Hydrodynamics

13.2.1 Bathymetry

Figure 13.2 shows the bathymetry of the assessment area. Loch Sligachan has one shallow sill at a depth of 4 m at its mouth. The sill is 650 m in length, and stretches from Rubh'an Torra Mhor in the north to Rubha Garbh in the south. To the west of the sill, the basin of Loch Sligachan reaches a maximum depth of 25 m. To the east of the sill, bathymetry slopes gently to approximately 35 m. The maximum depth within the assessment area to the east of the sill is 56 m, to the northwest of Rubh'a Chonnaidh. Depths of greater than 52 m can be found in isolated areas across the assessment area to the east of the sill.

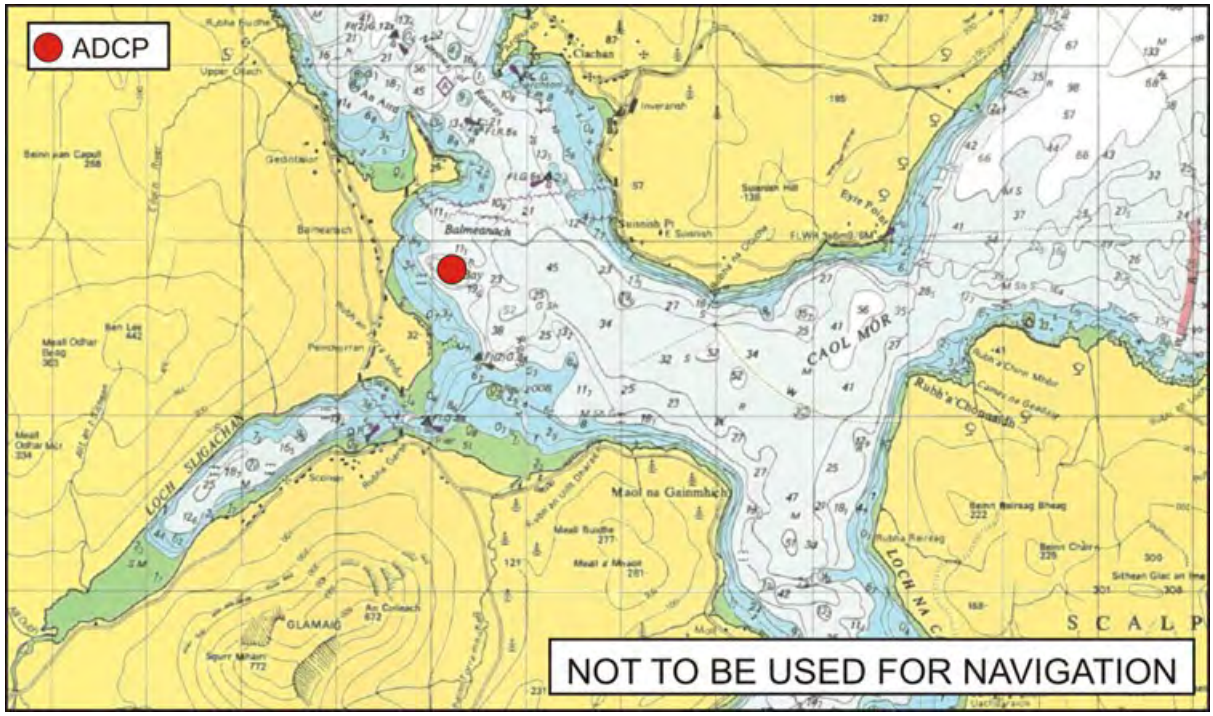


Figure 13.2 Admiralty chart (2209) extract for Loch Sligachan, with relevant ADCP station shown.

Bathymetry is generally gently sloping on either side of the sill and at the head of Loch Sligachan. A substantial gravelly and marshy intertidal area is found at the head of Loch Sligachan (Figure 13.1) and areas of intertidal gravel are also found to the east of the sill on both northern and southern shores at the mouth of the loch.

13.2.2 Tides

Tidal information is provided based on tidal characteristics determined from Portree. Portree is 11.5 km to the north of Loch Sligachan.

Standard tidal data for Portree, centred around the survey date of 7th July 2014, are shown in Figure 13.3. Tidal predictions for Portree indicate that in this region the tidal characteristics are semi-diurnal, with a well-developed spring-neap cycle.

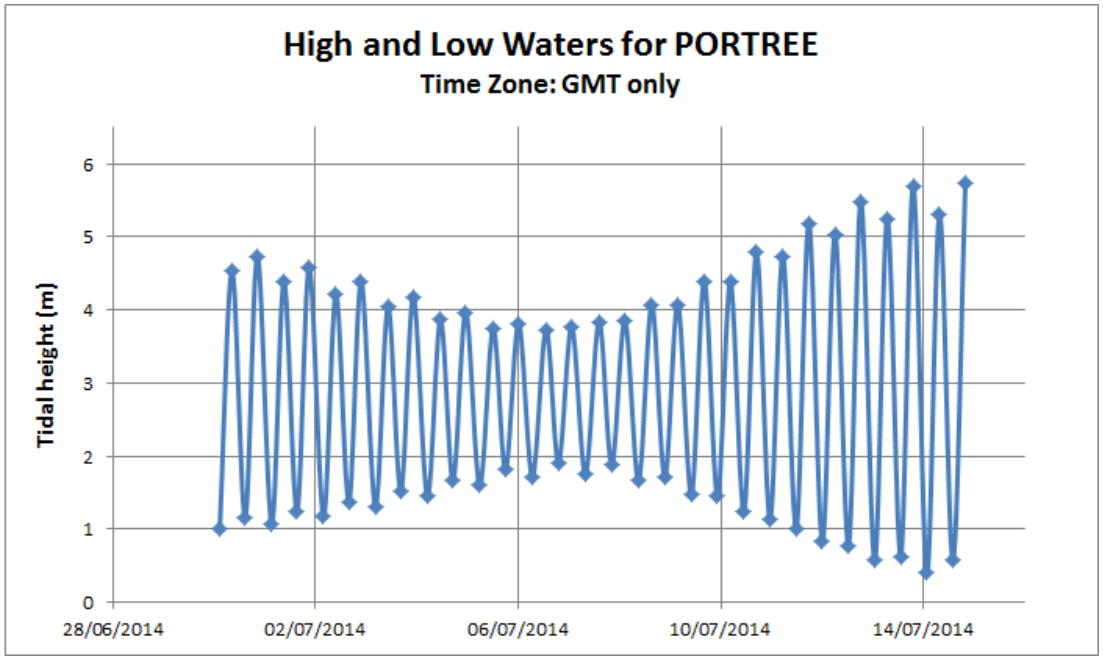


Figure 13.3 Two week tidal curve for Portree. Reproduced from Poltips3 [www.pol.ac.uk/appl/poltips3]

Tidal heights in Portree, data from Poltips3 [www.pol.ac.uk/appl/poltips3]:

Mean High Water Springs = 5.3 m
Mean Low Water Springs = 0.7 m
Mean High Water Neaps = 3.7 m
Mean Low Water Neaps = 1.9 m

This gives an approximate tidal volume of water within the assessment area during each tidal cycle of:

Springs: 6.36×10^7 m^3
Neaps: 2.49×10^7 m^3

13.2.3 Tidal Streams and Currents

There is a published tidal diamond in the narrows of Raasay, immediately to the north of the assessment area.

Tidal streams will be enhanced by the shallow sill at the mouth of Loch Sligachan, and around headlands such as Rubh'a Chonnaidh. Tidal streams in the entrance of Loch Sligachan are reported to have a max spring rate of 0.75 m/s, while in Caol Mor between Scalpay and Raasay, the spring rate is 0.5 m/s (Laurence, 1990).

Current meter data were available at a single site within the assessment area. Data were obtained from SEPA for a site towards the northern boundary of the assessment area, at Balmeanach Bay. There was no accompanying hydrographic report by the appointed contractor who obtained this dataset. This location is shown in Figure 13.4. The survey spanned 15 days between 21st February 2000 and 9th March 2000; a half-lunar period, the minimum necessary to capture a spring-neap cycle.

Figure 13.4 Map showing 2000 Loch Sligachan sample site within the assessment area. Using the average principal current and residual current amplitudes and the assumption of a uniform sinusoidal tide, the cumulative transport distance and direction that might be expected during each phase of the tide is shown above. For clarity, arrows are scaled to 1/3 of expected transport distance.

Data from Balmeanach Bay, N57°19.91 W06°05.73 were collected between 21/02/2000 and 09/03/2000 and are summarised in Table 2.3.1. The average water depth recorded for the duration of the survey was 25.52 m at the ADCP site.

The use of an ADCP at Balmeanach Bay means that water velocities close to the surface have not been measured effectively because of the characteristics of the acoustic beam. The ADCP cannot measure the upper 15% of the water column (RDI, 1996) which in 25 m of water in Balmeanach Bay limits measurements to within 4 m of the surface.

Therefore, the reported values in the 'surface' and 'Level 1' in Table 13.1 are not reliable and have not been used in this study.

The mean current speeds calculated from the data suggest an enhancement of current speed towards the surface at Balmeanach Bay. The strongest currents at the site are found at Level 2, and are characterised by flows along a north-easterly to south-westerly axis.

Residual currents were variable throughout the water column, and strongest at Level 2. Residual currents generally flow in a north-easterly direction. Tidal current flows also show the expected variation across the spring-neap cycle, with strongest flows during the period of spring tides.

Table 13.1 Balmeanach Bay current data measured in 2000.

Average Depth Below Surface	Surface (0 m)	Level 1 (4.17 m)	Level 2 (8.04 m)	Level 3 (11.91 m)	Level 4 (15.78 m)	Level 5 (19.65 m)
Mean Speed (ms^{-1})	0.597	0.083	0.30*	0.201	0.159	0.102
Maximum Speed (ms^{-1})	0.98	0.290	1.18*	0.93	0.650	0.450
Principal Axis Amp & Dir (ms^{1}) & (ºM)	0.713 (53.25)	0.150 (66.40)	0.513 (46.82)*	0.450 (62.43)	0.634 (71.22)	0.254 (84.14)
Residual speed (ms^{-1})	0.456	0.054	0.224*	0.127	0.105	0.062
Residual direction (ºM)	52.77	11.25	40.08*	42.82	42.14	23.11

*Recording errors in current profiler data recording for Level 2 meant that characteristics listed above were calculated from data obtained between 21/02/2000 and 26/02/2000 only. Analysed Level 2 data includes datapoints from both spring and neap tides. The greyed out boxes indicate those levels where the ADCP is not able to measure effectively.

A weather station was also deployed at Sconser during the Loch Sligachan survey. Hourly wind speeds rarely exceeded 10 m/s, averaging 7.25 m/s, or a gentle breeze. Wind directions varied, but were most often from a westerly to north-westerly direction.

In general, the current meter data from Balmeanach Bay indicates moderate flows suggesting that the area is moderately flushed. Current flows, however, will vary substantially across the assessment area in both direction and speed, particularly inside Loch Sligachan, as a result of the shallow sill at its mouth.

Using the average principal current and 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 the Balmeanach Bay site as 6.36 km (based on an average principal current amplitude of 0.463 m/s). No distinction is made here for springs and neaps. The average principal used for this calculation included data from levels 2-5.

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 Loch Sligachan, or within the wider assessment area. Without such data it

is difficult to judge what the dispersive environment might be like. However, dispersion is likely to be enhanced by strong flows around the shallow sill at the mouth of Loch Sligachan, and by strong tidal currents through the Raasay Narrows.

13.2.4 River/Freshwater Inflow

The assessment area is fed by numerous streams and burns, while Loch Sligachan itself is fed by the River Sligachan at its head. Streams flowing into Loch Sligachan include Allt na Beiste and Eas Mor along its southern boundary and Allt na Mna Mairbh, Allt na h-Airighe Leachaich, Allt na Airighe Duibhe, Allt Garbh Beag, Allt Garbh Mor, and Allt Na Ba Grisionn along its northern boundary. Outside of Loch Sligachan, the assessment area is fed by numerous other streams and burns flowing from the Isle of Raasay and the hills on the Isle of Skye.

13.2.5 Meteorology

The nearest weather station for which a continuous rainfall dataset is available is located at Lusa, on the Isle of Skye. This station is situated approximately 20 km to the west of the assessment area. Rainfall records are available from January 2008 to December 2013.

While 2010 generally was the driest year (1199 mm), the highest rainfall for this time period was recorded in 2011 (2354 mm). High rainfall values (> 40 mm d^{-1}) occurred in 2009 and 2011-2013, but one rainfall event of > 60 mm d^{-1} was recorded in January 2009. Rainfall events of > 30 mm d^{-1} occurred in all months except June. Daily rainfall varied seasonally, from lower values in spring and summer months (March - July) to higher values in the autumn and winter months (August – February). Mean rainfall at Lusa peaks in October, though the 2011 extreme rainfall event of 60 mm d^{-1} occurred in January. For the duration of the dataset, daily rainfall of below 1 mm occurred on 46% of days, while daily rainfall above 10 mm occurred on 17% of days.

Run-off due to rainfall is expected to be highest in the autumn and winter months. However, it must also be noted that high rainfall events occurred in most months and consequently that high run-off can occur throughout the year. For Loch Sligachan, the annual precipitation in the area is approximately 3000 mm (Edwards & Sharples, 1986) with considerable seasonal variability.

Wind data were obtained from South Uist, located 76 km to the west of the assessment area. Given the distance between these two locations and varying topography, wind statistics may not be directly transferrable to the specific production area at Loch Sligachan. They are, however, valuable in providing the general pattern of the seasonal wind conditions. Data collected between January 2004 and December 2013 indicate that the predominant wind direction is between south and southwest. Seasonally the strongest winds occurred during the autumn and winter. Typically the wind came from around the south and west throughout the year but the spring and summer also saw

winds from the northeast. Local wind directions within the assessment area are likely to be influenced by the surrounding topography.

13.2.6 Model Assessment

Due to the paucity of data for this location and the unconstrained nature of the study area, it was not considered appropriate to set up a box model run for the assessment area. However, it is worth noting that the estimate of exchange using a simple tidal prism method is 1.5 days (Marine Scotland, 2012).

13.3 Hydrographic Assessment

13.3.1 Surface Flow

The site data indicate that the discharge of freshwater into the surface will occur across all of the assessment area with significant inflow into the head of Loch Sligachan. The meteorological data indicate a moderate seasonal variation in freshwater discharge which will mean that any exchange driven by estuarine circulation will also have a seasonal variation.

The general patterns and speed of flow are likely to be highly variable across the assessment area. However, from the single current meter deployment, we have estimated the cumulative transport distance on each phase (flood/ebb) of the tide at around 6 km at this location.

There is likely to be relatively free transport of the surface layer in the more open and dynamic outer part of the assessment area. In the more confined Loch Sligachan the surface flow will be somewhat more confined and the shallow sill at the entrance will restrict exchange of deeper water considerably. Near-surface residual flow in Balmeanach Bay is towards the north east and residual flow in Loch Sligachan will be seaward (also north east) through estuarine circulation. In the outer part of the assessment area the conjunction of sounds, narrows and sills, will lead to complex surface flows with rather high dispersion.

This will be enhanced by winds blowing along the axis of the loch or through the Narrows. Given the relatively strong tidal flows in the area we anticipated that surface waters will become rather well mixed.

13.3.2 Exchange Properties

Due to the complex and unconstrained nature of the assessment area and the variety of tidal conditions that might be experienced in the area it is not possible to provide a quantitative measure of exchange. However, it is anticipated that Loch Sligachan will have a relatively short flushing time, on the order of a few days. Further, due to the tidal flow through the area it is expected that the study site will be a moderately-well flushed system throughout most of the year with surface contaminants being dispersed in any surface residual flow.

There are data from one current meter deployment in the assessment area. However, it is limited to a single site and there is also a complete lack of long term hydrographic data coverage for other parts of the assessment area, particularly data sets with seasonal resolution. There is also rather little descriptive literature for the flow properties of the area. Therefore the confidence level of this assessment is LOW.

14. Shoreline Survey Overview

The Loch Sligachan shoreline survey was conducted between the 14th and 16th July 2014. Light rain was recorded in the week prior to the survey and on the first survey day, turning heavy in the afternoon. Heavy rain also fell on the third survey day.

The fishery is for King scallops and these are harvested by hand diving. The harvest area currently lies within the loch, though the harvester (Mr Oakes) stated that he has previously also had lantern nets around, and outside, the loch in the past. No information was obtained on seasonality of the fishery.

The land around Loch Sligachan has small pockets of human population. Sconser village is located to the southeast of the loch and contains a hotel, several B&B's and public toilets associated with the ferry terminal. At the head of the loch were a hotel and campsite, whilst there was also some tourist accommodation on the northeast shore of the loch.

The majority of properties appeared to have private STs with 17 sewage-related observations made during the survey. The discharge from the ST associated with the ferry terminal returned a freshwater sample result of 20000 *E. coli* cfu/100. Two seawater samples associated with pipes from houses on the southern shoreline also returned high results of 900 and 4500 *E. coli* cfu/100 ml. At the head of the loch, a freshwater sample taken from a pipe discharging to shore also returned high result of 33000 *E. coli* cfu/100 ml.

The largest watercourse was the River Sligachan at the head of the loch. A further large watercourse, Abhuinn Torra-mhichaig, discharged into a bay of the Inner Sound east of Sconser. Several smaller watercourses were also noted. Several of the watercourses sampled yielded high *E. coli* results (up to 60,000 *E. coli* cfu/100 ml), indicating marked faecal contamination. Some of these were directly south of the several fishery area.

Moorings were noted west of the Sconser ferry terminal. East of the terminal there was a fish farm shore base, which had a small pontoon and slipway for loading vessels. Several small boats were beached ashore around the survey area, particularly to the north of the loch in the Peinachorrain area. A quarry was located at Achadh Mor, outside the loch.

Sheep were the only livestock observed around Loch Sligachan, specifically in the hills east and near the shoreline west of Sconser, and around the Peinachorrain area, where active crofts were noted, and around Balmeanach Bay. Gulls and oystercatchers were the only wildlife observed.

Landcover was predominantly grassland nearshore, turning to heath and moorland inland. Areas of improved grassland were noted around settlements. Plantation forest was located southeast of the Achadh Mor quarry. .

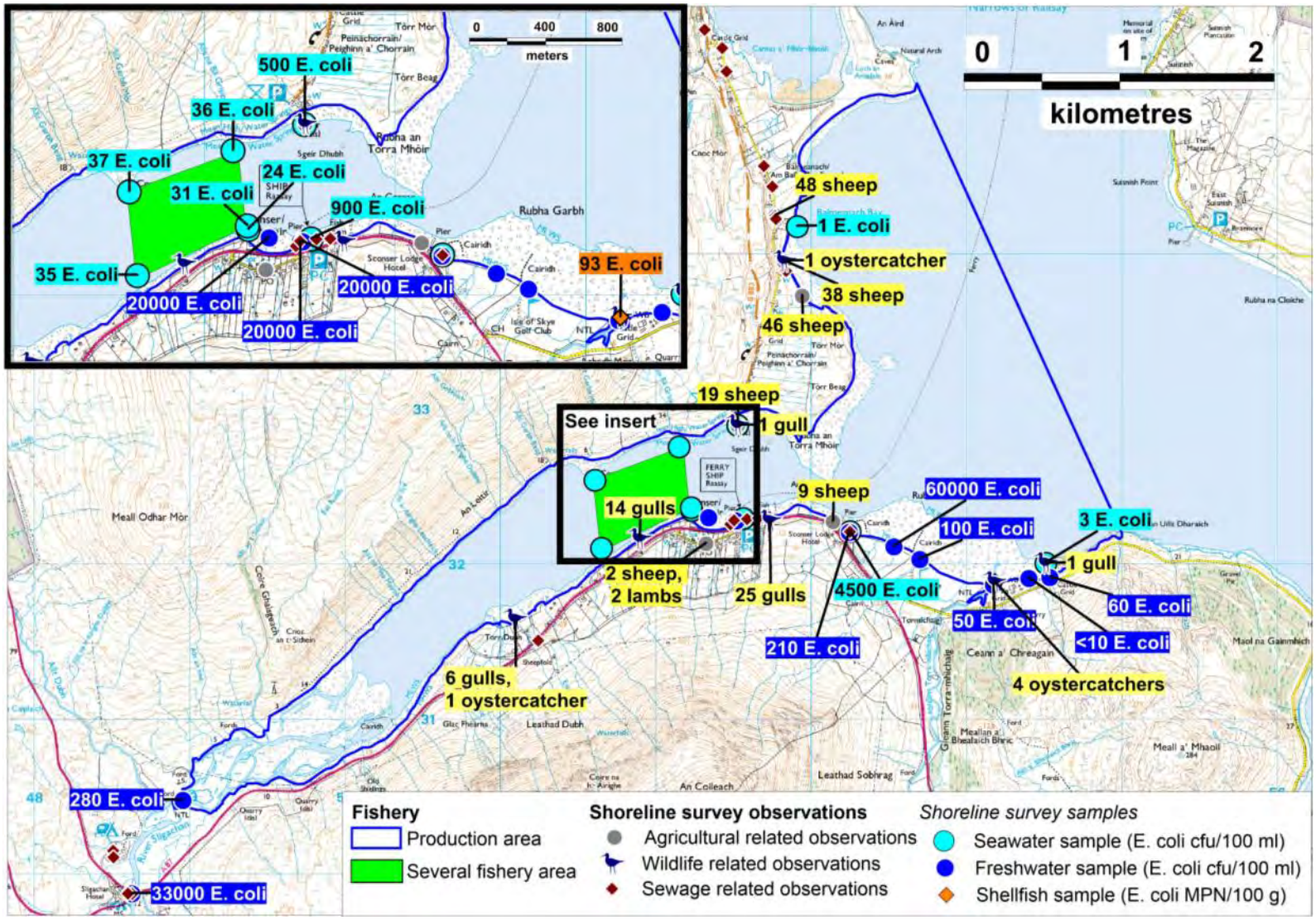


Figure 14.1 Map of shoreline survey observations at Loch Sligachan

15. Bacteriological Survey

A bacteriological survey was not undertaken at this site due to the subtidal nature and offshore location of the harvested fishery.

16. Overall Assessment

Human sewage impacts

The population around Loch Sligachan is generally low although there are small centres around Sconser and Peniachorrain near the mouth of the loch and southwest of the head of the loch. There are no community discharges to the area and the main sources of human sewage in the vicinity of the present fishery are small private discharges around the village of Sconser. There are also two large septic tanks which discharge to the River Sligachan near the head of the loch. There are a number of septic tank discharges located outside the loch which would be expected to have a greater impact at the RMP site than at the present scallop fishery.

There is a fallowed fish farm west of the scallop area. If this is brought back into production, there is potential for an increase in sewage discharges from work boats or barges servicing the farm (there is no explicit data on *E. coli* contamination arising from salmon farms themselves) . The other fish farms in the area are sufficiently distant to be unlikely to contribute significantly to faecal contamination at the scallop area.

Agricultural impacts

Contributions of faecal contamination from livestock are expected to be low to moderate, with livestock grazing on the improved pasture to the northeast and southeast of the scallop fishery potentially having the greatest effect on the eastern side of the area.

Wildlife impacts

Faecal contributions to the loch from wildlife are expected to be relatively minor and sporadic both spatially and temporally. Any effects will mainly be due to seabirds although there may also be other contributions from mammals such as seals, otters and deer.

Seasonal variation

Human population in the area is expected to be greatest in the summer months due to tourism. The numbers of sheep are expected to be highest in spring and summer. Scallop *E. coli* results greater than 230 *E. coli* MPN/100 g were all seen between May and October and there was a statistically significant difference in average *E. coli* between seasons, with that in summer being significantly higher than in spring.

Rivers and streams

The greatest faecal impacts from watercourses on the current scallop fishery area are expected to be to the southeastern side of the fishery. No significant association was seen between the amount of rainfall prior to sampling and the magnitude of *E. coli* results in the scallops. However, the scallop samples were attributed to two separate locations and differences in response to freshwater contamination between the two locations may have affected the analyses. A salinity difference between subsurface and depth of up to 5 psu was seen in CTD casts taken at two locations along the southern shore of the loch, indicating some freshwater influence on that side of the loch at the time of the shoreline survey. The salinity difference seen in CTD casts taken at two locations along the northern shore was less than this.

Movement of contaminants

General patterns and speed of flow are likely to be highly variable across the loch. Using data from a single current meter deployment, the estimated cumulative transport distance on each phase (flood/ebb) of the tide is around 6 km. There is likely to be relatively free transport of the surface layer in the outer part of the assessment area. Within Loch Sligachan itself, the surface flow will be somewhat more confined and the shallow sill at the entrance will restrict exchange of deeper water. The near-surface residual flow in Balmeanach Bay will be towards the north east and that within Loch Sligachan will be seaward (also north east) through estuarine circulation. It is expected that the surface waters will be well mixed.

A highly statistically significant correlation was found between the spring/neap tidal cycle and *E. coli* results, with the high results mainly occurring at spring tide. This may indicate that at least some of the impacting sources of faecal contamination are not located close to the fishery as transport distances are expected to be greater at spring tide. Alternatively, contamination associated with the surface, or near-surface, layer may have a greater effect on the benthic scallops at low-water springs.

Temporal and geographical patterns of sampling results

Sampling has been reported against both the RMP, located outside of the mouth of the loch, and at an alternative RMP located on the southeastern side of the present fishery. Although most of the results exceeding 230 MPN/100 g were reported against the RMP, there was no significant difference in average *E. coli* concentrations obtained at the two locations. Overall, there has been some reduction in the level of *E. coli* results over time since 2009: this may be due to a change in sampling location although assessment of the reasons for the change is complicated by the continuing use of both RMPs.

Conclusions

Impacting sources of faecal contamination from human and farm animal sources, and borne by watercourses, are likely to have the greatest combined impact on the

southeastern side of the several fishery area. There is some indication that there may be, at least occasionally, a greater extent of contamination immediately outside the mouth of the loch.

17. Recommendations

A summary of the recommendations is shown in the map in Figure 17.1.

Production area

Given that the present fishery is limited to the area covered by the several order, and that there are identified sources of faecal contamination outside of the area, it is recommended that the production area be redefined as: the area between lines drawn between NG 5150 3269 and NG 5150 3186 and between NG 5225 3283 and NG 5225 3227 extending to MHWS.

RMP

It is recommended that the RMP be located at the southeastern corner of the current scallop fishery in order to reflect the sources identified as potentially impacting in that location. The present alternative RMP does not lie within the area defined in the several order and so it is recommended that the RMP be located at NG 5216 3237.

Tolerance

It is recommended that a 40 m tolerance be applied to allow for some variation in density of stock.

Depth of sampling

Not applicable as the scallops are hand-collected by diving.

Frequency

Sampling should be undertaken monthly.

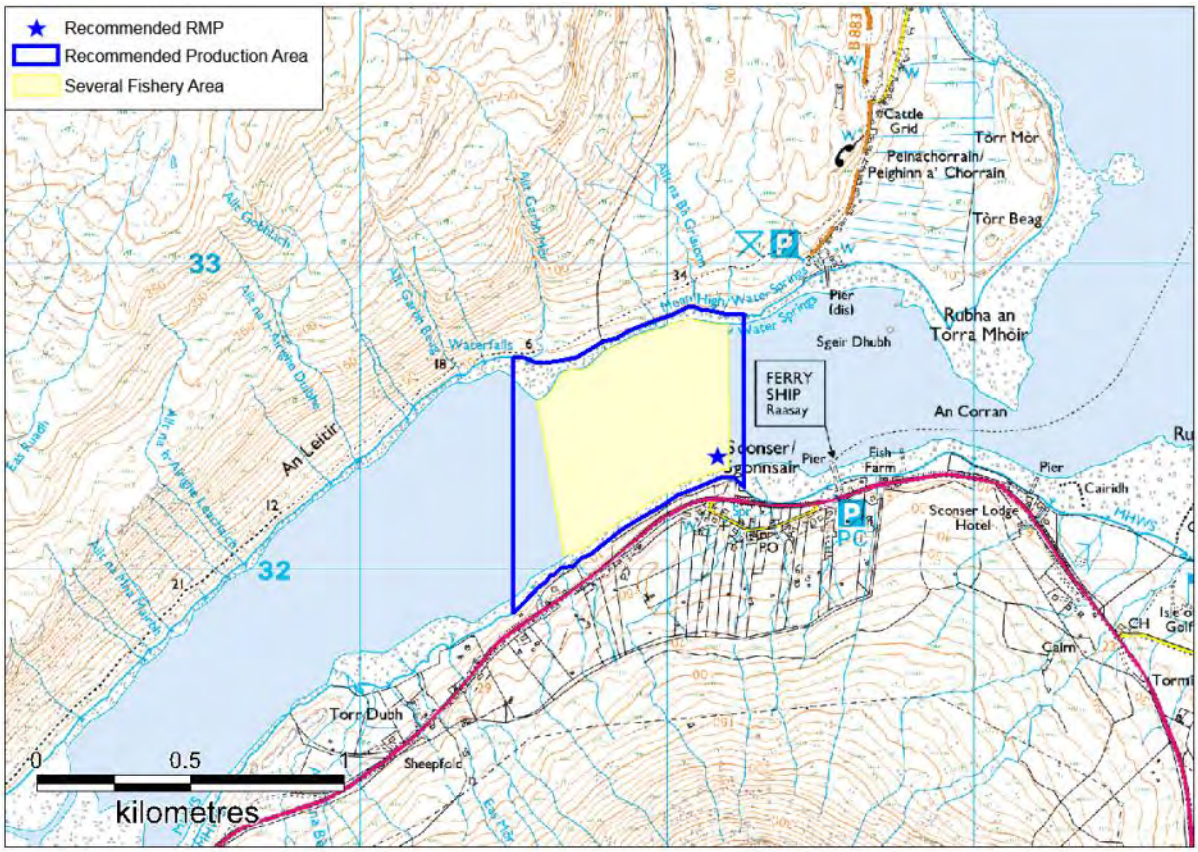


Figure 17.1 Map of recommendations at Loch Sligachan

18. References

Brown, J., 1991. The final Voyage of Rapaiti:A measure of surface drift velocity in relation to the surface wind. *Marine Pollution Bulletin,* 22(1), pp. 37-40.

Burkhardt, W. et al., 2000. Inactivation of indicator microorganisms in estuarine waters. *Water Research,* 34(8), pp. 2207-2214.

CalMac Ferries Limited, 2014. *Sconser- Raasay Ferry Timetable.* [Online] Available at: http://status.calmac.info/Timetables/summer-raasay--sconser-raasay.pdf
[Accessed 22 09 2014].

Clyde Cruising Club, 2007. *Sailing Directions and Anchorages - Part 3 Ardnamurchan To Cape Wrath,* Glasgow: Clyde Cruising Club Publications Ltd..

Edwards, A. & Sharples, F., 1986. *Scottish Sea Lochs: a Catalogue,* Oban: Scottish Marine Biological Association/Nature Conservancy Council.

GOV.UK, 2013. *Guidance Shellfisheries: Several Orders and Regulating Orders.* [Online]
Available at: https://www.gov.uk/shellfisheries-several-orders-and-regulating-orders
[Accessed 08 09 2014].

IsleofSkye.com, n.d. *Wildlife.* [Online]
Available at: http://www.isleofskye.com/skye-guide/wildlife
[Accessed 19 06 2014].

Jagger, M. & Jagger, E., 2011. *Loch Aluinn Bed and Breakfast, Sconser, on the Isle of Skye.* [Online]
Available at: http://www.holiday-accommodation-sconser.co.uk/bed-breakfast/
[Accessed 25 09 2014].

JNCC, 2014. *Seabird colony data.* [Online]
Available at: http://jncc.defra.gov.uk/page-4460
[Accessed 23 05 2014].

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

Laurence, M., 1990. *Yachtsman's Pilot to the West Coast of Scotland "Castle Bay to Cape Wrath".* St Ives: Imray Lorie Norie & Wilson.

Lee, R. J. & Morgan, O. C., 2003. Envrionmental factors influencing the microbial contamination of commercially harvested shellfish.. *Water Science and Technology,* Issue 47, pp. 65-70.

Mallin, M. A. et al., 2001. Demographis, landscape and meterological factors controlling the microbial pollution of coastal waters. *Hydrobiologica,* Issue 460, pp. 185-193.

Marine Scotland, 2012. *Locational Guidelines for the authorisation of marine fish farmes in Scottish waters.,* Edinburgh: Produced for Marine Scotland Science by the Marine Scotland Performance Graphics Group.

Mitchell, I. P., Newton, S. F., Ratcliffe, N. & Dunn, T. E., 2004. *Seabird populations of Britain and Ireland: results of the Seabird 2000 census (1998-2002),* London: T & A D Poyser.

RDI, 1996. *Acoustic Doppler Current Profiler: Principles of operation a practical primer pp.54.* [Online].

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4. **Hydrographic Section Glossary**
5. **Shoreline Survey Report**
6. **SEPA Discharge Consents**
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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.

Otters

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.

References

Alderisio, K. A. & DeLuca, N., 1999. Seasonal enumeration of fecal coliform bacretia from the feces of ring-billed gulls (Larus delawerensis) and Canada geese (Branta canadensis). *Applied and Environmental Microbiology,* 65(12), pp. 5628-5630.

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

Lisle, J. T., Smith, J. J., Edwards, D. D. & McFeters, G. A., 2004. Occurence of microbial indicators and Clostridium perfringens in wastewater, water coloum samples, sediments, drinking water and weddel seal faeces collected at McMurdo Station, Antarctica. *Applied and Environmental Microbiology,* 70(12), pp. 7269-7276.

Poppe, C. et al., 1998. Salmonella typhimurium DT104: a virulent and drug-resistant pathogen. *The Canadian Veterinary Journal,* 39(9), pp. 559-565.

Scottish National Heritage, n.d. *Otters and Development.* [Online] Available at: http://www.snh.org.uk/publications/on-line/wildlife/otters/biology.asp [Accessed 10 10 2012].

Stoddard, R. A. et al., 2005. Salmonella and Campylobacter spp. in Northern Elephant Seals, California. *Emerging Infections Diseases,* 11(12), pp. 1967-1969.

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. Statistical Data

One-way ANOVA: logec versus Season

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0.05

Equal variances were assumed for the analysis.


Factor Information

Factor  Levels  Values
Season       4  1, 2, 3, 4


Analysis of Variance

Source  DF  Adj SS  Adj MS  F-Value  P-Value
Season   3   3.004  1.0014     3.40    0.025
Error   47  13.849  0.2947
Total   50  16.854


Model Summary

       S    R-sq  R-sq(adj)  R-sq(pred)
0.542834  17.83%     12.58%       3.83%


Means

Season   N   Mean  StDev      95% CI
1       15  1.411  0.537  (1.129, 1.692)
2       17  1.938  0.600  (1.673, 2.202)
3        9  1.905  0.525  (1.541, 2.269)
4       10  1.496  0.454  (1.151, 1.842)

Pooled StDev = 0.542834
```

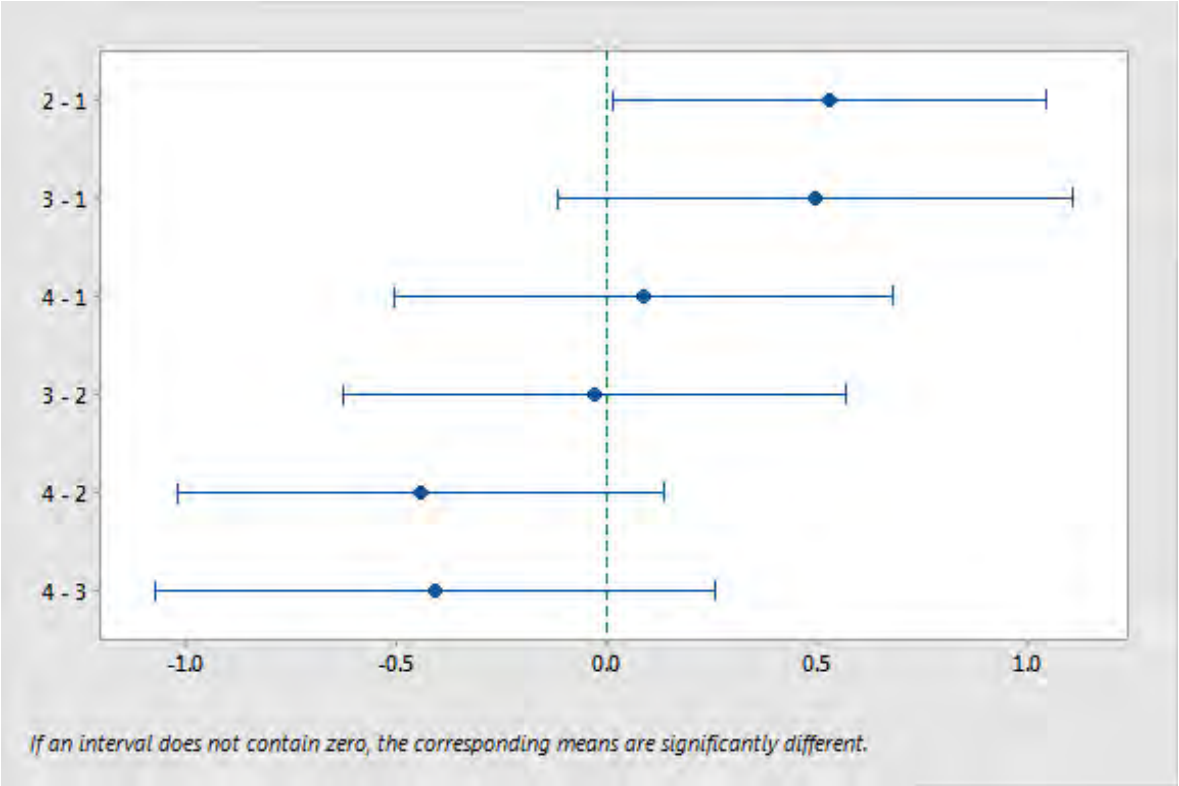
Tukey Pairwise Comparisons

```
Grouping Information Using the Tukey Method and 95% Confidence

Season   N   Mean  Grouping
2       17  1.938  A
3        9  1.905  A B
4       10  1.496  A B
1       15  1.411    B

Means that do not share a letter are significantly different.
```

Tukey Simultaneous 95% CIs



4. 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.

5. Shoreline Survey Report

Shoreline Survey Report

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

Document Number	B0067_Shoreline 0034

Revision History

Revision	Changes	Date
A	Issue for internal review	24/07/2014
B	Second issue for internal review	29/07/2014
01	First formal issue to Cefas	13/08/2014
02	Second corrected issue to client	28/08/2014

	Name & Position	Date
Author	Colin Abernethy & Lars Brunner	17/07/2014
Checked	Andrea Veszelovszki	27/08/2014
Approved	Mark Hart	28/08/14

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

Production area:	Loch Sligachan
Site name:	Loch Sligachan Loch Sligachan Pier
SIN:	SL-195-291-07 SL-195-292-07
Species:	King Scallops
Harvester:	Mr Dave Oakes, Sconser Scallops
Local Authority:	Highland Council, Skye & Lochalsh
Status:	Survey review
Date Surveyed:	14th to 16th July 2014
Surveyed by:	Colin Abernethy & Lars Brunner
Existing RMP:	NG 5460 3240
Area Surveyed:	**1.** Southern shore of Loch Sligachan from Torr Dubh through Sconser to the quarry at Achadh Mor. **2.** Area from the Sligachan hotel to the confluence of the Allt Dubh & River Sligachan. **3.** Short section of the northern shoreline of Loch Sligachan to the south of the village of Peinachorrain. **4.** A short section of the coast of Balmeanach Bay.

Weather

There had been intermittent, light rainfall in the week preceding the survey.

Weather during the survey;

Monday 14th of July: W 3-4, increasing 5-6 with gusts, light rain turning heavy with squalls as the day progressed. 100% cloud, visibility moderate to poor.

Tuesday15th of July : W 1-2, perhaps F3 later in day. Dry, cloud cover 30% in morning, reducing to 5-10% later in day, visibility good.

Wednesday 16th of July: W3-4. Heavy rain, visibility poor.

Stakeholder engagement during the survey

Contact was made with Mr Allan MacDonald, the sampling officer for Highland Council, prior to the survey and he organised the boat work with the harvester Mr Dave Oakes. In addition, the survey team met with Mr MacDonald at Sconser pier on both the 14th & 15th July, where he introduced the team to Mr Oakes and also provided useful information as to the state of the fishery and access to the survey route.

The survey team met Mr Dave Oakes on the 15th July, and he and his son Ben Oakes provided us with access on his boat to his dive sites to collect seawater and CTD samples.

Fishery

The fishery in Loch Sligachan is for King Scallops (*Pecten maximus*), collected by hand diving. The harvester, Mr Oakes, has had sites on the loch for 16 years and has experimented with harvesting from different areas, as well as stocking new areas. In the past he has used lantern nets to hold scallop stock, at locations around, and outside the loch, but he has largely discontinued this practice, as numbers had diminished using this method. They now harvest material from an area of Loch Sligachan bounded by the waypoints 46, 49, 51 and 53 noted in Figure 3.

No other sea fishery (prawns, dredging) takes place in the loch, although Mr Oakes noted that there was occasionally some dredging at the mouth of the loch, in the Inner Sound.

Sewage Sources

The area around Loch Sligachan consists of a mixture of small villages, crofts and isolated houses. The largest and most concentrated centre of population is Sconser on the southern shore of the loch. The only public facilities present in Sconser are public toilets located at the ferry terminal. A small hotel is located on the shoreline to the east of the village.

The area to the west of the loch is sparsely inhabited. There is a hotel and campsite present at Sligachan, with two detached dwellings. The area to the north of the loch (Braes & Peinchorran) consists of crofts and detached dwellings with no public facilities present.

Most of the properties present on the survey appeared to use septic tank facilities with ground run-offs, although some discharges to fresh- and seawater were present. Due to the presence of summer vegetation growth, and access limitations due to private property and livestock, it was not possible to verify every discharge along the survey route.

Seasonal Population

In the Sconser area, there was a small hotel and several B&Bs & self-catering properties. A hotel and campsite were present in Sligachan, and evidence of some self-catering properties in Braes & Peinchorran was also evident from signage along the roadside. The area around Sligachan in particular is a

popular tourist area, and it would be reasonable to assume that there is a marked increase in population during the summer season.

Boats/Shipping

The only large pier present on the survey route was the ferry terminal at Sconser, which was used several times daily for the Raasay ferry, operated by a hybrid-electric drive through vessel, the MV Hallaig. There were moorings for small craft to the west of the terminal, and immediately to the east of the terminal there is a fish farm shore base, this possessed a small pontoon and slipway for loading vessels.

Several small vessels were beached ashore around the survey area, especially to the north of the loch in the Braes & Peinchorran area. No yachts or fishing boats were seen in the loch during the survey.

Farming and Livestock

Sheep were noted in the area to the west of Sconser, as well as in the hills above the village to the east. In the Braes/Peinchorran area to the north of the loch, sheep were noted grazing on the shoreline around Balmeanach Bay.

The only animals seen on survey were sheep, four of which were seen in Sconser, with nine noted in the hills above the shoreline of the village. More animals were noted in the Braes-Peinchorran area, which seemed to have several active crofts. Nineteen sheep were noted in the shoreline above the survey area in Peinchorran, with a further forty six in the fields above Balmeanach Bay.

Land Use

The land use in the survey area is predominantly rural. Habitation consists of the small village of Sconser, with isolated houses to the west and southeast of the village, the hotel and campsite at Sligachan, and the township crofting communities of Braes and Peinchorran. The predominant industry in the area is agriculture and tourism, with some industry in the form of salmon farming and quarrying also evident. The agriculture is sheep farming, based around crofts, and some larger areas of upland grazing. Industry is present in the form of the fish farm base to the east of Sconser village, and the large quarry at Achadh Mor.

Land Cover

The predominant land cover is low quality grassland nearer the shore, becoming heath and moorland higher up. There are areas of improved grassland around the villages, with some small sections of native woodland, and a plantation forest to the south of the quarry at Achadh Mor. In addition, there is a large golf course with improved ground to the east of Sconser.

Watercourses

The largest watercourse on the survey route is the River Sligachan, which discharges into Loch Sligachan in a large braided channel centred at the head of the loch. The other large watercourse is the Abhuinn Torra-mhichaig, which passes the golf course and quarry, and discharges into a bay of the Inner Sound at NG 541 318 (waypoint 45).

There are several smaller watercourses discharging along the route of the survey, and these are noted in the survey notes.

Wildlife/Birds

Birds were noted throughout the survey, with six gulls and one Oystercatcher being noted in west Loch Sligachan, another sixteen and then twenty five gulls in the middle Loch, with four Oystercatchers and a gull noted in the eastern part of the Loch.

No other wildlife was seen on the survey.

Specific observations made during the survey are displayed in Figures 1-5 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figure 6. Bacteriology results are given in Tables 2 and 3. Photographs are presented in Figures 7-19.

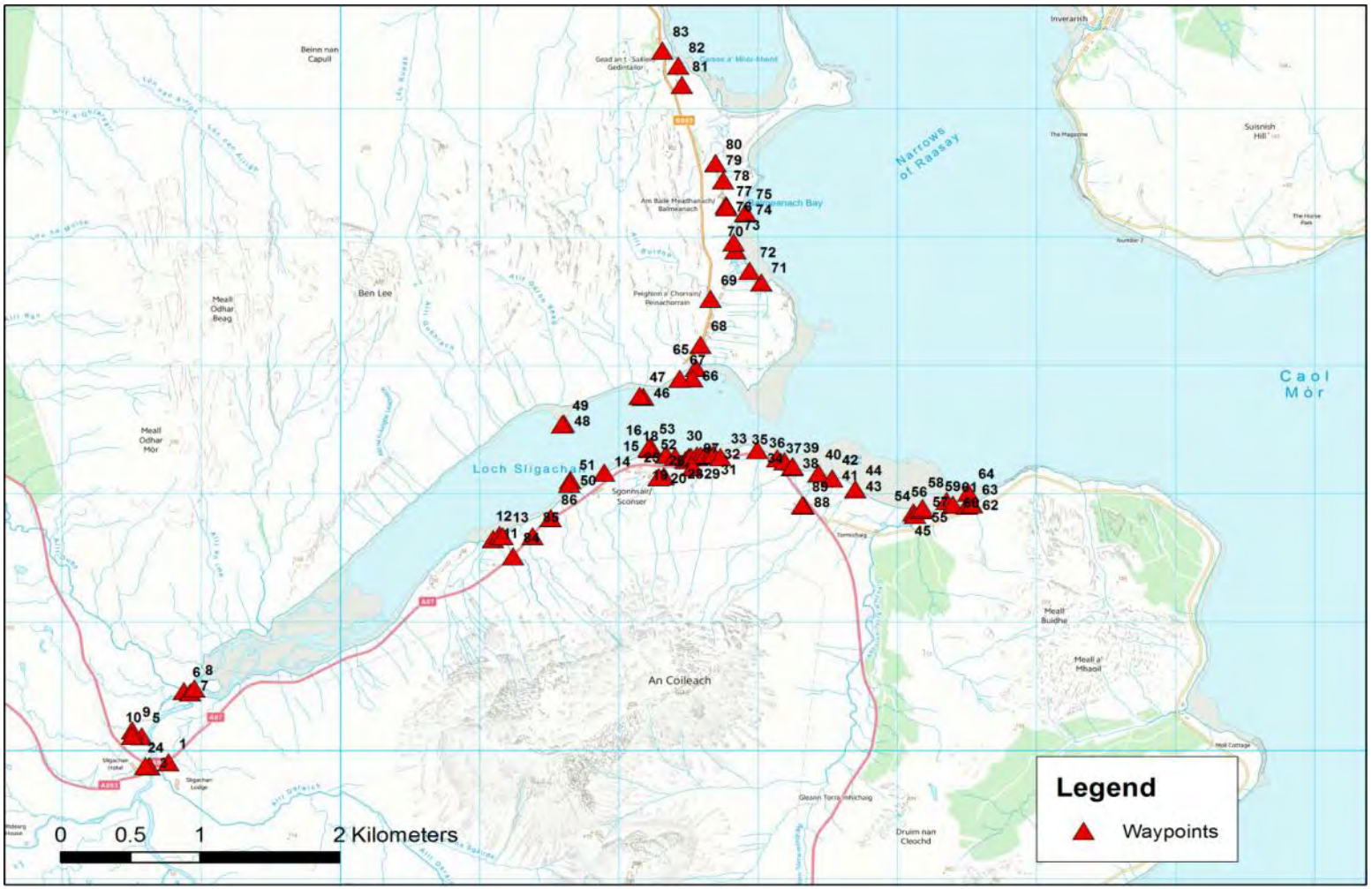


Figure 1. Loch Sligachan waypoints overview

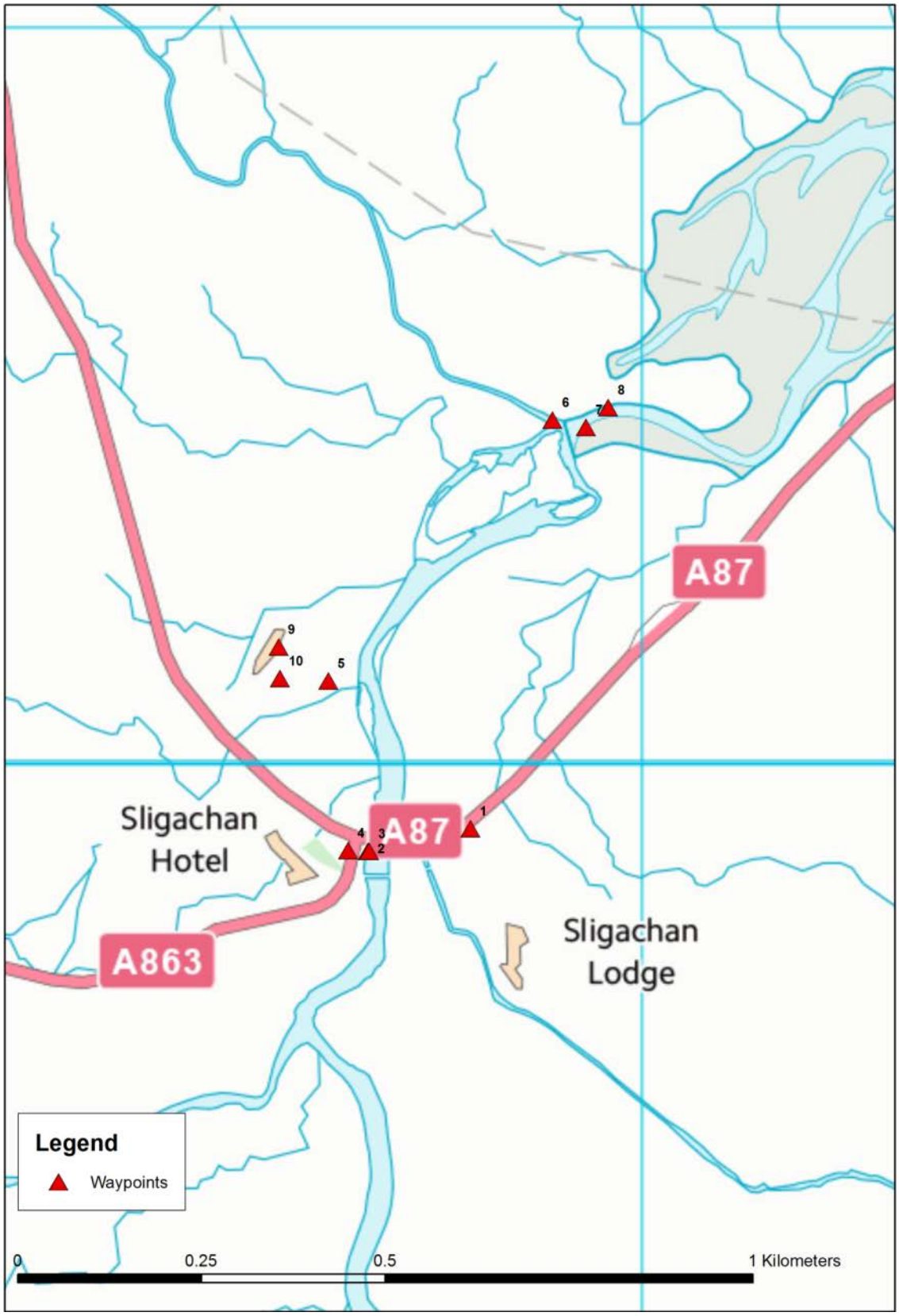


Figure 2. Loch Sligachan waypoints Map 1

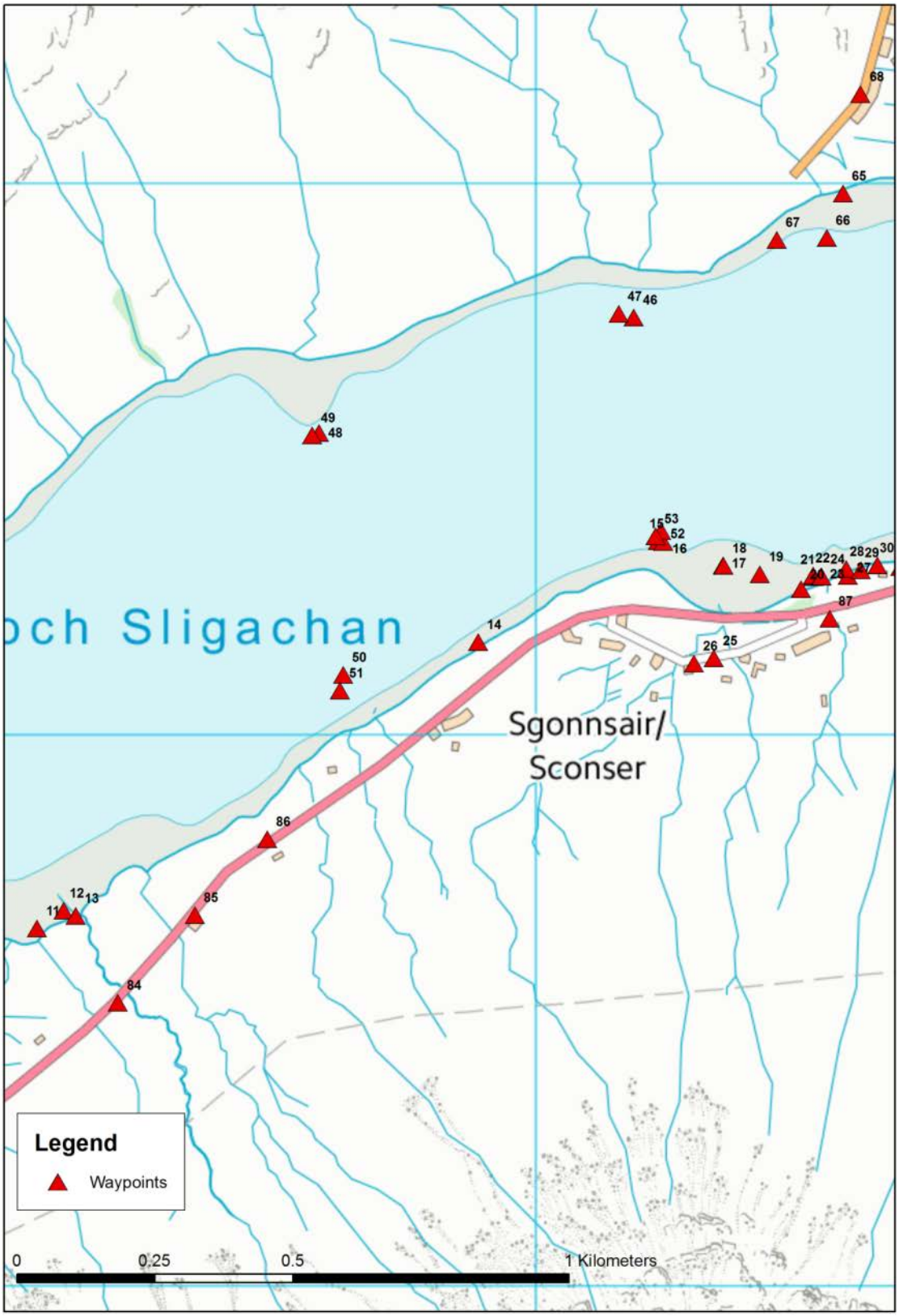


Figure 3. Loch Sligachan waypoints Map 2

Figure 4. Loch Sligachan waypoints Map 3

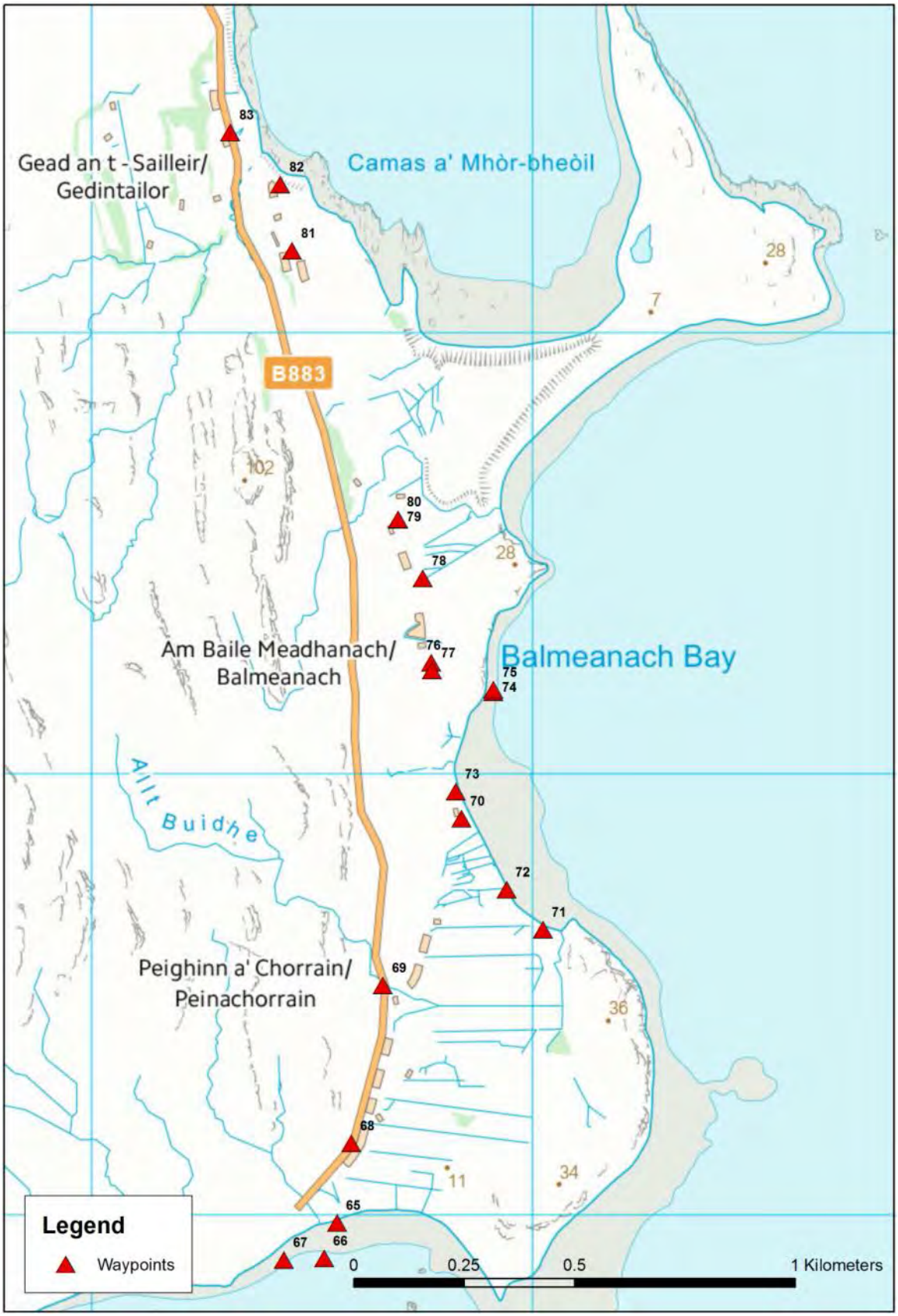


Figure 5. Loch Sligachan waypoints Map 4

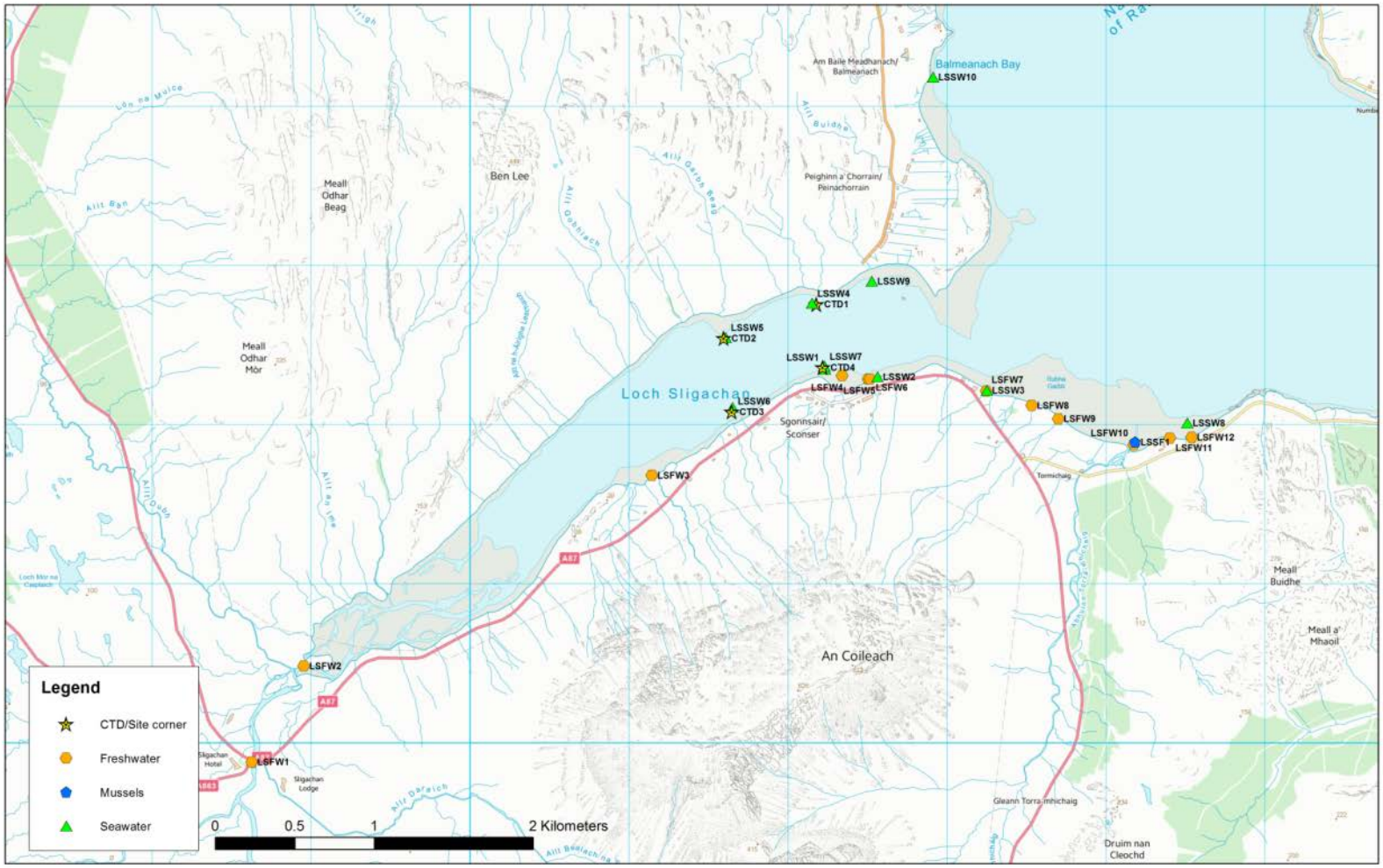


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Figure 6. Loch Sligachan Samples

Table 1 Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	14/07/2014	11:31	NG 48766 29910	148767	829910			Start of survey. Sligachan Hotel
2	14/07/2014	11:40	NG 48627 29879	148627	829880		LSFW1	Contaminated freshwater sample. Observations recorded Waypoint (WP) 3
3	14/07/2014	11:41	NG 48628 29879	148628	829880	Fig 7		Discharge to river, pipe running under A863 road into river. Width 14cm. Depth 2cm. Flow 0.901m/sec SD 0.119. Measurement difficult due to access to pipe.
4	14/07/2014	11:47	NG 48600 29881	148600	829881			Large septic tank below hotel. 7x2m chambered connected to discharge pipe (WP 2 and 3)
5	14/07/2014	11:53	NG 48573 30111	148573	830111			Campsite: 19 tents, 5 campervans, 1 caravan. Toilet block. Campsite approx. 30% full.
6	14/07/2014	12:07	NG 48878 30466	148878	830467			Allt Dubh measurement. Split river. Two sets of measurements taken. Branch 1 Width 1.5m. Depth 13cm. Flow 0.496m/sec SD 0.006. Branch 2 Width 1.35m. Depth 10cm. Flow 0.341m/sec, SD 0.018.
7	14/07/2014	12:13	NG 48923 30456	148924	830457			River Sligachan Branch 1 - Width 9.1m (4 depth and flow measurements taken across span of this branch) (1) Depth 22cm. Flow 0.866m/sec, SD 0.046; (2) Depth 11cm. Flow 0.624m/sec SD 0.035(3); (3) Depth 17cm. Flow 1.025m/sec SD0.068; (4) Depth 10cm. Flow 0.631m/sec SD 0.026. Branch 2 - Width 24m (7 Depth and flow measurements taken across span of this branch) (1) Depth 10cm. Flow 0.372m/sec SD 0.010; (2) Depth 8cm. Flow 0.289m/sec SD0.013; (3) Depth 9CM. Flow 0.376m/sec SD0.008; (4) Depth 13cm. Flow 0.956m/sec SD0.022; (5) Depth 15cm. Flow 0.302m/sec SD0.033; (6) Depth 8cm. Flow 0.295m/sec SD0.008; (7) Depth 3cm. Flow 0.250m/sec SD 0.008.
8	14/07/2014	12:28	NG 48954 30483	148954	830484		LSFW2	Freshwater sample. Observations with WP6 and 7.Sample taken after confluence of rivers.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
9	14/07/2014	12:42	NG 48505 30157	148505	830158			Manholes at toilet block, no sign of drain.
10	14/07/2014	12:43	NG 48507 30115	148507	830115	Fig 8		Septic tank. Met owner who says he has visit from SEPA annually. Very positive in respect to Mr Oakes Scallop business based on the Loch.
11	14/07/2014	13:31	NG 51096 31648	151096	831649			Start of survey section 2. Stream, not sampled. Six gulls and 1 oyster catcher on shore.
12	14/07/2014	13:34	NG 51144 31681	151144	831682		LSFW3	Freshwater sample. Observations with WP13.
13	14/07/2014	13:40	NG 51166 31671	151166	831672			Observations: Width 1.3m. Depth 9cm. Flow 0.463m/sec SD 0.006.
14	14/07/2014	14:00	NG 51895 32168	151896	832168			Fourteen gulls take off from shore. No sign of discharge to seawater.
15	14/07/2014	14:10	NG 52221 32351	152222	832351			Alternate RMP site. Approx. 20m off shore of WP. Only accessible at very low tide. Survey on spring tides so not possible to reach it. No sign of mussels on shore around alternate RMP so no possibility of shellfish sample here.
16	14/07/2014	14:12	NG 52231 32350	152231	832350		LSSW1	Seawater sample.
17	14/07/2014	14:17	NG 52339 32307	152340	832308		LSFW4	Freshwater sample. Observations taken at WP 18.
18	14/07/2014	14:18	NG 52340 32306	152340	832307			Observations: Width 2.1m. Depth 11cm. Flow 0.356m/sec SD 0.006.
19	14/07/2014	14:24	NG 52406 32291	152407	832291			Ten moorings off Sconser slipway. Two launches, 1rib.
20	14/07/2014	14:27	NG 52480 32263	152481	832264	Fig 9		West end of Sconser Pier complex. Calmac terminal for Raasay ferry. Concrete pier, shelter with waiting area. Septic tank at car park level.
21	14/07/2014	14:31	NG 52503 32286	152503	832286		LSFW5	Freshwater sample. Observations with WP22
22	14/07/2014	14:37	NG 52502 32289	152503	832289	Fig 10		Water coming out underneath rock facia below carpark wall. Below septic tank. Extensive green algal growth. Observations: Width 22cm. Depth 3cm. Flow in 5 seconds 500ml (100ml/sec). Too shallow to sample with flow meter.
23	14/07/2014	14:44	NG 52517 32286	152517	832287		LSFW6	Freshwater sample. Observations with WP24.
24	14/07/2014	14:45	NG 52518 32287	152518	832287	Fig 11		Observations: Pipe width 80cm. Depth 5cm. Flow meter being problematic, so took flow measurement with jug. Flow 2.5litres/sec.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
25	14/07/2014	15:07	NG 52323 32139	152323	832139			Sconser village. No septic tanks or discharges visible. Two sheep and two lambs in lower field.
26	14/07/2014	15:09	NG 52287 32129	152287	832130			Manhole by side of road with WOV water signage. No sign of septic tanks or discharges.
27	15/07/2014	8:50	NG 52565 32288	152566	832289			Start of 2nd day of survey. Sconser slipway.
28	15/07/2014	8:51	NG 52562 32300	152563	832301		LSSW2	Seawater sample.
29	15/07/2014	8:54	NG 52589 32298	152589	832299	Fig 12		Discharge to seawater (SW), 10cm PVC pipe, no flow. House just above shore.
30	15/07/2014	8:57	NG 52619 32307	152619	832307			High tide, making way above shore as no access through private property.
31	15/07/2014	9:01	NG 52660 32304	152661	832304			Discharge to SW, 15cm PVC pipe. No flow. House across road above pipe.
32	15/07/2014	9:03	NG 52683 32306	152683	832307			Small burn running from hillside. Far corner of fish farm site. Not sampled.
33	15/07/2014	9:06	NG 52732 32286	152733	832286			Fish farm site, pontoon with two workboats on it. WP taken from the road. Twenty five gulls on shore around fish farm site.
34	15/07/2014	9:13	NG 52995 32343	152995	832344			Small burn running to shore. No houses or livestock in vicinity. No sample taken.
35	15/07/2014	9:18	NG 53139 32279	153140	832279			Small burn running off hillside under garden to shore. 9 sheep visible. No sample taken.
36	15/07/2014	9:21	NG 53190 32253	153191	832254			Sconser Lodge Hotel. Small slipway.
37	15/07/2014	9:24	NG 53246 32211	153246	832211		LSFW7	Freshwater sample. Observations with WP38.
38	15/07/2014	9:24	NG 53247 32210	153247	832211			Observations: Width 65cm. Depth 7cm. Flow 0.267m/sec SD 0.007.
39	15/07/2014	9:29	NG 53250 32216	153250	832216	Fig 13	LSSW3	Seawater sample. Sample taken from in front of end of discharge pipe. 15cm diameter PVC pipe submerged.
40	15/07/2014	9:37	NG 53434 32161	153435	832161			Small burn running off hill through golf course. No sample taken.
41	15/07/2014	9:41	NG 53532 32120	153533	832121		LSFW8	Freshwater sample. Observations with WP 42.
42	15/07/2014	9:41	NG 53532 32120	153533	832121			Observations: Width 1.6m.Depth 12cm. Flow 0.103m/sec SD0.010.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
43	15/07/2014	9:48	NG 53699 32037	153700	832037		LSFW9	Freshwater sample. Observations with WP 44.
44	15/07/2014	9:48	NG 53699 32037	153700	832037			Observations: Width 1.1m. Depth 12cm. Flow 0.078m/sec SD0.021.
45	15/07/2014	9:58	NG 54118 31855	154118	831856			Stopped survey activity to go and meet harvester.
46	15/07/2014	10:55	NG 52177 32756	152178	832757		CTD1	Mr Oakes (harvester's son) takes survey team out on Rib to WP and sample the marked extent points of the scallop site.
47	15/07/2014	10:57	NG 52150 32763	152151	832764		LSSW4	Seawater sample. Edge of sampling area.
48	15/07/2014	11:02	NG 51607 32547	151607	832548		LSSW5	Seawater sample. Edge of area.
49	15/07/2014	11:03	NG 51594 32543	151595	832543		CTD2	Edge of area.
50	15/07/2014	11:06	NG 51650 32108	151651	832109		LSSW6	Seawater sample. Edge of area.
51	15/07/2014	11:07	NG 51645 32080	151645	832081		CTD3	Edge of area.
52	15/07/2014	11:11	NG 52227 32369	152228	832370	Fig 14	LSSW7	Seawater sample. Alternate RMP point marker buoy.
53	15/07/2014	11:12	NG 52217 32360	152217	832360		CTD4	CTD measurement.
54	15/07/2014	13:45	NG 54131 31838	154131	831839			Continue survey from quarry, salt depot immediately across river.
55	15/07/2014	13:48	NG 54174 31873	154174	831874		LSFW10	Freshwater sample. Observations with WP56.
56	15/07/2014	13:48	NG 54176 31873	154176	831874			Observations: Width 1.5m. Depth 25cm. Flow 1.484m/sec SD0.039
57	15/07/2014	13:53	NG 54181 31890	154182	831890		LSSF1	Mussel sample taken from shore beside river. Four oyster catchers on shore.
58	15/07/2014	14:07	NG 54353 31944	154354	831945			Discharge pipes x2. Metal pipes overgrown and filled with sand. No discharge.
59	15/07/2014	14:17	NG 54401 31915	154402	831915		LSFW11	Freshwater sample. Observations with WP60.
60	15/07/2014	14:17	NG 54402 31915	154402	831916	Fig 15		Observations: Width 12cm. Depth 3cm. Flow 0.457m/sec SD0.029. This sample was taken to give appropriate coverage of this area due to sample site in WP61 not being viable.
61	15/07/2014	14:22	NG 54501 31909	154501	831909			Site of planned NGS4503190 water sample. Stagnant pool. Sample not taken.
62	15/07/2014	14:24	NG 54537 31921	154538	831921		LSFW12	Freshwater sample. Observations with WP63.
63	15/07/2014	14:25	NG 54535 31919	154536	831919	Fig 16		Observations: Width 1m. Depth 6cm. Flow 0.266m/sec SD0.017
64	15/07/2014	14:32	NG 54511 32011	154512	832011		LSSW8	Seawater sample. A gull on shore.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
65	15/07/2014	15:27	NG 52556 32982	152557	832982			Start of survey area on the north shore adjacent to Sconser Pier.
66	15/07/2014	15:29	NG 52527 32901	152528	832902		LSSW9	Seawater sample. Nineteen sheep above shore. No sign of septic tanks or discharges. A rib on mooring, 1 seagull on shore. One dinghy and 1 rib above shore.
67	15/07/2014	15:33	NG 52436 32897	152437	832898			End of survey area on the north shore adjacent to Sconser Pier.
68	15/07/2014	15:39	NG 52588 33162	152589	833162			Houses on downhill side of road, searching for evidence of septic tanks and soakaways. Nothing found. No access to private properties or crofting fields below.
69	15/07/2014	15:42	NG 52660 33520	152661	833520			No sign of soakaways, mains water running along.
70	15/07/2014	15:52	NG 52838 33898	152839	833899	Fig 17		Manhole cover.
71	15/07/2014	15:58	NG 53024 33647	153024	833647			Start of survey area south end of Balmeanach Bay.
72	15/07/2014	16:01	NG 52941 33737	152942	833737			Small stream with very low flow (trickle) coming through field. No sample taken. Forty six sheep in adjacent field.
73	15/07/2014	16:07	NG 52826 33959	152827	833960			Standard 10cm water pipe coming through field. Looks unused. Thirty eight sheep in adjacent field. One oyster catcher on shore.
74	15/07/2014	16:16	NG 52911 34184	152911	834185		LSSW10	Seawater sample.
75	15/07/2014	16:16	NG 52912 34190	152912	834191			End of survey area.
76	15/07/2014	16:30	NG 52770 34252	152770	834252			Septic tank cover, 48 sheep in field.
77	15/07/2014	16:34	NG 52772 34234	152773	834234			Septic tank cover.
78	15/07/2014	16:36	NG 52751 34442	152751	834443			Septic tank, concrete lid.
79	15/07/2014	16:38	NG 52695 34575	152695	834576	Fig 18		Plastic green lid in field 1x1 metre, possible septic tank.
80	15/07/2014	16:38	NG 52695 34576	152696	834577			Concrete manhole 1.5m by 1.5m
81	15/07/2014	16:43	NG 52454 35186	152455	835186			Concrete area with PVC pipe vent. Suspected septic tank.
82	15/07/2014	16:44	NG 52428 35335	152429	835336	Fig 19		Concrete plinth PVC pipe air vent, suspected septic tank.
83	15/07/2014	16:46	NG 52314 35454	152315	835454			Camus more house. Concrete area 1mx1m, suspected septic tank.
84	16/07/2014	9:42	NG 51242 31514	151243	831514			Vent pipe to surface in private garden. Suspected septic tank.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
85	16/07/2014	9:47	NG 51382 31672	151382	831673			No evidence of septic tank (manhole or plastic covers, air vents or concrete slabs) visible from boundary of private property.
86	16/07/2014	9:52	NG 51513 31810	151513	831811			No evidence of septic tank (manhole or plastic covers, air vents or concrete slabs) visible from boundary of private property.
87	16/07/2014	9:55	NG 52532 32210	152533	832211			No evidence of septic tank (manhole or plastic covers, air vents or concrete slabs) visible from boundary of private property.
88	16/07/2014	10:00	NG 53329 31909	153329	831910			No evidence of septic tank (manhole or plastic covers, air vents or concrete slabs) visible from boundary of private property.
89	16/07/2014	10:00	NG 53316 31912	153317	831912			No evidence of septic tank (manhole or plastic covers, air vents or concrete slabs) visible from boundary of private property.

Photographs referenced in the table can be found attached as Figures 7-19.

Sampling

Seawater and freshwater samples were collected at the sites marked in Figure 6.

All seawater samples on the survey plan were acquired, as well as one additional sample from in front of a submerged outflow pipe associated with WP39.

All but one of the planned freshwater samples were acquired, with the planned site at WP61 only having a stagnant pool which could not be sampled.

One common mussel sample was taken from the shore WP57.

All the samples were transferred to a Biotherm 30 box with ice packs and posted to Glasgow Scientific Services (GSS) for *E. coli*. analysis. Nine freshwater and seven seawater samples were sent to the laboratory on the 15th July, the temperature on arrival at the laboratory was recorded as 4.4 °C. Three freshwater,3 seawater and one shellfish sample were collected and sent in a Biotherm box to the laboratory on the 16th July the temperature on arrival at the laboratory was recorded as 10.7°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 following formula:

$$\text{Salinity (ppt)} = 0.0018066 \times Cl^{-} \text{ (mg/L)}$$

Table 2. Water Sample Results

No	Date	Sample	Grid Ref	Type	E. coli (cfu/100ml)	Salinity (ppt)
1	14/07/2014	LSFW1	NG 48627 29879	Freshwater	33000	
2	14/07/2014	LSFW2	NG 48954 30483	Freshwater	280	
3	14/07/2014	LSFW3	NG 51144 31681	Freshwater	10	
4	14/07/2014	LSSW1	NG 52231 32350	Seawater	24	34.33
5	14/07/2014	LSFW4	NG 52339 32307	Freshwater	20000	
6	14/07/2014	LSFW5	NG 52503 32286	Freshwater	20000	
7	14/07/2014	LSFW6	NG 52517 32286	Freshwater	20000	
8	15/07/2014	LSSW2	NG 52562 32300	Seawater	900	30.89
9	15/07/2014	LSFW7	NG 53246 32211	Freshwater	210	
10	15/07/2014	LSSW3	NG 53250 32216	Seawater	4500	31.80
11	15/07/2014	LSFW8	NG 53532 32120	Freshwater	60000	
12	15/07/2014	LSFW9	NG 53699 32037	Freshwater	100	
13	15/07/2014	LSSW4	NG 52150 32763	Seawater	36	32.34
14	15/07/2014	LSSW5	NG 51607 32547	Seawater	37	31.80
15	15/07/2014	LSSW6	NG 51650 32108	Seawater	35	29.63
16	15/07/2014	LSSW7	NG 52227 32369	Seawater	31	30.53
17	15/07/2014	LSFW10	NG 54174 31873	Freshwater	50	
18	15/07/2014	LSFW11	NG 54401 31915	Freshwater	<10	
19	15/07/2014	LSFW12	NG 54537 31921	Freshwater	60	
20	15/07/2014	LSSW8	NG 54511 32011	Seawater	3	32.70
21	15/07/2014	LSSW9	NG 52527 32901	Seawater	500	31.62
22	15/07/2014	LSSW10	NG 52911 34184	Seawater	1	34.69

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	Sample depth (m)	E. coli (MPN/100g)
1	15/07/2014	LSSF1	NG 54181 31890	Mussels	Shore sample	**Error! Not a valid link.**

Salinity Profiles

CTD profiles were taken at four locations marking the corners of the production area (refer to Figure 6 for map locations). The gathered data will be sent to client as a separate document

Photographs

Figure 7. Discharge pipe running under A863 road into river. Site of LSFW1. Associated with Waypoint (WP) 3.

Figure 8. Septic tank on campsite grounds. Associated with WP10.

Figure 9. Septic tank over the wall from car park at Sconser Pier. Associated with WP20.

Figure 10. Water flow from below septic tank at car park, Sconser Pier. Site of LSFW5. Associated with WP22.

Figure 11. Site of LSFW6. Associated with WP 24.

Figure 12. Discharge to seawater, pipe below house protruding onto shore. Site of LSSW2. Associated with WP 29.

Figure 13. Submerged discharge pipe. Site of LSSW3. Associated with WP39.

Figure 14. Alternate RMP point marker buoy. Site of LSSW7. Associated with WP52

Figure 15. LSFW11. Associated with WP60.

Figure 16. LSFW12. Associated with WP63.

Figure 17. Possible soakaway. Associated with WP70.

Figure 18. Possible septic tank site. Associated with WP79.

Figure 19. Suspected site of septic tank. Associated with WP82.

6. SEPA Discharge Consents

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/L/1001917	NG 48639 29792	Hotel	Sewage (Private) Secondary	River Sligachan	E100
CAR/L/1002346	NG 53400 34200	Balmeanach Bay MCFF, Sound of Raasay	Fish Farm Marine Cage		
CAR/L/1002356	NG 56400 30800	Maol Ban, Loch Ainort	Fish Farm Marine Cage		
CAR/L/1003869	NG 5540 2860	Cairdh Marine Cage Fish Farm	Fish Farm Marine Cage		
CAR/L/1003966	NG 48642 30183	Camp Site, Isle of Skye	Sewage (Private) Primary	River Sligachan	1
CAR/L/1009643	NG 56561 30742	Maol Ban East MCFF, Caol Mor, Isle of Skye	Fish Farm Marine Cage		
CAR/L/1010432	NG 55982 29008	Cairidh MCFF, Moll, Isle Of Skye	Fish Farm Marine Cage		
CAR/L/1014265	NG 5530 2850	Cairidh MCFF, Moll, Isle Of Skye	Fish Farm Marine Cage		
CAR/L/1105323	NG 56043 39700	Raasay WTW, Isle of Raasay	Other Effluent Potable Water Treatment and Supply		0
CAR/R/1007453	NG 50620 31080	Sconser Common Grazings	Sheep Dip onto Land		
CAR/R/1007780	NG 57190 36080	South Raasay Common Grazing,GWR-BH1	Sheep Dip onto Land		
CAR/R/1007823	NG 52550 33600	Ben Lee Common Grazings,GWR-BH1	Sheep Dip onto Land		
CAR/R/1009888	NG 55270 37810	Youth Hostel, Creachan Cottage, Raasay	Sewage (Private) Primary	Land	4
CAR/R/1012095	NG 56490 28050	Dwelling, Luid, By Broadford, Isle of Skye	Sewage (Private) Primary	Loch Ainort	5
CAR/R/1016050	NG 52200 32180	Dwelling, Sconser, Isle of Skye	Sewage (Private) Primary	Land	5
CAR/R/1016205	NG 58520 28000	Dwelling, Dunan, Broadfield	Sewage (Private) Primary	Soakaway	5
CAR/R/1018539	NG 53250 32240	Hotel, Sconser, Skye	Sewage (Public) Primary	Loch Sligachan	30
CAR/R/1019641	NG 56120 27870	Dwelling, Luib, Isle of Skye, IV49 9AN	Sewage (Private) Primary	Land	6

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1019897	NG 52173 35418	Dwelling, Braes, By Portree	Sewage (Private) Primary	Land	5
CAR/R/1022242	NG 52782 34096	Dwelling, The Braes, Portree, Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1022610	NG 55360 35540	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Soakaway	5
CAR/R/1024244	NG 54710 38230	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Soakaway	5
CAR/R/1026665	NG 59122 27218	Business, Strollamus, Isle of Skye	Sewage (Private) Primary	Loch na Cairidh	5
CAR/R/1026667	NG 59081 27040	Business, Strollamus, Isle of Skye	Sewage (Private) Primary	U/T of Loch na Cairidh	5
CAR/R/1028741	NG 57810 29020	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1029598	NG 54656 36374	Business, New Raasay Ferry Terminal	Sewage (Private) Primary	Soakaway	5
CAR/R/1029630	NG 54657 36374	Temporary Dwelling, Tigh An Achaidh, Kyle	Sewage (Private) Primary	Soakaway	5
CAR/R/1035837	NG 52134 32186	2 Dwellings, Isle of Skye	Sewage (Private) Primary	Soakaway	10
CAR/R/1036355	NG 56350 36270	Dwelling, Isle of Raasay	Sewage (Private) Primary	Soakaway	5
CAR/R/1038412	NG 54734 38210	Dwelling, Isle of Raasay	Sewage (Private) Primary	Soakaway	6
CAR/R/1039575	NG 56170 27910	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Land	15
CAR/R/1041826	NG 52320 35164	Dwelling,	Sewage (Private) Primary	Land	5
CAR/R/1042044	NG 58140 28691	Dwelling, Ardoch, Isle of Skye	Sewage (Private) Secondary	Loch na Cairidh	6
CAR/R/1042327	NG 52300 35180	Dwelling,	Sewage (Private) Primary	Soakaway	5
CAR/R/1042988	NG 55380 35570	Dwelling, West Suisnish, Kyle	Sewage (Private) Primary	Land	5
CAR/R/1042996	NG 50958 37669	Dwelling, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1043000	NG 50809 37465	Dwelling, Portree	Sewage (Private) Primary	Soakaway	5

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1043081	NG 52290 35420	Dwelling, Gedintailor, Portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1043085	NG 52251 35527	2 Dwellings, Gedintailor, Portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1043301	NG 51470 37230	Dwelling, Portree	Sewage (Private) Primary	Land	5
CAR/R/1044151	NG 50560 38290	Dwelling, Conordon, Portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1044205	NG 50794 38866	2 Dwellings, Braes, Skye	Sewage (Private) Primary	Land	6
CAR/R/1044523	NG 57750 28950	Dwelling, By Broadford, Isle of Skye	Sewage (Private) Primary	Soakaway	6
CAR/R/1044670	NG 52490 35180	Dwelling, Gedintailor, Portree	Sewage (Private) Primary	Soakaway	7
CAR/R/1044689	NG 54900 37840	Dwelling, Raasay, Kyle	Sewage (Private) Primary	Soakaway	5
CAR/R/1044690	NG 52480 35190	Dwelling, Gedintailor, Portree	Sewage (Private) Primary	Soakaway	15
CAR/R/1044697	NG 52560 35150	Dwelling, Gedintailor, Braes	Sewage (Private) Primary	Soakaway	15
CAR/R/1045559	NG 53300 31870	Dwelling, Sconser, Isle of Skye	Sewage (Private) Primary	Land	5
CAR/R/1045633	NG 52580 32312	Dwelling, Isle of Skye	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1045822	NG 52380 32130	Dwelling, Isle of Skye	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1045852	NG 55310 35560	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Narrows of Raasay	5
CAR/R/1046847	NG 51530 31770	Dwelling, By Kyle, Isle of Skye	Sewage (Private) Primary	Soakaway	7
CAR/R/1046874	NG 50790 38760	Dwelling, Braes Salmon Station, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1046951	NG 55040 35980	Dwelling, Clachan, Kyle	Sewage (Private) Primary	Soakaway	5
CAR/R/1047188	NG 53260 31930	Dwelling, Sconser, Isle of Skye	Sewage (Private) Primary	Soakaway	9
CAR/R/1047227	NG 52730 34560	Dwelling, The Braes, Portree	Sewage (Private) Primary	Soakaway	5

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1047575	NG 55300 36010	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Soakaway	15
CAR/R/1047788	NG 59190 27110	Dwelling, Broadford	Sewage (Private) Primary	Mound Soakaway	6
CAR/R/1047900	NG 52705 34609	Dwelling, Portree	Sewage (Private) Primary	Soakaway	7
CAR/R/1048246	NG 52630 33228	Dwelling, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1048730	NG 55563 27712	Dwelling, Luib, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1048733	NG 52190 32188	Dwelling, Isle of Skye, Donald I Blackman	Sewage (Private) Primary	Soakaway	5
CAR/R/1048824	NG 52660 33240	Dwelling, Portree	Sewage (Private) Primary	Land	5
CAR/R/1048893	NG 52646 33209	Dwelling,	Sewage (Private) Primary	Soakaway	6
CAR/R/1049008	NG 54900 37970	Dwelling, Inverness	Sewage (Private) Primary	Soakaway	5
CAR/R/1050011	NG 50650 37970	Dwelling, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1050094	NG 52780 34170	Dwelling, Balmeanach, Portree	Sewage (Private) Primary	Land	5
CAR/R/1051038	NG 58627 27890	Dwelling, Broadford,Isle Of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1051147	NG 56009 27988	Dwelling, Luib,Isle Of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1052726	NG 52498 35008	Dwelling, The Braes,Portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1052727	NG 59142 27170	Dwelling, Broadford	Sewage (Private) Primary	Soakaway	5
CAR/R/1053187	NG 55326 36016	Dwelling, isle of raasay, kyle	Sewage (Private) Primary	Soakaway	6
CAR/R/1053238	NG 52790 33620	Dwelling, Peinachorran, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1053737	NG 52211 32112	Dwelling, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1053738	NG 52266 32104	Dwelling, Sconser, Isle Of Skye	Sewage (Private) Primary	Soakaway	10

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1054149	NG 51825 31997	Dwelling, Isle Of Skye	Sewage (Private) Primary	Soakaway	10
CAR/R/1054722	NG 52486 32175	Dwelling, Isle of Skye	Sewage (Private) Untreated	Soakaway	5
CAR/R/1055070	NG 55431 36022	Dwelling, Isle of Raasay	Sewage (Private) Primary	Soakaway	5
CAR/R/1061385	NG 52497 34987	Dwelling, The Braes, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1064945	NG 52739 34278	Dwelling, The Braes, Isle Of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1064953	NG 52329 32223	Dwelling, Isle-Of-Skye, IV48 8TD	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1065109	NG 51599 36403	Dwelling, Braes, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1065519	NG 54824 36283	Dwelling, Isle of Raasay, By Kyle	Sewage (Private) Primary	Churchton Bay	5
CAR/R/1065792	NG 54940 38110	Dwelling, Isle of Raasay, Rossshire	Sewage (Private) Primary	Soakaway	5
CAR/R/1065944	NG 54960 36071	Dwelling, Isle Of Raasay	Sewage (Private) Primary	Soakaway	5
CAR/R/1066170	NG 52750 34346	Dwelling, The Braes, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1066184	NG 52748 34360	Dwelling, The Braes, Portree,Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1066209	NG 51988 36268	Dwelling, Upper Oliach, Braes, Portree, Skye	Sewage (Private) Primary	Narrows of Raasay	5
CAR/R/1067099	NG 51290 37231	Dwelling, Braes, Portree, Isle Of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1067107	NG 51240 37230	Dwelling, Portree, Isle of Skye	Sewage (Private) Primary	Soakaway	10
CAR/R/1067770	NG 52338 32225	Dwelling, Isle Of Skye	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1068310	NG 52410 32180	Dwelling, Isle of Skye	Sewage (Private) Primary	Land	8
CAR/R/1068555	NG 51270 37150	Dwelling, Portree, Isle Of Skye	Sewage (Private) Primary	Land	5
CAR/R/1068684	NG 54900 36290	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Soakaway	5

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1068712	NG 57880 34120	Dwelling, Eyre, Isle of Raasay	Sewage (Private) Primary	Soakaway	5
CAR/R/1069022	NG 56510 28120	Dwelling, Luib, By Broadford, by Skye	Sewage (Private) Primary	Loch Ainort	5
CAR/R/1069149	NG 50670 38080	Dwelling, Braes, Isle Of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1069176	NG 52690 32260	Dwelling, Sconser, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1069295	NG 56480 28038	Dwelling, Luib, Broadford, Isle Of Sky	Sewage (Private) Primary	Loch Ainort	15
CAR/R/1069299	NG 52357 32133	Dwelling, Sconser,Isle of Skye	Sewage (Private) Secondary	UN/WC	5
CAR/R/1069317	NG 52310 35520	Dwelling, Isle of Skye	Sewage (Private) Primary	Land	10
CAR/R/1069435	NG 52710 33480	Dwelling, Portree	Sewage (Private) Primary	Land	5
CAR/R/1070749	NG 51629 31950	Dwelling, Isle Of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1070784	NG 55400 35980	Dwelling, Isle Of Raasay, Kyle	Sewage (Private) Primary	Soakaway	7
CAR/R/1071262	NG 55360 35970	Dwelling, Isle Of Raasay	Sewage (Private) Primary	Soakaway	5
CAR/R/1071905	NG 54928 38096	Dwelling, Isle of Raasay	Sewage (Private) Primary	Soakaway	15
CAR/R/1072613	NG 51280 37130	Dwelling, Lower Ollach, Braes, Portree	Sewage (Private) Primary	Land	7
CAR/R/1073051	NG 55190 35980	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Soakaway	9
CAR/R/1075574	NG 50590 38230	Dwelling, The Braes, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1075646	NG 56452 30164	Dwelling, Sconcer, Isle of Skye	Sewage (Private) Primary	Loch Ainort	5
CAR/R/1075945	NG 52800 33850	Dwelling, Braes, Isle of Skye	Sewage (Private) Primary	Soakaway	6
CAR/R/1076185	NG 54870 36328	Dwelling, Raasay, Kyle	Sewage (Private) Primary	Soakaway	6
CAR/R/1076496	NG 56450 28140	Dwelling, Luib, Isle of Skye	Sewage (Private) Primary	Loch Ainort	6

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1076673	NG 52266 35487	Dwelling, Gedintailor, The Braes,Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1076743	NG 52430 32132	Dwelling, Isle of Skye	Sewage (Private) Primary	land	5
CAR/R/1076749	NG 51407 37130	Dwelling, Braes, Portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1076767	NG 54849 36298	Dwelling, Isle of Raasay	Sewage (Private) Primary	Soakaway	5
CAR/R/1076853	NG 52721 34461	Dwelling, Braes, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1076859	NG 58600 28180	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Loch na Cairidh	6
CAR/R/1076861	NG 52756 34442	Dwelling, Braes, Portree	Sewage (Private) Primary	UN/WC	5
CAR/R/1076872	NG 55330 35530	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Narrows of Raasay	5
CAR/R/1076960	NG 59317 27019	Dwelling, Isle of Skye	Sewage (Private) Primary	Loch na Cairidh	5
CAR/R/1077024	NG 54030 27960	Dwelling, Sconser, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1077035	NG 59249 27087	Dwelling, Broadford, Isle Of Skye	Sewage (Private) Primary	Loch na Cairidh	5
CAR/R/1077200	NG 51117 37351	2 Dwellings, Portree, Skye	Sewage (Private) Primary	Soakaway	10
CAR/R/1077430	NG 52740 34332	Dwelling, Isle of Skye	Sewage (Private) Primary	Soakaway	6
CAR/R/1077439	NG 50656 38059	Dwelling, Braes, Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1077734	NG 56460 27830	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1077746	NG 51250 31500	Dwelling, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1077881	NG 52427 35230	Dwelling, the Braes, portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1077915	NG 52026 35440	Dwelling, Portree	Sewage (Private) Primary	Soakaway	6
CAR/R/1077928	NG 55302 35319	Dwelling, Suisnish, Isle of Raasay	Sewage (Private) Primary	U/T of Narrows of Raasay	5

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1078539	NG 56470 27970	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1078546	NG 54860 36290	Dwelling, Raasay, Kyle, Ross shire	Sewage (Private) Primary	Soakaway	5
CAR/R/1079043	NG 51600 32031	Dwelling, Sconser, Skye	Sewage (Private) Primary	Loch Sligachan	5
CAR/R/1079857	NG 58891 27757	Dwelling, Dunan, Isle of Skye	Sewage (Private) Secondary	Loch na Cairidh	11
CAR/R/1080146	NG 52743 34262	Dwelling, Braes, Portree, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1080204	NG 54618 37993	Dwelling, Isle of Raasay	Sewage (Private) Primary	Sounf of Raasay	5
CAR/R/1080665	NG 58690 27870	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1084013	NG 57580 34120	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Caol Mor	5
CAR/R/1089575	NG 52624 33160	Dwelling, Portree	Sewage (Private) Primary	Soakaway	5
CAR/R/1094085	NG 58000 28830	Dwelling, Isle of Skye	Sewage (Private) Primary	Soakaway	8
CAR/R/1095701	NG 56340 27750	Dwelling, Broadford, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1097645	NG 55532 36020	Dwelling, Isle of Raasay	Sewage (Private) Primary	Inverarish Burn	5
CAR/R/1098171	NG 52810 33840	Dwelling, Braes, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1100270	NG 56140 27880	Dwelling, Luib, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1104262	NG 52529 32289	Dwelling, Sconser, Isle of Skye	Sewage (Private) Secondary	Coastal Waters	15
CAR/R/1106677	NG 55480 36000	Dwelling, Isle of Raasay, Kyle	Sewage (Private) Primary	Soakaway	5
CAR/R/1108618	NG 51543 36539	Dwelling, Upper Ollach, Portree,	Sewage (Private) Primary		5
CAR/R/1110769	NG 58320 28170	Creag na Mara, 8 Dunan, Broadford	Sewage (Private) Primary	Soakaway	5
CAR/R/1112360	NG 51135 37405	2 Dwellings, Portree, Skye	Sewage (Private) Secondary	Loch Crion	10

Consent Number	Discharge Location	Discharge name	Discharge Type	Discharging to	PE
CAR/R/1116969	NG 51350 31620	Dwelling, Sconser, Skye	Sewage (Private) Primary	Soakaway	5
CAR/R/1117339	NG 57680 28980	Dwelling, Ard Dorch, Isle of Skye	Sewage (Private) Primary	Soakaway	5
CAR/S/1008975	NG 55220 35870	Community Facilities Site, Mill Park, Raasay	Sewage (Private) Secondary	Soakaway	25
CAR/S/1020826	NG 54389 36747	Business, Raasay Hse, Raasay	Sewage (Private) Secondary	Narrows of Raasay	86
CAR/S/1021302	NG 59217 26633	Strollamus WTW, Broadford	Other Effluent Potable Water Treatment and Supply		
CAR/S/1023437	NG 54480 36230	Business, Churchton Bay, Isle of	Sewage (Public) Primary	Churchton Bay	37
CAR/S/1081657	NG 50800 31180	Sconser Common Grazings	Sheep Dip onto Land		
CAR/S/1081657	NG 50700 31220	Sconser Common Grazings	Sheep Dip onto Land		
CAR/S/1081657	NG 50630 31200	Sconser Common Grazings	Sheep Dip onto Land	Land	
CAR/S/1098878	NG 55100 35790	3 Dwellings, School Park, Isle of Raasay	Sewage (Private) Primary	Churchton Bay	28
PPC/N/0060043	NG 54395 31761	Sconser Quarry, Isle of Skye			
WML/N/0050024	NG 55386 37954	HC closed Rassay LFS, Oscaig, Creachan			
WML/XC/1084279	NG 55180 36580	Borodale Field Access Road, Raasay			

LS=Land/Soakaway, SW= Seawater Body, FW= Freshwater Body, PE= Population Equivalent, - = Not applicable E=Estimated by local SEPA office

7. Loch Sligachan CTD data

Data obtained during the shoreline survey. The locations of the casts are shown in Figure A8.1.

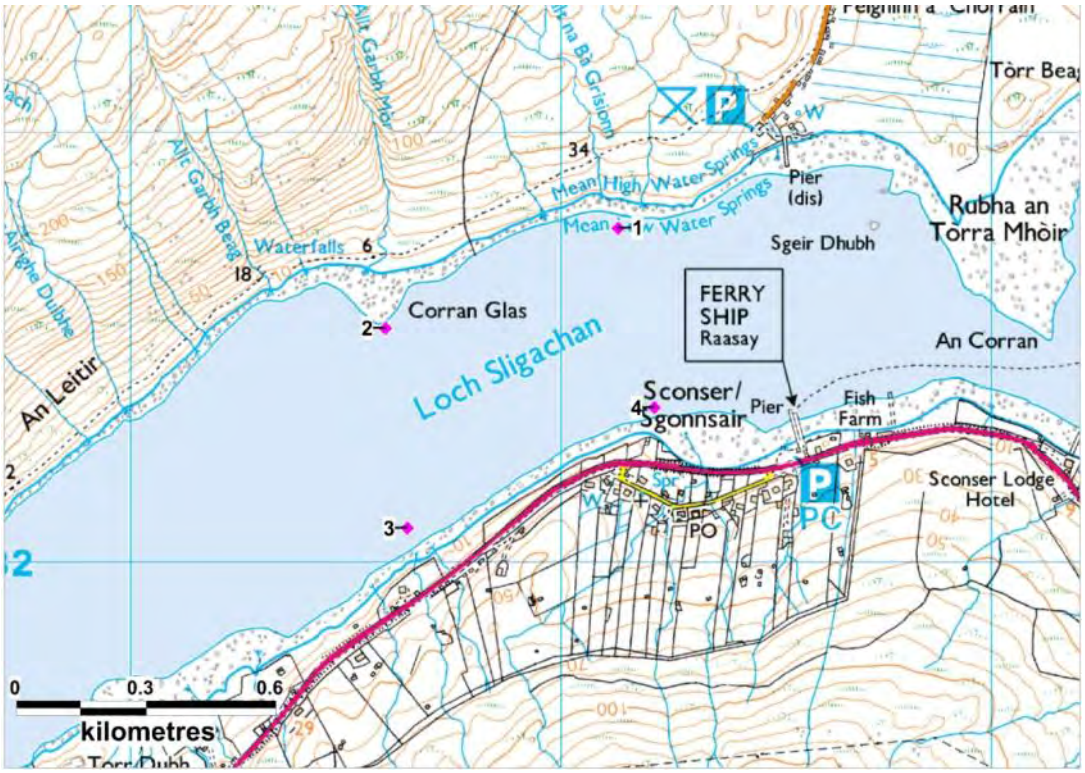

Figure A7.1 Location of CTD cast

CAST 1

Data Header

% Device	10G100653
% File name	10G100653_20140715_095813
% Cast time (local)	15/07/2014 10:58:13
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	57.3179715
% Start longitude	-6.1183812
% Start GPS horizontal error(Meter)	2.180000067
% Start GPS vertical error(Meter)	2.890000105
% Start GPS number of satellites	6
% Cast duration (Seconds)	56.8
% Samples per second	5
Calibration Date	March 2013
Calibration offset for Temperature	-0.033
Calibration offset for Salinity	0.029

CTD data (calibration offsets applied)

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
0.149191247	11.69637007	31.8589061
0.447557215	11.69174572	31.84397059
0.745930072	11.69100172	31.84630709
1.044293738	11.69410312	31.92281681
1.342626706	11.70289538	32.11761566
1.640917388	11.70227216	32.29579601
1.939171183	11.69872987	32.43999327
2.237398794	11.68625222	32.52071539
2.535611517	11.67077628	32.56215691
2.833790631	11.58817836	32.79203139
3.131886943	11.46540196	33.24363465
3.429871175	11.38899826	33.73434457
3.727766805	11.27896003	33.98131897
4.025623685	11.24476698	34.04064614
4.323468998	11.22501453	34.06812948
4.621309102	11.21627708	34.07712887
4.91914673	11.2126086	34.0841762
5.21698203	11.20616249	34.09239755
5.514814893	11.2022192	34.1003563
5.812645604	11.19776656	34.10652034
6.110474718	11.199914	34.11097627
6.408302449	11.19966579	34.11623785
6.706129623	11.19849984	34.1126017
7.003956972	11.19775412	34.11127072
7.301782919	11.19298983	34.12075261
7.599607311	11.19332795	34.12102884
7.897431675	11.20018053	34.11970925
8.195255102	11.19607919	34.12699109
8.584329068	11.19934061	34.12644236

CAST 2

Data Header

% Device	10G100653
% File name	10G100653_20140715_100316
% Cast time (local)	15/07/2014 11:03:16
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	57.3155919
% Start longitude	-6.1271122
% Start GPS horizontal error(Meter)	2.210000038
% Start GPS vertical error(Meter)	2.50999999
% Start GPS number of satellites	7
% Cast duration (Seconds)	51.2
% Samples per second	5
Calibration Date	March 2013
Calibration offset for Temperature	-0.033
Calibration offset for Salinity	0.029

CTD data (calibration offsets applied)

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
0.149276766	11.81261553	31.13189822
0.447811872	11.80109008	31.12316661
0.746354239	11.80196753	31.11777623
1.044892786	11.81310194	31.15675062
1.343425337	11.81828705	31.17160482
1.641952729	11.82170326	31.20138087
1.940469586	11.81364062	31.2606339
2.238926229	11.76771299	31.71809002
2.537126365	11.62252154	33.48220831
2.835089036	11.56666515	33.76938401
3.13299922	11.51633837	33.91894086
3.430887125	11.50164701	33.94833628
3.728770385	11.49561454	33.95219287
4.015189207	11.49989845	33.96850793

CAST 3

Data Header

% Device	10G100653
% File name	10G100653_20140715_100715
% Cast time (local)	15/07/2014 11:07
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	57.3114606
% Start longitude	-6.1257972
% Start GPS horizontal error(Meter)	2
% Start GPS vertical error(Meter)	2.480000019
% Start GPS number of satellites	8
% Cast duration (Seconds)	42.2
% Samples per second	5
Calibration Date	March 2013
Calibration offset for Temperature	-0.033
Calibration offset for Salinity	0.029

CTD data (calibration offsets applied)

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
0.14953817	11.91458534	28.84764178
0.448593185	11.92194013	28.8731127
0.747642523	11.92568075	28.95125067
1.046637981	11.88740192	29.33739754
1.345423046	11.72476263	30.75875811
1.643838595	11.53775264	32.51757662
1.941984196	11.45252733	33.07898812
2.240035195	11.39041967	33.3171759
2.538046557	11.36317006	33.40587607
2.836036268	11.34134213	33.49435292
3.13400776	11.33072167	33.55656748
3.431963078	11.33100035	33.6321314
3.729900771	11.36857446	33.71850113
4.027812921	11.38994462	33.86918344
4.32570245	11.40687434	33.92487597
4.623586033	11.42042189	33.9260587
4.921473104	11.40006375	33.88940638
5.219361823	11.37691922	33.8982133
5.517247849	11.35935664	33.90069825
5.8151356	11.33714841	33.8705981
6.113023506	11.30555386	33.88370422
6.410907013	11.28907793	33.89529428
6.708787509	11.28533609	33.90264773
7.00666672	11.28832491	33.9035209
7.417086479	11.29922882	33.91197389

CAST 4

Data Header

% Device	10G100653
% File name	10G100653_20140715_101209
% Cast time (local)	15/07/2014 11:12
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	57.3142834
% Start longitude	-6.1165736
% Start GPS horizontal error(Meter)	1.970000029
% Start GPS vertical error(Meter)	2.450000048
% Start GPS number of satellites	8
% Cast duration (Seconds)	40.2
% Samples per second	5
Calibration Date	March 2013
Calibration offset for Temperature	-0.033
Calibration offset for Salinity	0.029

CTD data (calibration offsets applied)

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
0.149418641	11.8749734	29.89369176
0.44820205	11.80816223	30.18361347
0.746863409	11.69232856	30.98210301
1.045273239	11.56795373	32.34744507
1.343489658	11.50963704	32.6463877
1.641652402	11.45145298	32.79202147
1.939791588	11.45377302	32.83875162
2.237912726	11.43853708	32.94571182
2.535990635	11.41946205	33.21026181
2.834008992	11.40938173	33.46297431
3.131988473	11.41372823	33.55006938
3.429955474	11.4164089	33.57213852
3.727915036	11.41871818	33.61413238
4.025867892	11.41900554	33.62914836
4.323820445	11.42589089	33.61552849
4.628844066	11.4335189	33.64292544