Scottish Sanitary Survey Review

Loch Scridain East and Loch Scridain:Killiemore
AB-314, AB-663, AB-664, AB-665 and AB-666
October 2014

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Review Specification and Introduction

Sanitary surveys are used to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004, whereby if the competent authority decides in principle to classify a production or relay area it must:

- make an inventory of pollution sources of human/animal origin likely to be a contamination source for the production areas;
- examine the quantities of organic pollutants which are released during the different periods of the year, according to the seasonal variations of both human and animal populations in the catchment area, rainfall readings, wastewater treatment, etc.;
- determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal regime in the production area;
- establish a sampling programme of bivalve molluscs in the production area which is based on the examination of established data, and with a number of samples, a geographical distribution of the sampling points and a sampling frequency which must ensure that the results of the analysis are as representative as possible for the area considered.

The EURL Good Practice Guide (GPG) for the monitoring of bivalve molluscs harvesting areas recommends the re-evaluation of sanitary surveys every six years. Location, extent and nature of fisheries and faecal pollution sources may change over time and the review is conducted to determine whether the sampling plan and/or production area boundaries remain appropriate and protective of public health.

As specified by the Food Standards Agency, this review is comprised of a brief desktop search of publicly available information together with a shoreline survey. No additional data requests are usually submitted to external bodies. The review is intended to identify significant changes in:

- Historic microbiological data.
- Sewage treatment and sewerage infrastructure.
- Housing and development.
- Harvester operations.

The output of the review is a report identifying any new information that has been obtained and/or whether major elements of the original sanitary survey can be regarded as essentially unchanged. That report includes an overall assessment as to whether the production area/classification zone boundaries and/or RMPs should be modified from those recommended in the original report and if so, a description of the revised boundaries and a revised sampling plan with the boundaries and RMP(s) locations.

A sanitary survey was undertaken in 2008 for Loch Scridain East. The survey was conducted to identify the location, extent and nature of the shellfishery and the potential sources of faecal contamination to the shellfishery, and to recommend boundaries and sampling plans for the production areas. The associated shoreline survey was undertaken in September 2007.

The output of the sanitary survey included a report and recommended sampling plans for the four production areas within the sound. These sampling plans are identified on the following pages alongside the recommended changes following findings from this review.

The present report constitutes a review of publicly available information in order to assess changes that have occurred since the 2008 sanitary survey report (see the Review Specification section for further detail). It is not intended to present detailed information relating to pollution sources that were identified in the previous report. This review should be read in conjunction with the 2008 sanitary survey report.

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Sampling Plan – Loch Scridain

	2008 report	2014 review	Changes
Production Area	Loch Scridain East		No change
Site Name	Loch Scridain	Aird Fada	Aird Fada replaces Loch Scridain to better identify the location of the RMP
SIN	AB-314-054-08		No change
Species	Common mussels*		No change
Type of Fishery	Longline aquaculture		No change
NGR of RMP	NM 4597 2489	NM 4597 2489	No change
Easting	145970	145970	
Northing	724890	724890	
Tolerance (m)	20	40	Increased to allow for longline drift
Depth (m)	1	1-3	Expanded to allow greater scope for obtaining samples
Method of Sampling	Hand		No change
Frequency of Sampling	Monthly		
Local Authority	Argyll and Bute Council		
Authorised Sampler(s)	Christine McLachlan, William MacQuarrie, Ewan McDougall, Donald Campbell	Fraser Anderson, William MacQuarrie, Ewan McDougall, Alison Hardie	Change in personnel
Recommended Production Area	The area drawn between NM 4507 2700 and NM 4477 2478 and between NM 4618 2690 and NM 4618 2448.	The area bounded by lines drawn between NM 4507 2700 and NM 4478 2479 and between NM 4618 2690 and NM 4618 2448.	Slight amendment to the southwestern co-ordinate in the boundary description in order that it is located at MHWS

*The same location may be used for the sampling of Pacific oysters, native oysters, King scallops and Queen scallops if separate monitoring is required for each species.

Sampling Plan – Loch Scridain: Killiemore

Production Area	Loch Scridain: Killiemore
Site Name	Killiemore
SIN	AB-661-1437-07, AB-662-1438-26, AB-659-1435-13, AB-660-1436-12
Species	Common mussels
Type of Fishery	Longline aquaculture
NGR of RMP	NM 5079 2890
East	150790
North	728900
Tolerance (m)	40 m
Depth (m)	1-3 m
Method of Sampling	Hand
Frequency of Sampling	Monthly
Local Authority	Argyll and Bute Council
Authorised Sampler(s)	Fraser Anderson, William MacQuarrie, Ewan McDougall, Alison Hardie
Recommended Production Area	The area bounded by lines drawn between NM 5017 2858 and NM 5239 2798 and between NM 5215 2883 and NM 5094 2933.

*The same location may be used for the sampling of Pacific oysters, native oysters, King scallops and Queen scallops if separate monitoring is required for each species.

1. Area Description and Fishery

Loch Scridain is located on the west coast of the Isle of Mull. The location is shown in Figure 1.1.

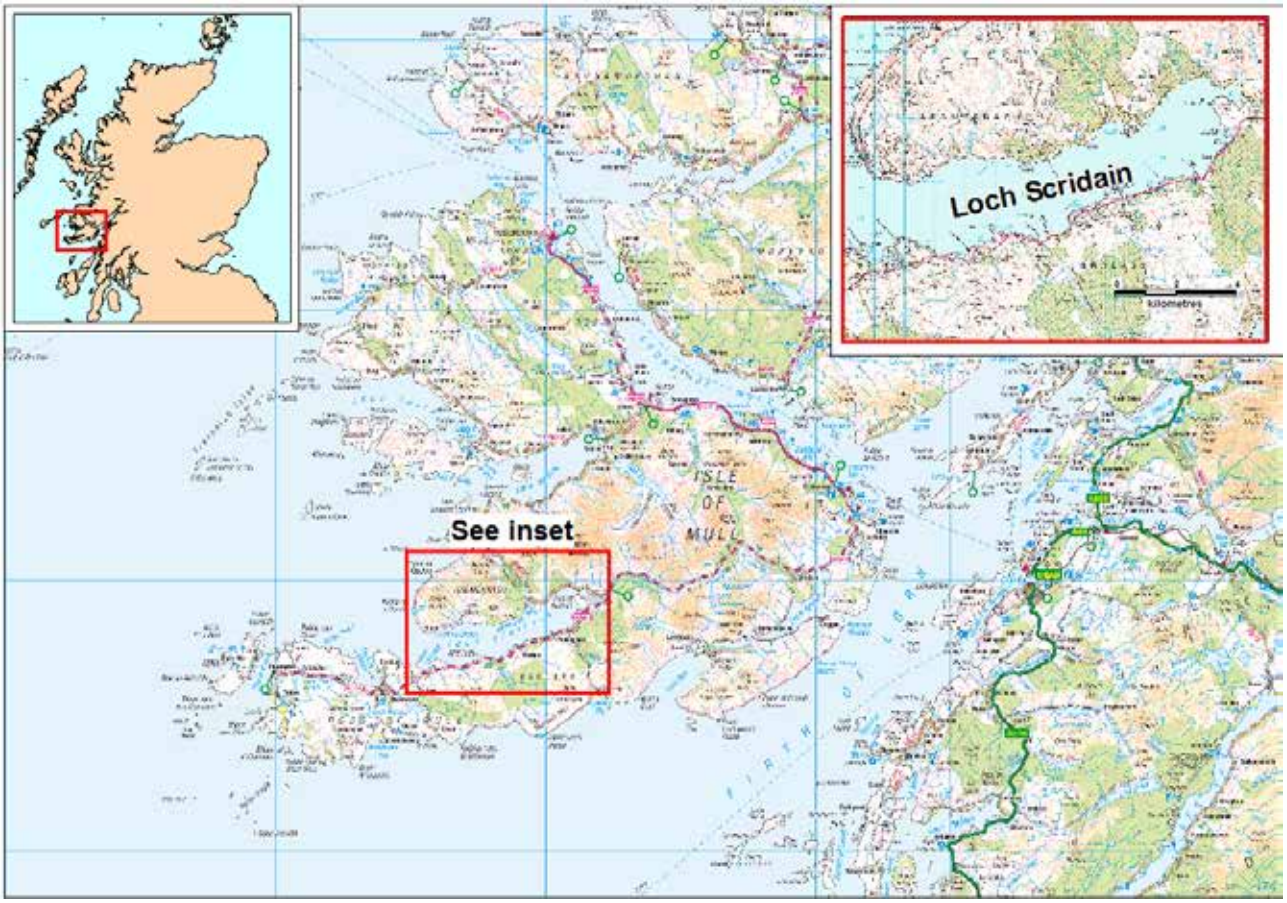

Figure 1.1 Location of Loch Scridain

The Loch Scridain East mussel fishery was the subject of the 2008 sanitary survey. This remains classified and a summary is given in Table 1.1.

Table 1.1 Loch Scridain East classification details

Production area	Site	SIN	Species	RMP
Loch Scridain East	Loch Scridain	AB-314-054-08	Common mussels	NM 4597 2489

The current RMP and production area for the Loch Scridain East fishery are shown in Figure 1.2. The production area boundary recommended in the 2008 sanitary survey report was: the area bounded by lines drawn between NM 4507 2700 and NM 4477 2478 and between NM 4618 2690 and NM 4618 2448.That given in the 2014/15 classification listing is slightly different, being defined as: area bounded by lines drawn between NM 4507 2700 and NM 4470 2478 and between NM4618 2690 and NM 4618 2448. The currently specified RMP remains unchanged from that recommended in the 2008 report.

The 2008 sanitary survey report also included information and recommendations relating to the Loch Scridain West: Knockan fishery. This fishery was declassified in April 2012 and is not considered in this review.

A provisional RMP (pRMP) assessment was carried out in November 2013 for three standard application sites containing multi-species fisheries within Loch Scridain. These sites were named Killiemore, Aird Fada and Slochd Bay and all planned to cultivate King scallops, Queen scallops, Pacific oysters and native oysters. Details of these applications are listed in Table 1.2, with application area boundaries displayed in Figure 1.2.

Table 1.2 Multispecies standard application sites in Loch Scridain

Site No.	Name	Application Ref	SIN	Species
1	Loch Scridain: Killiemore	26/2013	AB-659-1435-13	Pacific oysters
		27/2013	AB-660-1436-12	Native oysters
		28/2013	AB-661-1437-07	King scallops
		29/2013	AB-662-1438-26	Queen scallops
2	Loch Scridain: Aird Fada	30/2013	AB-663-1439-13	Pacific oysters
		31/2013	AB-664-1440-12	Native oysters
		32/2013	AB-665-1441-07	King scallops
		33/2013	AB-666-1442-15	Queen scallops
3	Loch Scridain: Slochd Bay	34/2013	AB-667-1443-13	Pacific oysters
		35/2013	AB-668-1444-12	Native oysters
		36/2013	AB-669-1445-07	King scallops
		37/2013	AB-670-1446-15	Queen scallops

The 2007 shoreline survey reported three common mussel sites in Loch Scridain which correspond to the three areas which were the subject of the multispecies classification applications in 2013. The 2014 shoreline survey reported observations of mussel lines at the same three sites. The Aird Fada site corresponds to the Loch Scridain site, within the Loch Scridain East production area, which was the location of the RMP recommended in the 2008 sanitary survey report. The boundaries of these three sites from the 2014 shoreline survey are displayed in Figure 1.2. Individual site observations from the 2014 are as follows:

- Aird Fada (active - stocked) comprised of two 9x200 m long lines with droppers to 10 m. Most of the harvesting took place from this site.
- Slochd Bay comprised of four visible lines with miss-aligned and partially sunken dropper arrays. The majority of mussels that were present were juveniles.

- Killiemore comprised of 5x200 m long lines. The lines had been seeded with spat in the last year and the droppers were mainly coiled at the surface. Most mussels present were juveniles.

No information was given on seasonality of harvest. No additional infrastructure for any of the multi-species fisheries was identified during the 2014 shoreline survey. The pRMP identified for the Killiemore site was not in use at the time of survey.

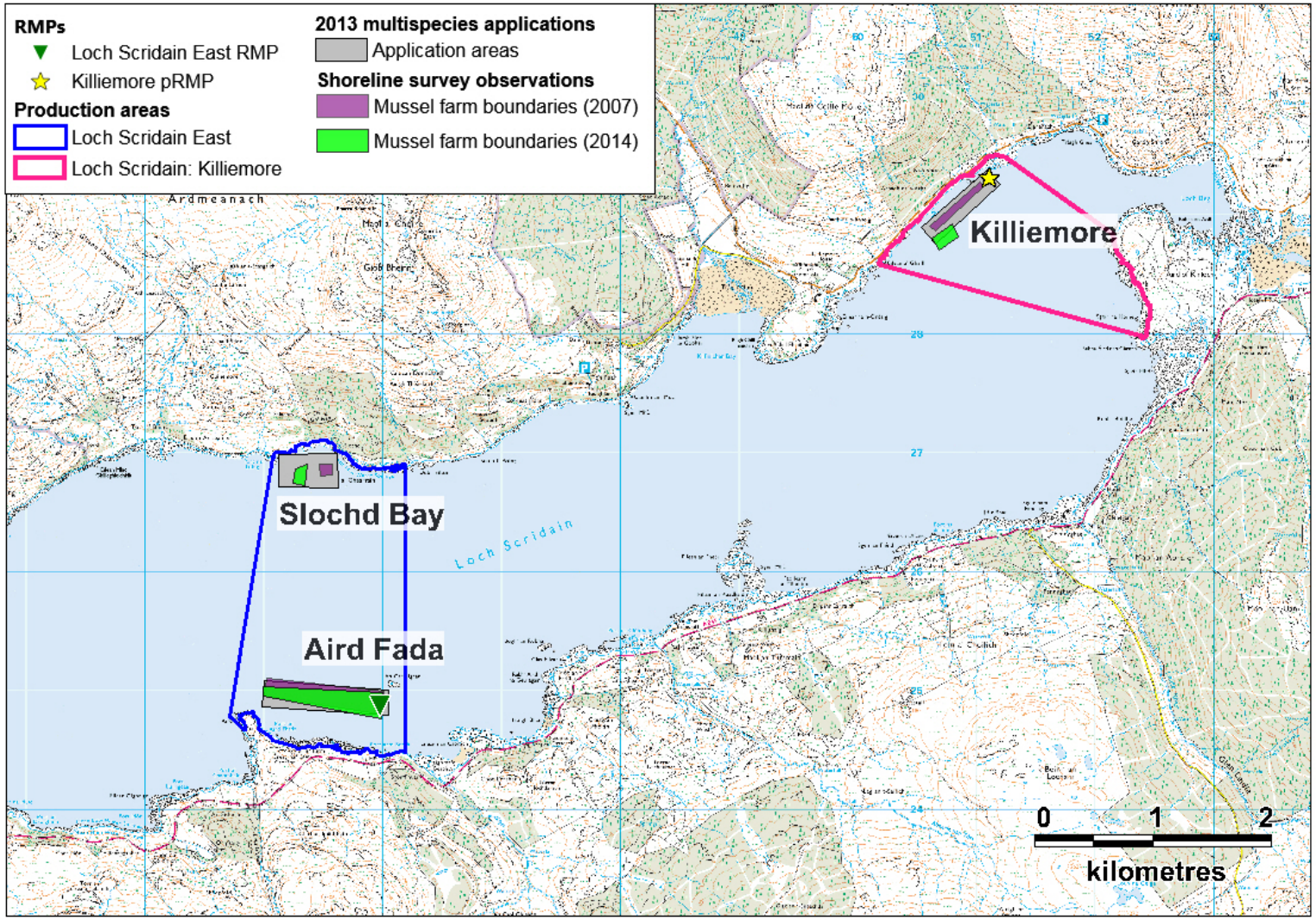

Figure 1.2 Loch Scridain fisheries

2. Population and Human Sewage Impacts

2.1 Population

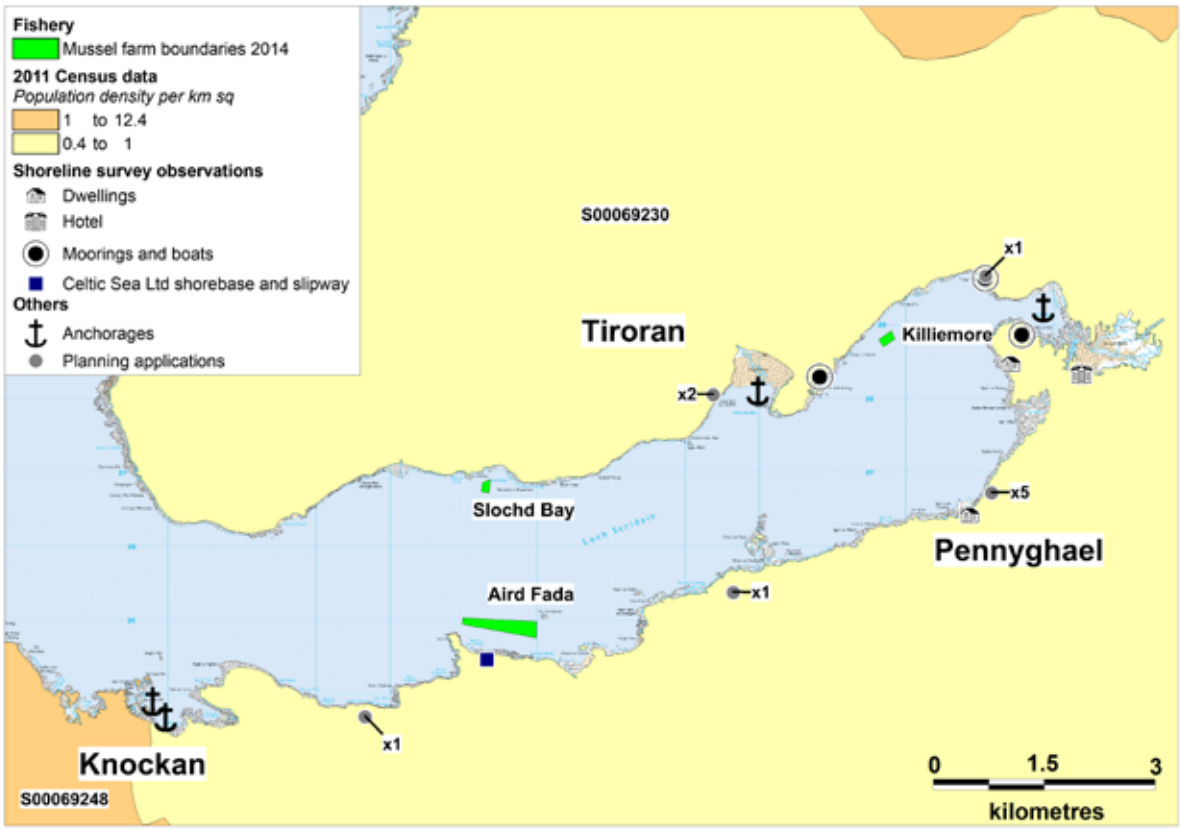

Figure 2.1 Current distribution of human population around Loch Scridain East

Population data from the General Register Office for Scotland from the 2001 and 2011 censuses are shown in Table 2.1.

Table 2.1 Scottish Government Census data for years 2001 and 2011

2001 Census data		2011 Census data	
60QD000583	63	S00069248	92
60QD000584	122	S00069230	129
TOTAL	**185**	**TOTAL**	**221**

The reference system for the census output areas changed between the two censuses: reference numbers for the corresponding areas are shown in Table 2.1. Human population has increased between census years in both census areas. A smaller increase is noted in the area in the vicinity of the identified fisheries (S0069230): the population density in that area remains low at approximately 0.5 person/km^2.

The main settlements include Tiroran (north shore) and Pennyghael and Knockan (south shore). A search was undertaken of Argyll & Bute Council planning records on relevant planning applications since 2008. This revealed that 10 planning

applications had been submitted in the vicinity of Loch Scridain. These applications were downloaded from the Argyll and Bute Council Planning portal (Argyll & Bute Council, 2014) in September 2014; full details are presented in Appendix 1. The mapped locations in Figure 2.1 were taken from the associated eastings and northings given in the applications or, where this is absent, from postcodes.

Seven of the applications were for sites located on the south shore, five of which related to the Pennyghael area with the other two being located between there and Knockan, to the west. The other three were for sites located on the north shore. All but one related to the building of a dwelling or the conversion of an existing building to a dwelling. The exception related to the placement of a mobile home for holiday letting west of Pennyghael. Six of the applications identified the intent to install new STs to soakaway/subsoil irrigation, two for STs to discharge to burns, one to connect to an existing ST (licence CAR/R/1039682) and lastly one planned to install a sewage treatment plant and filtration area.

The area is popular amongst wildlife enthusiasts and walkers, with visitor numbers expected to peak during warmer summer months. The area contains a number of hotels, B&Bs and self-catering cottages for holiday makers. The 2008 report noted that boat traffic was limited to the ferry service between Fionnphort and Iona, a small fishing fleet and a small number of pleasure craft. Jetties were located outside Bunessan (southwest), adjacent to Celtic Sea Ltd shore-base (on the southern shore at Aird Fada) and by Killiemore house (on the northern shore, to the west of the Killiemore mussel site). Information from the Clyde Cruising Club (2007) indicated four anchorages were located within Loch Scridain; one at Kilfinichen Bay and Loch Beg and two to the southwest near Bunessan (Knockan). A total of nine moorings were noted during the 2014 in use by pleasure craft. A slipway was also observed south of the Celtic Sea Ltd shore-base.

An anchorage at Bunessan is used during the Round Mull Race, an annual, three day yacht race around the Isle of Mull (Oban Sailing Club, 2014). This anchorage is expected to receive a high number of boats during the race, which takes place in June. Boat traffic overall is also expected to increase within Loch Scridain during the summer months. Apart from the time of the Round Mull Race, the extent of contamination from leisure boats is expected to be low and confined to the immediate area of any discharge.

2.2 Sewage Discharges

The 2008 sanitary survey included information on eight private discharge consents within the Loch Scridain area. In addition, six sewage related observations were made during the 2007 shoreline survey.

Information requests made to Scottish Water and SEPA in 2014 in support of a sanitary survey at Kilfinichen Bay within Loch Scridain covered the whole of the Loch

Scridain area. No community discharges were identified. Consents for 23 private discharges were identified by SEPA and the consented discharge locations are displayed in Figure 2.2. Summary information on the consented discharges is given in Appendix 2. The additional discharge consents identified since those included in the 2008 sanitary survey report may reflect an initiative to identify private discharge consents by SEPA in 2009. At least some of these discharges may therefore have been present at the time of the 2008 sanitary survey report.

One discharge consent related to a marine cage fish farm at Ardmeanach, near the north shore of the loch approximately 1.9 km west of the Slochd Bay site and 2 km northwest of the west end of the Aird Fada site. Information provided by SEPA identified that this fish farm site had not been developed due to it being refused planning consent.

Sewage related observations made during the 2014 Loch Scridain and 2014 Kilfinichen Bay shoreline surveys have been listed in Table 2.2. Observations made during the Kilfinichen Bay shoreline survey are pertinent to this review as they include an area of shoreline that was not covered during the Loch Scridain shoreline survey. The sewage-related observations from both shoreline surveys are displayed in Figure 2.2.

Table 2.2 Sewage discharge-related observations made during the 2014 Loch Scridain and 2014 Kilfinichen Bay shoreline surveys

Survey	No.	NGR	Description
Loch Scridain 2014	1	NM 5155 2965	Concrete septic tank seen at roadside with overflow pipe running offshore across beach. Pipe was 10cm diameter, cast iron. No discharge observed.
	2	NM 5185 2644	Concrete septic tank with 10cm diameter cast iron pipe; no discharge. Pennyghael Village Hall, tearoom and four houses.
Kilfinichen Bay 2014	1	NM 4826 2774	Unplanned freshwater sample - Contaminated. 11cm diameter PVC pipe. Flow 1cm deep at centre of pipe.
	2	NM 4852 2811	Large fibreglass septic tank next to shed. 10cm diameter PVC pipe running out into ground, re-appears alongside side of pier. No discharge present.
	3	NM 4865 2851	Concrete septic tank. No outflow. Large (12-13cm) metal pipe coming out shore side of tank, but running directly into ground. Searched for end of pipe, could not be seen.
	4	NM 4918 2857	10cm PVC pipe running to high tide mark from property. Exit blocked by reeds. No discharge. No sign of septic tank in garden above.

Loch Scridain observation 1 was observed in the 2007 survey and from the updated private discharge information relates to licence number CAR/R/1039682. This is a primary treated discharge to Loch Scridain with a PE of 5 and is located approximately 1 km northeast of the eastern extent of the Killiemore site.

Loch Scridain observation 2 relates to discharge licence number CAR/R/1017505. This is a primary treated discharge from the Pennyghael community hall and school house (PE 11) and discharges to Leidle River. This is assumed to be at the same location that an overflowing pipe was found to be discharging to Leidle River during

the 2007 survey. The pipe was not flowing at the time of the 2014 survey and a sample taken from the river gave a low result of 60 *E. coli* cfu/100 ml: this suggests that the pipe had not discharged in the immediate past.

Four sewage related observations were recorded during the Kilfinichen Bay shoreline survey, including an overflowing pipe located to the west of the bay (observation 1). A sample from this overflow returned an extremely high result of >10000000 *E. coli* cfu/100 ml. This indicated marked faecal contamination. The source of the pipe and effluent was not clear.

Conclusions

The human population remains low around Loch Scridain and whilst the area receives visitors during the summer months, this is not expected to significantly alter the population. A small influx of boats using anchorages in Loch Scridain is expected during summer months. Whilst a large number of boats are expected to moor at Bunessan during the Round Mull race in June each year, this area lies approximately 3.5 km west of the closest shellfish site and is therefore not anticipated to have any significant impact there.

Additional information on private sewage discharges indicates that the extent of contamination from these sources will be higher than assumed in the 2008 sanitary survey report. However, most of the septic tank locations are not in the immediate vicinity of the shellfish sites and thus while they will contribute to background *E. coli* levels within the loch, they should not cause direct impact at the sites.

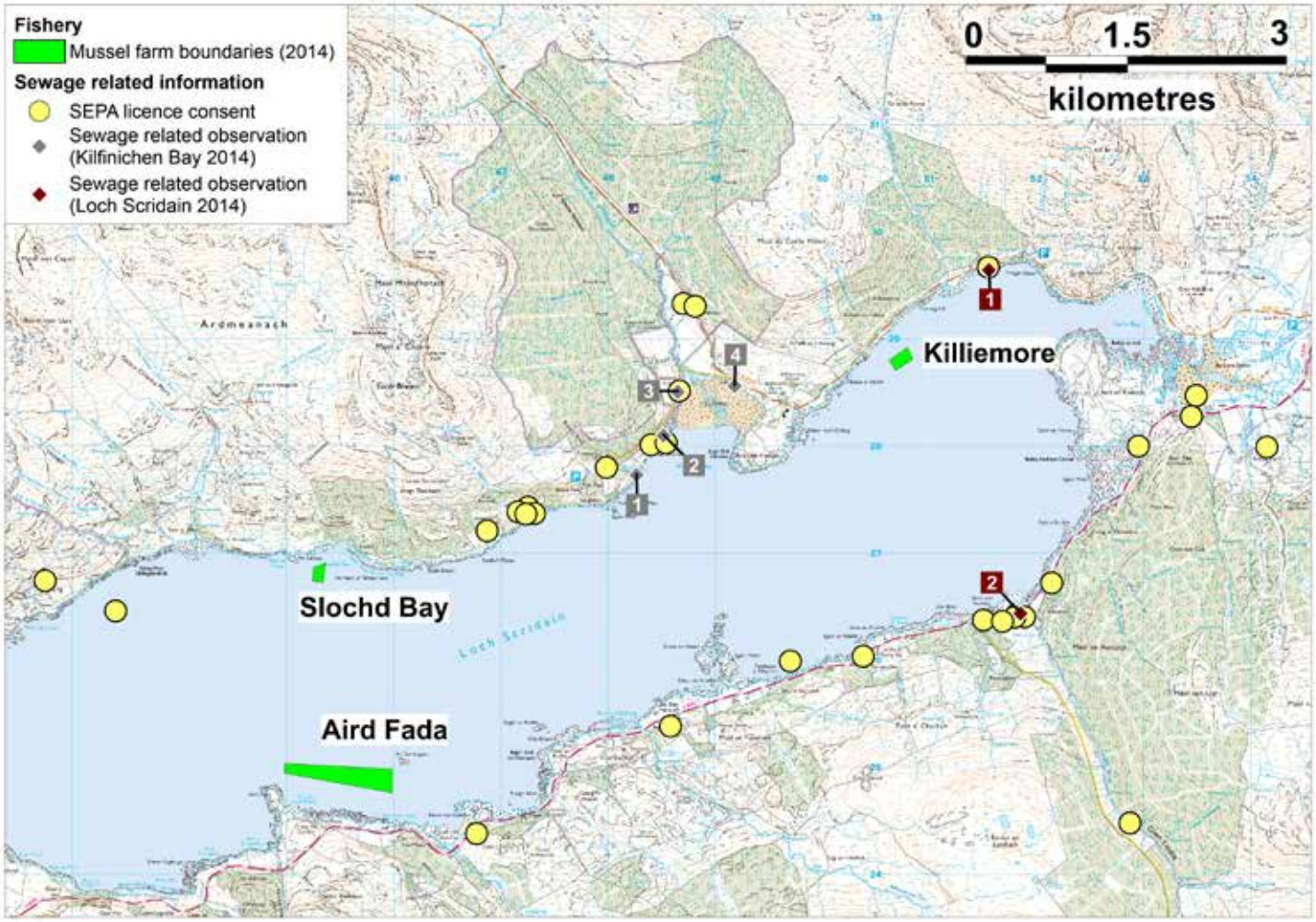

Figure 7.2 Map of consented private sewage discharges and sewage-related shoreline survey observations

3. Farm Animal Population and Agricultural Impacts

No farm census data was provided by Scottish Government in support of the 2008 sanitary survey report, as it considered that there were too few farms in the relevant parishes to ensure farm specific data could not be ascertained. The report therefore only considered observations made during the 2007 shoreline survey. It was concluded that the most significant agricultural contamination would enter Loch Scridain from the southeast, where the densest number of livestock was observed around Rossal Farm.

Agricultural parish data was requested for the 2014 Kilifinichen Bay sanitary survey report and covered the parishes around Loch Scridain. Livestock numbers in the Kilfinichen & Kilvickeon and Torosay parishes are listed in Table 3.1.

Table 3.1 Livestock numbers in the Kilfinichen & Kilvickeon and Torosay agricultural parishes, 2013

	Kilfinichen and Kilvickeon		**Torosay**	
	247 km^2		367 km^2	
	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	*	*
Poultry	24	388	8	210
Cattle	27	980	12	776
Sheep	38	14215	14	11794
Horses used in Agriculture	0	-	0	-
Other horses and ponies	8	26	7	20

The two agricultural census areas are of substantial size and it is therefore not possible to determine the number of livestock that are located within the catchment area of the shellfish sites and the spatial distribution of animals in relation to proximity to the shoreline. The livestock data in both census areas does highlight sheep as the most commonly reared livestock, with cattle and poultry also present in moderate numbers, with some horses and ponies also present.

Additional spatial information relating to livestock around Loch Scridain can also be taken from observations recorded during the 2014 Loch Scridain and Kilfinichen Bay shoreline surveys, which were both carried out in August 2014. Observations made during the 2014 Loch Scridain shoreline survey are displayed in Figure 3.1.

Both shoreline surveys indicated sheep remained the predominant livestock around Loch Scridain, with small numbers of cattle noted on land adjacent to Slochd Bay and Kilfinichen Bay. The majority of livestock observed during the Loch Scridain shoreline survey were noted southeast at Rossal Farm, located near the head of the loch. A large number of sheep and some cattle were also seen around Kilfinichen Bay where a second farm attached to the Kilfinichen Estate was identified. Livestock

located northeast of this farm were observed to have access to the shoreline, with feeders and hoof prints noted on the shoreline during the 2014 Loch Scridain survey. These were observed approximately 600 m west of the Killiemore site, which is expected to receive higher levels of contamination from these sources, compared to that coming from the southeast.

Livestock were also observed on land and shoreline adjacent to Slochd Bay, where there is also expected to be a moderate level of contamination to the northern extent of this site. No agricultural related observations were made on shorelines south of the Aird Fada site.

Conclusions

Sheep are the predominant livestock animals reared on land around Loch Scridain, with cattle and poultry also present in moderate numbers. Significantly fewer sheep were observed during the 2014 Loch Scridain shoreline survey than in the 2007 shoreline survey. It is not clear whether this reflects a true decrease in sheep kept in the area. Impacts from livestock droppings are expected to be greatest at the Killiemore site although some effect is also expect from animals on the shore immediately north of the Slochd site.

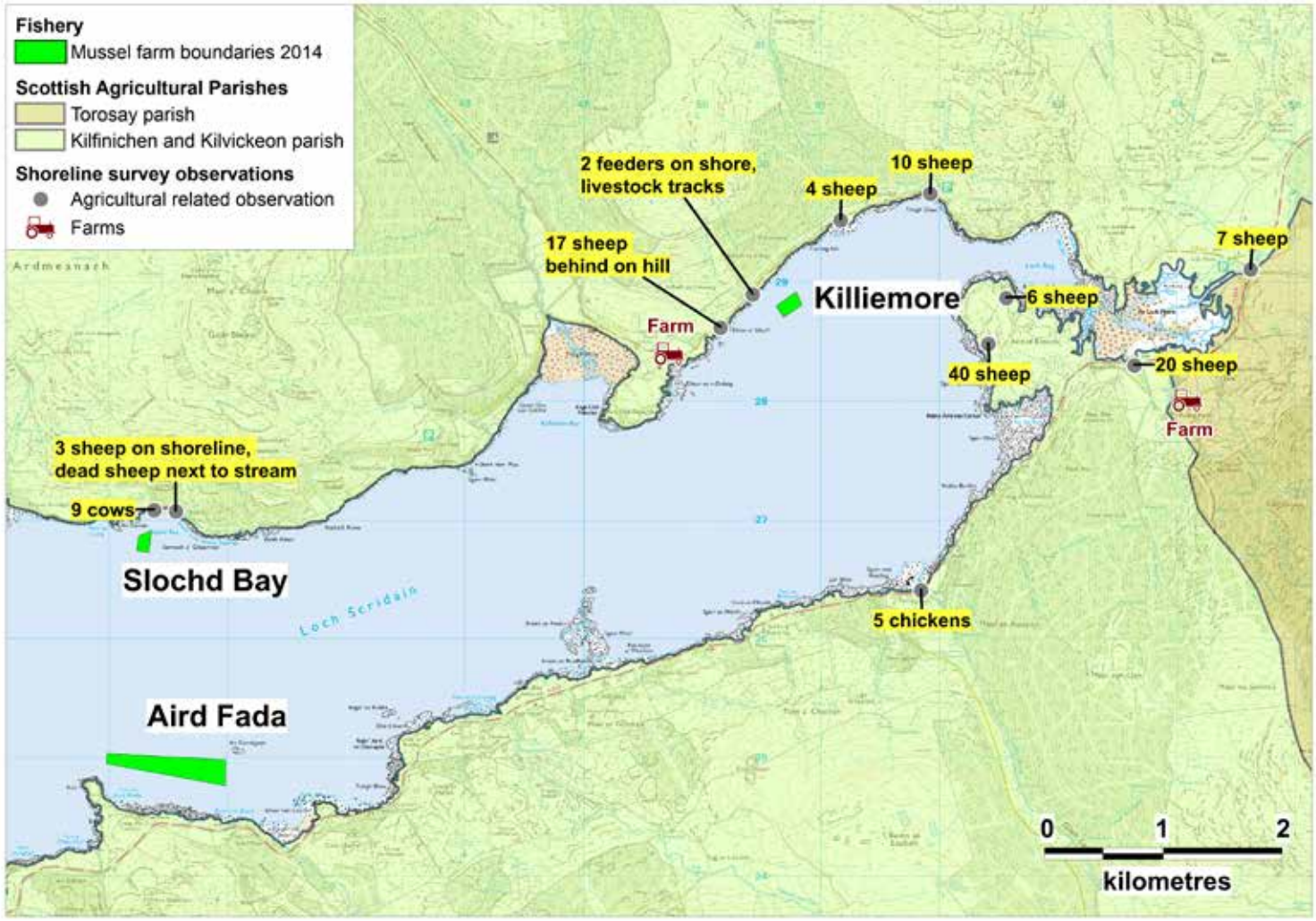

Figure 3.1 Map of farm animals and associated observations in Loch Scridain

4. Wildlife

For the purposes of this review, information on pollution sources from wildlife has been obtained from the JNCC collated dataset (http://jncc.defra.gov.uk/page-4460), through shoreline surveys conducted in 2007 and 2014, and through a desk-based internet search. Shoreline survey observation information only relates to the time of the surveys undertaken in September 2007 and on the September 2014. Wildlife observations from the 2014 survey and the JNCC dataset are displayed in Figure 4.1. Seals, cetaceans, waterbirds, deer and otter were anticipated to be the most significant faecal contamination from wildlife within Loch Scridain, but overall the impact from wildlife was unpredictable and would be of minor significance.

Pinnipeds

The Special Committee on Seals (2013) reported that there has been no significant change in the number of harbour seals observed hauled out along the west coast of Scotland (including the Outer Hebrides). Seals are noted to be present in and around Loch Scridain, however it was not possible to determine the specific distribution within the loch as distribution data was reported to 10 km squares. There are grey seal breeding colonies on the Isle of Mull, though none appeared to lie within Loch Scridain. No seals were observed during the 2014 shoreline survey.

Cetaceans

Cetacean sightings reported to the Hebridean Whale and Dolphin Trust for Loch Scridain for the years between 2008 and 2014 included bottlenose dolphins and harbour porpoises (Hebridean Whale and Dolphin Trust, 2014) for Loch Scridain. No cetaceans were observed during the 2014 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 4.1.

Table 4.1 Seabird 2000 census data for Loch Scridain East

Common name	Species name	Count*	Qualifier	Accuracy
Herring Gull	*Larus argentatus*	6	Occupied nests and territory	Accurate

*Counts for occupied nests, sites and territory were doubled, with total counts given using the adjusted data.

Very small numbers of breeding herring gulls were noted, one to the southwest of Loch Scridain, the other to the east at the island Eilean an Fheoir.

The Cnuic agus Cladach Mhuile Special Protected Area (SPA), designated for golden eagles, is located to the northeast of Loch Scridain and hosts 3.3% of the UK breeding population of these birds (JNCC, 2006).

During the shoreline survey, birds were the only wildlife observed and species included ducks, oystercatchers, gulls and herons. Ducks were the most common, with a particularly large number present on the southeast shoreline.

Otters

No specific survey reports were found of otters within Loch Scridain. There are however numerous anecdotal accounts of otters within the loch (Pure Travel, 2010). No otters were observed during the 2014 shoreline survey.

Deer

Red deer are widespread within the Isle of Mull (Wild Future, 2014) and are predominantly found on higher ground during summer months and low lying ground during winter. No deer were observed during the 2014 shoreline survey.

Conclusions

Overall contamination from wildlife such as birds, otters, deer, cetaceans and seals is expected to be low and will be sporadic from both a spatial and temporal perspective.

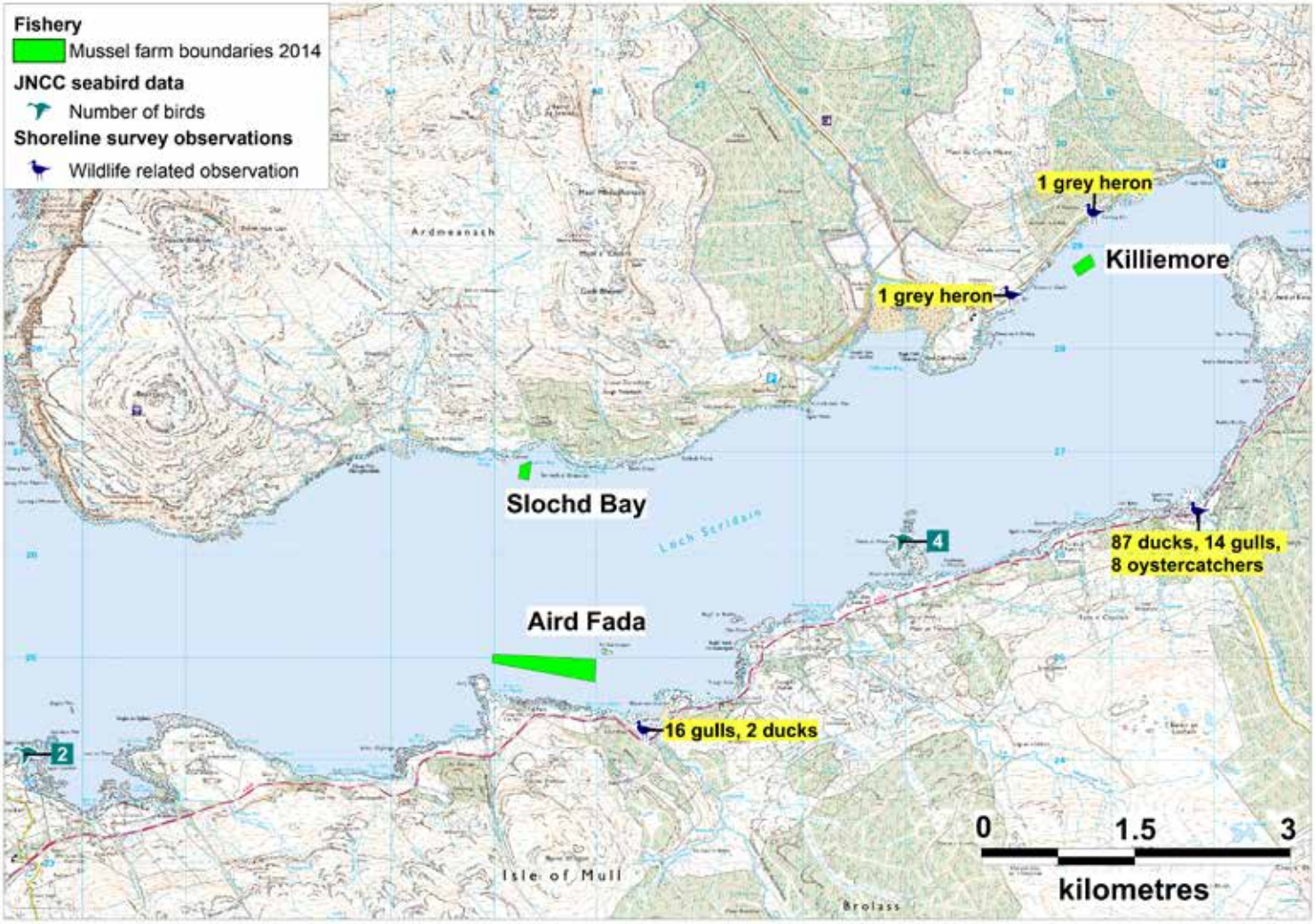

Figure 4.1 Map of wildlife around Loch Scridain

5.Watercourses

There are no gauging stations on watercourses that enter into Loch Scridain. Weather conditions were broadly similar between the two shoreline surveys. In 2007, rain fell on the majority of the survey days in both September and November. In 2014, intermittent showers and heavy rainfall fell during both survey days, with heavy rainfall also reported in the 48 hours prior to the survey.

Calculated loadings were provided for 20 watercourses in the 2008 sanitary survey report. However, estimated flow rates were used in loading calculations for five of the watercourses from the September survey and therefore a second survey was undertaken in November 2007 to accurately measure flow rates for these watercourses. Loadings for the Coladoir River were not estimated in the 2008 sanitary survey report.

A comparison of watercourse loadings calculated on the basis of accurate 2007 and September 2014 shoreline survey measurements and *E. coli* concentrations are displayed in Table 5.1. Of the 20 watercourses measured and sampled in the 2007 surveys, only three were re-sampled in 2014. Sample loadings from the 2014 survey are displayed in Figure 5.1. A full list of recorded flow measurements and sample results from the 2014 shoreline survey can be found in Appendix 3.

Table 5.1 Watercourse loadings to Loch Scridain estimated from measurements made during the Loch Scridain 2007 and 2014 shoreline surveys

No.[1]	Description	NGR	2007 Loading (*E. coli*/day)	2014 Loading (*E. coli*/day)
1	Unnamed watercourse	NM 4538 2709	-	$2.4x10^{10}$
2	Unnamed watercourse	NM 4557 2708	-	$6.9x10^{9}$
3	Alltan na Drochaid	NM 4626 2692	-	$1.2x10^{11}$
4	Allt Achadh na h-Innseig	NM 5037 2885	-	$7.0x10^{10}$
5	Allt Achadh na h-Atha	NM 5065 2913	-	$8.7x10^{9}$
6	Allt na Coille Moire	NM 5116 2953	(S) 7.9×10^{10}	$1.4x10^{11}$
7	Coladoir River	NM 5462 2912	-	$7.7x10^{11}$(C)
8	Leidle River	NM 5187 2641	(N) 7.3×10^{10}	$4.7x10^{10}$
9	Unnamed watercourse	NM 4563 2447	-	$3.8x10^{8}$
10	Unnamed watercourse	NM 4599 2443	-	$1.3x10^{9}$
11	Beach River	NM 4646 2429	(N) 3.4×10^{10}*	$1.6x10^{11}$

[1]Numbers relate to those given in the labels in Figure 5.1

*The associated sample was recorded at <100 and was therefore reassigned a value of 50 *E. coli* CFU/100 ml for calculating the loading.

(S) indicates that loadings were calculated from measurements taken from measurements/results from the September shoreline survey and (N) indicates that watercourse loadings were calculated from those taken during the November survey.(C) a conservative depth for one of the three depth measurements was used owing to poor accessibility to the watercourse.

Ten watercourses were also reported during the 2014 Kilfinichen Bay shoreline survey. Calculated loadings from measurements and samples taken during the

Kilfinichen Bay shoreline survey are listed in Table 5.2 and displayed in Figure 5.1. This survey was also undertaken in August 2014, with heavy rainfall reported in the 48 hrs prior to the survey and intermittent showers reported during the survey, some of which were heavy.

Table 5.2 Watercourse loadings to Loch Scridain estimated from measurements made during the Loch Scridain 2007 and 2014 Kilfinichen Bay shoreline surveys

No.[1]	NGR	Description	2007 Loading (*E. coli*/day)	2014 Loading (*E. coli*/day)
1	NM 4728 2735	Allt an Sgaphair	-	5.3×10^8
2	NM 4741 2743	Unnamed watercourse	-	2.1×10^9
3	NM 4825 2773	Allt Orain	-	6.5×10^{10}
4	NM 4844 2799	Unnamed watercourse	-	5.4×10^8
5	NM 4867 2839	Unnamed watercourse	-	Not determined
6	NM 4870 2873	Abhainn Bail a Mhuilinn	(N) 1.8×10^{10}*	9.3×10^{10}
7	NM 4909 2862	Unnamed watercourse	-	9.4×10^8
8	NM 4918 2857	Unnamed watercourse	-	Not determined
9	NM 4936 2845	Unnamed watercourse	-	Not determined
10	NM 4947 2828	Unnamed watercourse	-	Not determined

[1]Numbers relate to those given in the labels in Figure 5.1

*The associated sample was recorded at <100 and was therefore reassigned a value of 50 *E. coli* CFU/100 ml for calculating the loading.

(N) means watercourse loadings were calculated from the November 2014 Loch Scridain survey.

Estimations made on the basis of the 2014 shoreline survey observations show that freshwater inputs from watercourses entering Loch Scridain contained low to moderate loadings. Where estimated loadings for individual watercourses were of available from the 2007 and 2014 measurements, they were of the same order of magnitude. The highest loading estimated from the 2014 data arose from the Coladoir River. This river is located approximately 2.5 km east of the Killiemore site. Several other watercourses had estimated loadings that were not markedly lower than that from the river.

Conclusions

Estimated loadings were available for a greater number of watercourses for this review than for the original sanitary survey. Greatest impacts at the three sites from the sources are likely to be as follows:

Killiemore: on the northern and eastern sides of the site;

Slochd Bay: On the northern side of the site;

Aird Fada: on the southeastern side of the site.

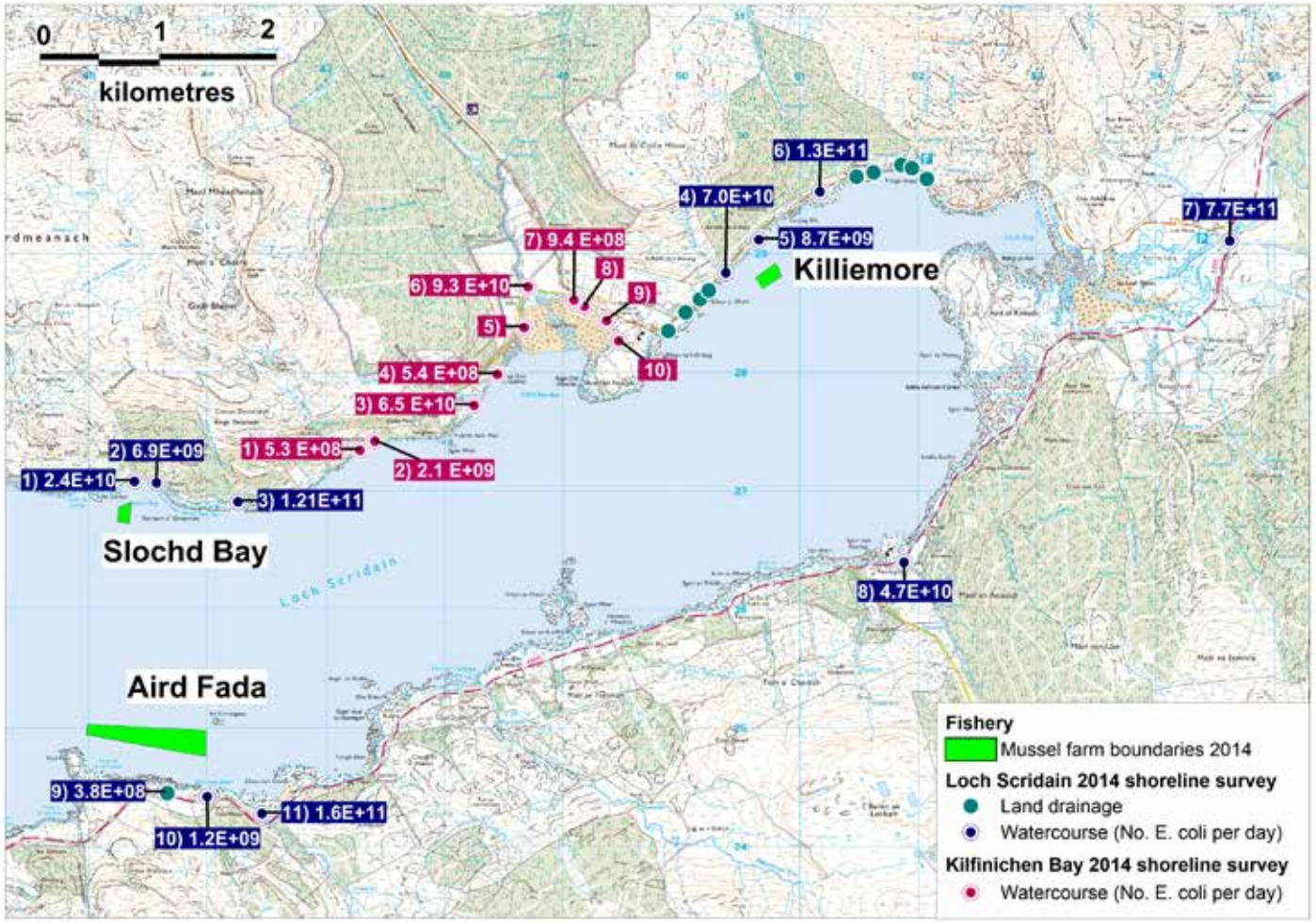

Figure 5.1 Watercourse loadings at Loch Scridain

Where the bacterial loading is labelled on the map, the scientific notation is written in digital format, as this is the only format recognised by the mapping software. So, where normal scientific notation for 1000 is $1x10^3$, in digital format it is written as 1E+03.

6. Meteorological data

Rainfall data had been purchased from the Meteorological Office for the period 01/01/2003 to 31/12/2006 for the analyses undertaken for the 2008 Loch Scridain sanitary survey report. Rainfall boxplots for 2003-2006 period were presented in that report and have not been reproduced here. Rainfall recorded in total daily rainfall (mm) was taken from the Mull: Gruline and Tiree weather stations, which respectively lie 13 km northeast and 45 km west of Loch Scridain. This was due to the Mull: Grulien data set being incomplete. Wind data for Tiree for the period 1998-2007 was presented in the 2008 sanitary survey report.

Meteorological data for this Review was purchased from the Meteorological Office in March 2014 for the period 01/01/2007-31/12/2013. Rainfall data from Mull: Gruline was available for 98% of the survey days. Wind roses for Tiree for 2004-2013 are presented in section 6.2.

6.1 Rainfall

Storm events and high rainfall levels are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or wild animals are present and through sewer and waste water treatment plant (WWTP) overflows (Mallin, *et al*., 2001; Lee & Morgan, 2003).

The Mull: Gruline weather station rainfall dataset for 2007-2013 is presented by year in Figure 6.1 and by month in Figure 6.2.

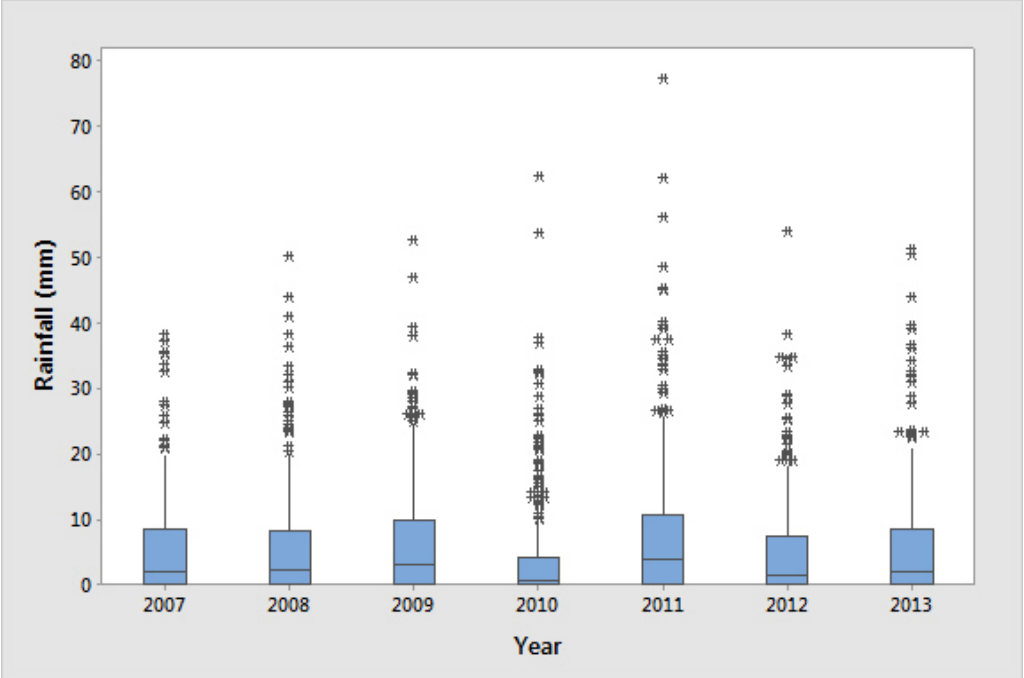

Figure 6.1 Boxplot of daily rainfall at Mull: Gruline by year (2007-2013)

The bulk of rainfall observations presented in the 2008 sanitary survey report were below 10 mm rainfall/day. This was also the case for most years in the assessment presented here, although a greater proportion (still a minority) of observations in 2011 were above this value. In the 2008 sanitary survey report, two rainfall events >50 mm were noted in 2004. In the 2007-2013 dataset there have been rainfall events of >50 mm in all years except 2007. Rainfall events of >60 mm have also occurred in years 2010 and 2011, with a rainfall event of >70 mm in 2011.

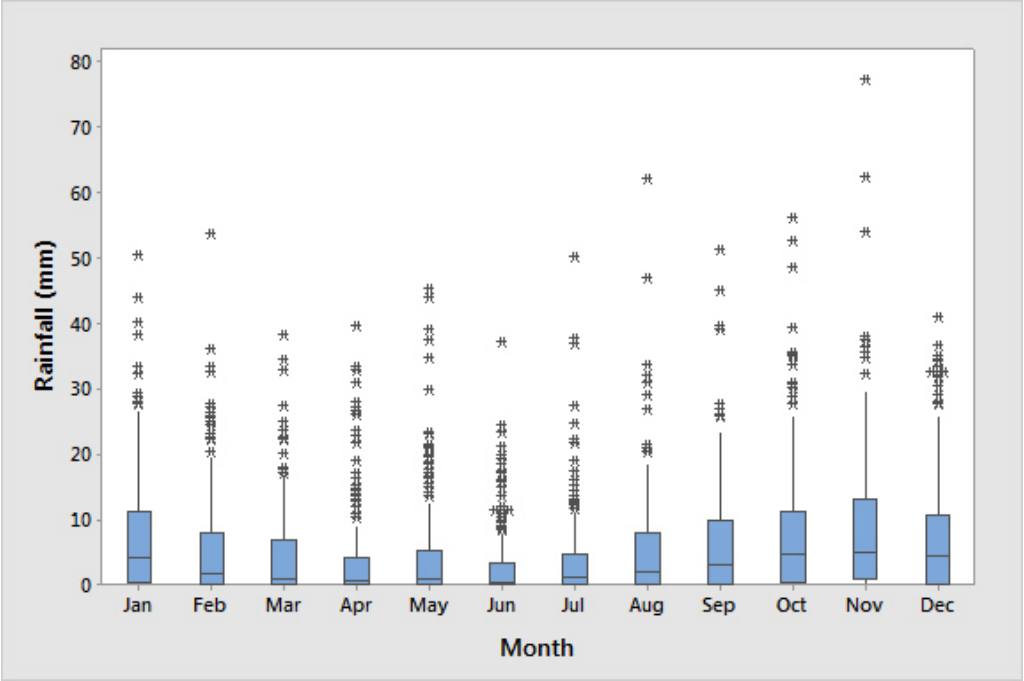

Figure 6.2 Boxplot of daily rainfall at Mull: Gruline by month (2007-2013)

The 2008 report concluded that the wettest months were between September and January, with rainfall events of >50 mm in January and August. In the 2007-2014 period, rainfall events >50 mm occurred in January and February and in months between August and November. Rainfall events >60 mm occurred in August and November, with the latter month also having a rainfall event of >70 mm. Driest months were noted as July in the 2008 report and June in the 2008-2013 dataset.

6.2 Wind

Wind speed and direction drive surface water and currents that play an integral part in particulate dispersal. Winds typically drive surface water at ca. 3% of the wind speed (Brown, 1991) so a gale force wind (a minimum of 34 knots/17.2 m/s) would drive a surface water current of about 1 knot or 0.5 m/s.

Figure 6.3 shows seasonal wind roses for Tiree for the period 2004-2013 while Figure 6.4 shows the annual wind rose for the same period. The local topography at Loch Scridain may result in differing wind patterns to those shown in the wind roses (Tiree is located approximately 45 km west of Loch Scridain). Wind data between

1998 and 2007 was presented in the 2008 sanitary survey report allowing for comparisons with the data presented here.

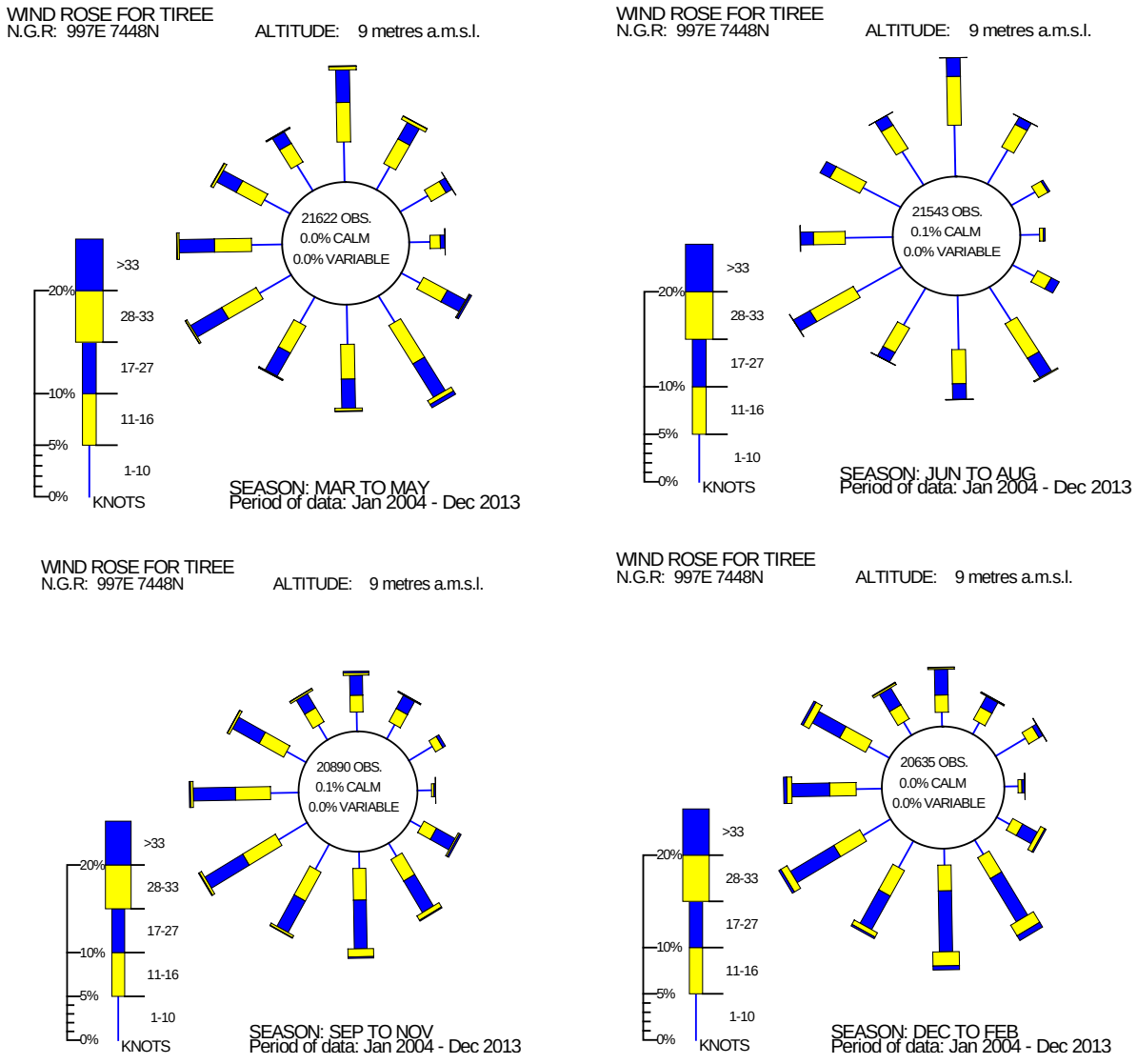

Figure 6.3 Seasonal wind roses for Tiree (2004-2013)

The 2008 sanitary survey report noted that the prevailing wind direction at Tiree was from the south and west. Winds were lightest in the summer and strongest in the winter. In the data presented here, the prevailing wind direction is southwest and is strongest in autumn and winter months. Northerly winds were also noted to be common in spring and autumn, when winds were lightest. Winds in the south-southeast direction were also common in winter, spring and summer months.

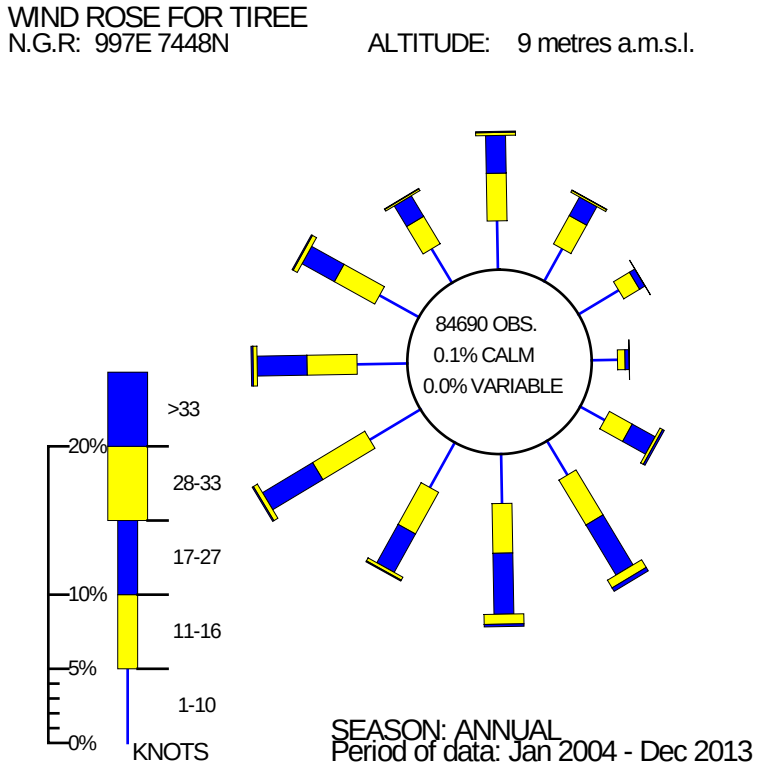

Figure 6.4 Annual wind rose for Tiree (2004-2013)

Overall the wind direction remains the same in Tiree, with southwest winds prevailing though south-southeast winds were also prominent. The southwest aspect of Loch Scridain is expected to facilitate the effects of wind and aid contaminant movement.

7.Historical *E. coli* Data

Results for all species at the Aird Fada site (equivalent to the Loch Scridain site for mussels) between 01/01/2007 and 12/09/2014 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. Data was extracted in September 2014. No results were recorded for native oysters from the Aird Fada site, or for any species from the other two sites(Killiemore and Slochd Bay). Historical *E. coli* data used in the 2007 report had already been extracted and validated. For the purposes of this report, samples pre-dating 2001 were deleted. All *E. coli* results were reported as most probable number per 100 g of shellfish flesh and intravalvular fluid.

E. coli results reported as <18, 19 or <20 were reassigned a value of 10 *E. coli* MPN/100 g and results >18000 or 18100 were reassigned values of 36000 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

Two Loch Scridain common mussel results were recorded as rejected and were omitted from further analysis in this review. The remaining Loch Scridain samples and Aird Fada Pacific oyster, King scallop and Queen scallop sites were received at the laboratory within 48 hours of collection, had box temperatures of <8^{o}C and were taken from within the production area.

7.1 Summary of microbiological results

Sampling and results summaries of historical *E. coli* results from Aird Fada are displayed for mussels and other species in Tables 7.1 and 7.2 respectively.

Table 7.1 Sampling summary results for mussels at Aird Fada 2001-2014

Sampling Summary				
Production area	Loch Scridain East			
Site	Loch Scridain			
Species	Common mussels			
SIN	AB-314-054-08			
Location	various			
Years	2001-2006		2007-2014	
Total no. of samples	57		88	
	2001	9	2007	8
	2002	11	2008	11
	2003	10	2009	12
	2004	8	2010	12
	2005	10	2011	12
	2006	9	2012	12
			2013	12
			2014	9
Results Summary				
Minimum	<20		<18	
Maximum	>18000		490	
Median	<20		<20	
Geometric mean	67		19	
90 Percentile	1390		131	
95 Percentile	5770		310	
No. Exceeding 230/100g	10 (18%)		5 (6%)	
No. Exceeding 1000/100g	6 (11%)		0	
No. Exceeding 4600/100g	3 (5%)		0	
No. Exceeding 18000/100g	1 (2%)		0	

No sample results >1000 *E. coli* MPN/100 g have been reported since 2006.

Table 7.2 Sampling summary results for the eight new sites at Loch Scridain East 2013-2014

Sampling Summary			
Production area	Loch Scridain East King Scallops	Loch Scridain East Pacific Oysters	Loch Scridain East Queen Scallops
Site	Aird Fada King Scallops	Aird Fada Pacific Oysters	Aird Fada Queen Scallops
Species	King scallops	Pacific oysters	Queen Scallops
SIN	AB-665-1441-07	AB-663-1439-13	AB-666-1442-15
Location	All within 22m of NM 4597 2489		
Total no. of samples	11	11	11
2013	2	2	2
2014	9	9	9
Results Summary			
Minimum	<18	<18	<18
Maximum	45	50	78
Median	<18	<18	<18
Geometric mean	14	14	14
90 Percentile	40	50	71
95 Percentile	45	50	78
No. Exceeding 230/100g	0	0	0
No. Exceeding 1000/100g	0	0	0
No. Exceeding 4600/100g	0	0	0
No. Exceeding 18000/100g	0	0	0

Sampling started at Aird Fard in November 2013 and the same number of samples has been taken for the three species. All sample results for all species have so far been <100 *E. coli* MPN/100 g.

7.2 Geographical patterns of results

The geographical locations of all 88 samples assigned to the Loch Scridain site have been plotted in Figure 7.1.

Two distinct areas of sampling were evident: an area towards the eastern end of the site within approximately 200 m of the current RMP at NM 4597 2489 and an area towards the middle of the current mussel farm boundaries. The reported locations of the samples taken at the latter location were in the area of the RMP identified by FSAS prior to the 2008 sanitary survey report. The samples were taken in 2008 and 2009, with one sample from 2007 (although the grid references for the 2007 samples were only reported to 100 m accuracy). The remaining samples were taken within the eastern group. A comparison of results within the eastern and mid areas is listed in Table 7.3.

Table 7.3 Comparison of summary statistics from the two areas of mussel sampling at Loch Scridain (2007-2014)

Site	No. of samples	Minimum	Maximum	Median	90%ile
East	68	<18	490	<18	112
Mid	20	<18	430	20	310

A two sample t-test was carried out to determine whether there was a significant difference between the *E. coli* results between the east and mid sampling areas. No statistically significant difference was found (t-test, t=1.83, df: 25, p=0.079).

The geographical locations of the multi-species samples assigned to Aird Fada have not been mapped as they were taken at essentially the same location. Samples for all species except mussels were taken within 22 m of the RMP at NM 4596 2489, located at the eastern end of the Aird Fada site.

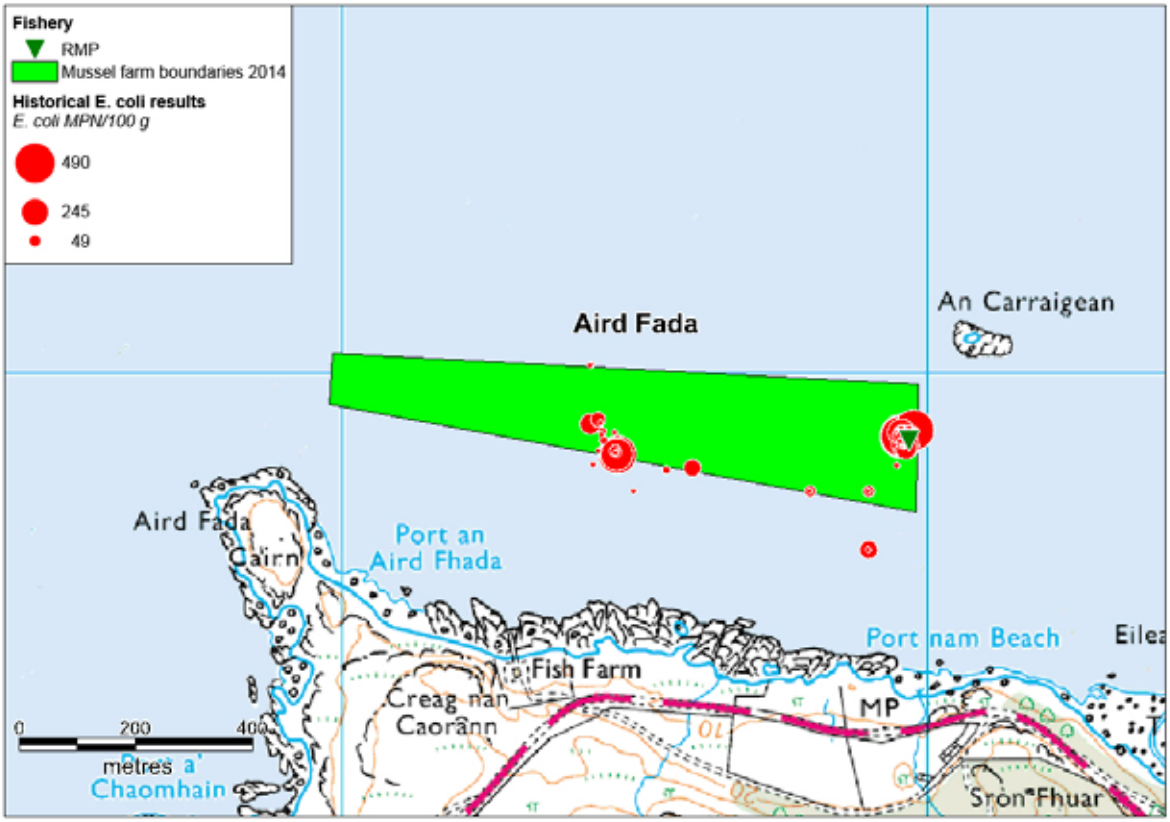

Figure 7.1 Mussel sampling locations at Aird Fada, 2007-2014

7.3 Temporal patterns of results

The trends of mussel *E. coli* results for Loch Scridain were analysed for the years between the previous sampling period (2001-2006) and the current sampling period (2007-2014). To test for significant differences between samples taken over the two sampling periods, the following statistical analyses were carried out:

- A two sample t-test (using $\log_{10}$ transformed *E. coli* data) to determine whether there was a statistically significant difference between *E. coli* results between the two sampling periods.

- A Chi-squared test was used to test for a significant difference in the observed and expected *E. coli* results above the critical level of 230 *E. coli* MPN/100 g from both sampling periods. A Fisher's Exact Test was used to test for a significant difference in the observed and expected *E. coli* results above the critical level of 1000 *E. coli* MPN/100 g from both sampling periods. A Fisher's Exact Test was used instead of a Chi-squared test in this case as two cells had expected counts of less than five from both sampling periods.

A comparison between sampling periods for other species at Aird Fada was not possible due to sampling having only begun in 2013.

The temporal trends for the mussels and the other three species at Aird Fada are displayed in Figures 7.2 and 7.3 respectively.

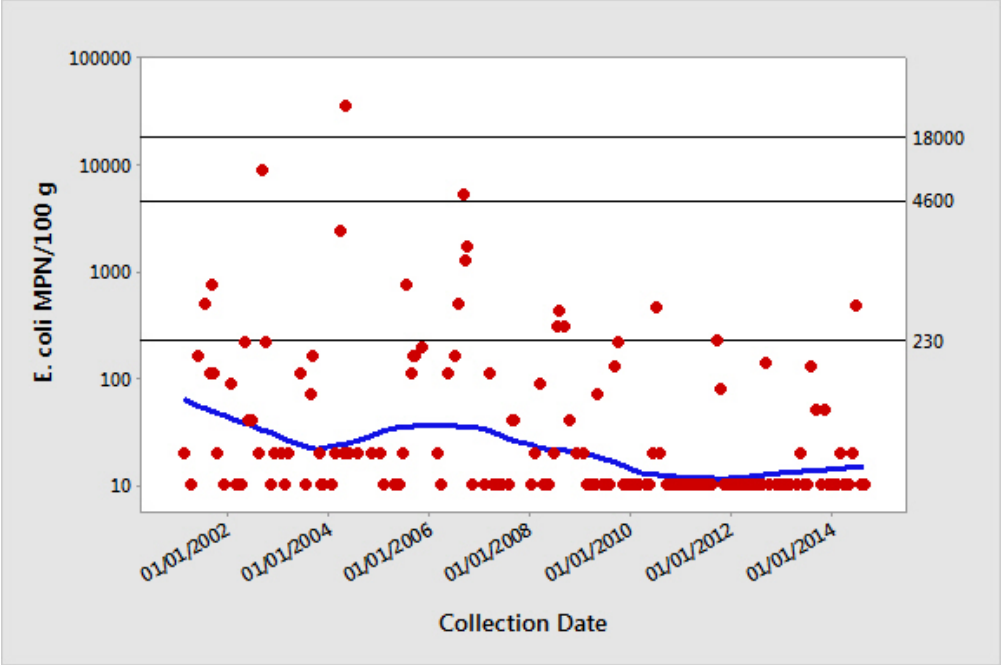

Figure 7.2 Scatterplot of Loch Scridain *E. coli* results by date (2001-2014)

Overall, contamination levels show a gradual decline over time, with an increasing proportion of sample results at <20 *E. coli* MPN/100 g.

A very highly significant difference was found between Loch Scridain common mussel log transformed *E. coli* results from the two survey periods (two sample t-test, t = 4.28, DF = 78, p = 0.000).

Table 7.4 Mussel *E. coli* results above and below 230 and 1000 *E. coli* MPN/100 g at Loch Scridain

	***E. coli* MPN/100g**			***E. coli* MPN/100g**		
	≤230	>230	**Total**	≤1000	>1000	**Total**
2001-2006	47	10	57	51	6	57
2007-2014	83	5	88	88	0	88
Total	130	15	145	139	6	145

A significant difference was found between sampling results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Pearson chi squared test, Chi = 5.248, DF = 1, p = 0.022).

A highly significant difference was found between sampling results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.003).

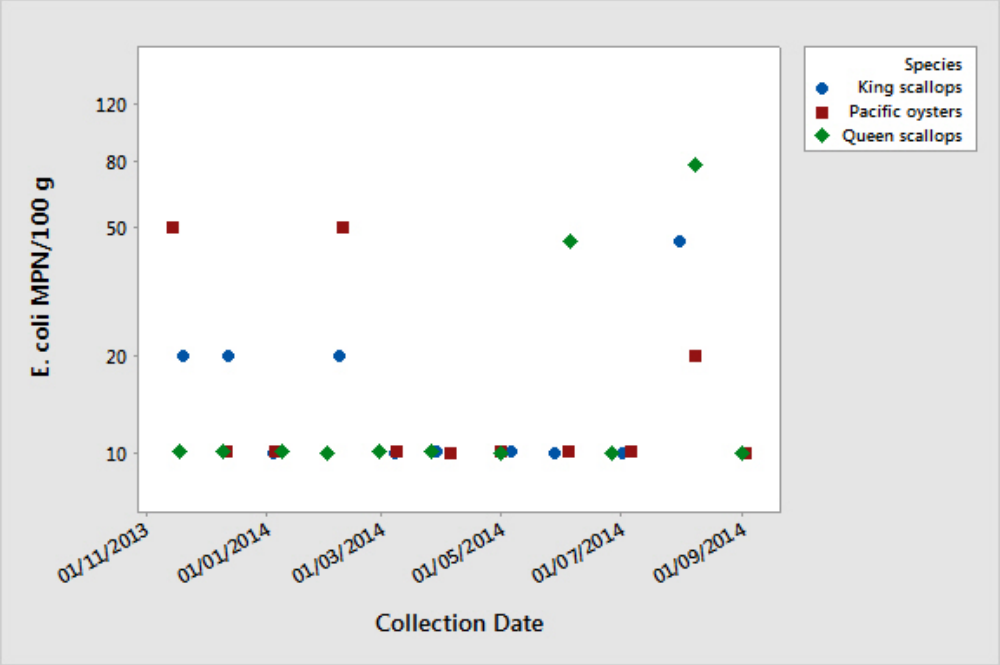

Figure 7.3 Scatterplot of Aird Fada multi-species site (2013-2014)

Comparison of results between species

Mussels at Aird Fada had been sampled on 10 of the 11 occasions that the other three species had been sampled at the same site. A two-way ANOVA was undertaken on the $\log_{10}$-transformed *E. coli* results using species and sampling date as factors. No significant difference in average *E. coli* concentration was seen between species (F=0.26, d.f. = 3,27, p= 0.855). However, the highest result seen in mussels was 490 *E. coli* MPN/100 g whereas the highest result seen in any of the other species was 78 *E. coli* MPN/100 g (queen scallops).

Conclusions

There has been a significant decrease in mussel *E. coli* results with time at the Aird Fada site. No significant difference was seen in mussel *E. coli* results at different sampling locations at that site.

Sampling results across the three other species at the Aird Fada site have been low with a maximum of 78 *E. coli* MPN/100 g since sampling started in November 2013.Comparison of results from all four species did not show any significant difference in average *E. coli* levels.

8. Movement of contaminants

The 2008 sanitary survey report noted that the following would affect the movement of contamination around Loch Scridain:

- Currents are likely to form an eddy in the lee of the headland west of the Loch Scridain fishery during tidal exchange which may affect movement of contaminants from south and east of the farm on an outgoing tide
- Slow flushing time of six days
- Poor mixing at the head of the loch
- Slow current speeds at the mouth of the loch on both ebb and flood tides

During an internet search undertaken for this review, no further information was found on the movement of contaminants around Loch Scridain.

A hydrographic assessment carried out for the Kilfinichen Bay sanitary survey report covered other parts of Loch Scridain, as well. This assessment indicated that:

- Freshwater discharge is an important aspect of circulation and exchange in the system.
- The relatively weak tidal flow and the abundance of freshwater sources in Loch Scridain indicate that it is likely that a well-developed surface layer will form in many areas of the loch, particularly towards the head.
- It is presumed that the flow of water is rather simple with axial flow on the flood and ebb tides that follows the alignment of the loch. The cumulative transport distance on each phase (flood/ebb) of the tide has been estimated at around 0.9 km, which is rather small compared to the length of the loch.
- Surface residual flows would be enhanced by winds along the axis of the loch and an inflowing residual might be related to winds blowing with a dominant westerly component.
- Using a value of residual flow speed measured at the surface (0.005 m/s), the net transport over a tidal cycle of approximately 12 hours would be around 0.2 km. This is much less than the transport from tidal flow.
- Based on the current meter measurements in Scridain, it is likely that any surface contaminant in the loch would be transported along rather short distances on each tidal cycle which could increase its residence time in the loch.

9. Overall Assessment

This assessment considers the information obtained since the 2008 report and the potential changes in extent and location of faecal contamination.

Human sewage Impacts

The small increase in human population on land around Loch Scridain is not expected to have a marked effect on contamination at the shellfish sites. The number of planning applications for new dwellings in the area matches that of the population increase. Small amounts of contamination from boats are expected to be localised around anchorages/moorings, none of which are located close to the shellfish sites.

The additional private sewage discharges identified since the 2008 report suggests the original conclusion that the sewage-derived contamination in Loch Scridain was low was not correct. However, the inputs are small compared to their distance from the fisheries (in general, more than 500 m) and thus while they will contribute to the background contamination within the loch they will not have a direct impact at the fisheries.

Agricultural impacts

The highest agricultural input of faecal contamination is expected to come from the Rossal Farm area to the southeast of the loch head. However, contamination is also expected around the northeast shoreline due to the relatively large number of livestock observed there. It is expected this will contribute significant contamination to the northwest extent of the Killiemore site. Some impact is also expected at the northern extent of Slochd Bay from livestock both on land and on the shoreline.

Wildlife Impacts

Impacts from wildlife are likely to be low and are not anticipated to have significantly changed since the 2008 report.

Seasonal Variation

Visitors are expected to continue to visit the area during summer months. A large number of boats are expected to attend the Round Mull race in June each year: however, they anchor at Bunessan, outside of Loch Scridain. Contamination from livestock is also expected to remain greatest during the spring/summer lambing and calving season. Increased impacts from run-off may occur due to high rainfall events which seem to be occurring more frequently.

Watercourses

Freshwater impacts remain highest at the head of the loch which is expected to significantly impact the Killiemore site. Freshwater impacts are also expected along the northeast extent of the Slochd Bay site and the southeastern extent of the Aird Fada site. CTD casts were undertaken at 5 locations on the shellfish sites during the shoreline survey. The only cast that showed marked reduction in salinity at the surface compared to depth (a little over 7 psu) was that at Killiemore, supporting the contention of freshwater input potentially affecting that site.

Movement of contaminants

Hydrographic assessment from the 2014 Kilifinichen Bay sanitary survey report stated that the strongest currents were broadly aligned with the shoreline. The transport distance over a single tidal phase (flood or ebb) was estimated to be approximately 0.9 km. This means that sources closest to the shellfish farms are most likely to have an impact there, and also that contaminants may persist over longer than a tidal cycle.

Analysis of Results

Historical *E. coli* results

Results from the mussels at Loch Scridain have decreased significantly over time. Sampling location within the 2007-2014 period has varied, with samples taken since October 2009 reported to the east the fishery within approximately 200 m of the current RMP. However, no statistically significant difference was found between sample results and sampling location.

Sample results for Pacific oysters, King and queen scallops at Aird Fada have been <100 *E. coli* MPN/100g since sampling started in November 2013. A comparison of results between all four species showed no significant difference in average *E. coli* levels although the highest result was seen in mussels.

Shoreline Survey results

Four shellfish samples were taken at the Aird Fada site; two to the northwest and two from the mid-east extent, with one sample from the surface and one from the bottom at each location. Both samples from the northwest corner returned results of 330 *E. coli* MPN/100 g, whilst the samples taken from the mid-east extent of the site returned a much higher result from the sample taken at 10 m depth (1100 *E. coli* MPN/100 g) compared to the surface sample (230 *E. coli* MPN/100 g). Samples of juvelnile mussels taken at the surface at Slochd Bay and Killiemore gave results of 790 and 9200 *E. coli* MPN/100 g respectively.

Seawater samples taken at both shellfish sampling locations at Aird Fada, the west extent of the Slochd Bay site returned low results of between 1 and 3 *E. coli* cfu/100 ml, with salinities of 35 ppt. The seawater sample taken to the northeast extent of the Killiemore site comparatively returned a very high result of 400 *E. coli* cfu/100 ml: the sample had a low salinity of 24.2 ppt.

Conclusions

The main factors influencing the recommendations made in the 2008 report were as follows:

- Seasonality and variability of historic monitoring results, diffuse agricultural inputs and seasonal fluctuations in population levels would suggest monthly monitoring is appropriate.

- Higher levels of contamination are associated with fresh water, and so areas of lower salinity at the head of the loch should be excluded from the production area as they will be more likely to be contaminated.

- Higher results were found in shellfish taken from the top of the water column, so the RMP should be set at the top of the water column to reflect this.

- Beach River is expected to impact Loch Scridain fishery

The main changes to those factors considered in the 2008 report are as follows:

- Background levels of faecal contamination from sewage inputs are higher than originally assumed in the 2008 report, owing to the large number of additional private discharges identified by SEPA. These levels will have been added to by sewage from the 10 new planning applications.

- Moderate levels of agricultural contamination are expected to impact the northwest extent of the Killiemore site and low levels are also anticipated at the northern extent of the Slochd Bay site, from livestock kept on land with access to the shoreline.

- Freshwater contamination levels remain highest at the head of the loch and will therefore have a significant impact on the Killiemore site. Impacts are also expected to the southeast of Aird Fada site from Beach River which discharges 500 m from this site.

- The frequency of high rainfall events seems to be increasing.

- An improved hydrographic assessment indicates that tidal movement is largely aligned with the shore and the distance travelled over each phase of a tidal cycle is in the order of 0.9 km.

- Mussel *E. coli* results have significantly decreased over time.

- There was no significant difference in the average level of contamination seen in the four species at Aird Fada. However, in parallel monitoring, the highest result was seen in mussels.

Sources affecting the Killiemore site are different to those affecting the other two sites and the former is expected to be exposed to higher levels of faecal contamination.

10. Recommendations

The conclusions support the recommendations of the pRMP assessment that the Killimore site should be monitored separately to the other two sites and therefore that the two separate production areas be maintained.

Given the results from parallel monitoring at the Aird Fada site, it is recommended that consideration is given to the use of mussels as an indicator species for both production areas.

Loch Scridain East

It is recommended that the southwestern co-ordinate defining the production area boundary is moved slightly in order to locate it at MHWS. It is recommended that the RMP location remain as defined at present.

Production area: the area bounded by lines drawn between NM 4507 2700 and NM 4478 2479 and between NM 4618 2690 and NM 4618 2448.

RMP: NM 4597 2489

Tolerance: It is recommended that this be increased to 40 m (as recommended in the pRMP assessment) to allow for movement of mussel lines.

Depth: 1-3 m

Loch Scridain: Killiemore

It is recommended that the production area for Loch Scridain: Killiemore be amended slightly to exclude contamination from Allt na Coille Moire. It is also recommended that the RMP be moved slightly so that it lies on the observed extent of the longlines while still reflecting any contamination arising from identified sewage-related and freshwater sources.

Production area: the area bounded by lines drawn between NM 5017 2858 and NM 5239 2798 and between NM 5215 2883 and NM 5094 2933.

RMP: NM 5079 2890

Tolerance: 40 m to allow for movement of mussel lines (as recommended in the pRMP assessment).

Depth: 1 - 3 m

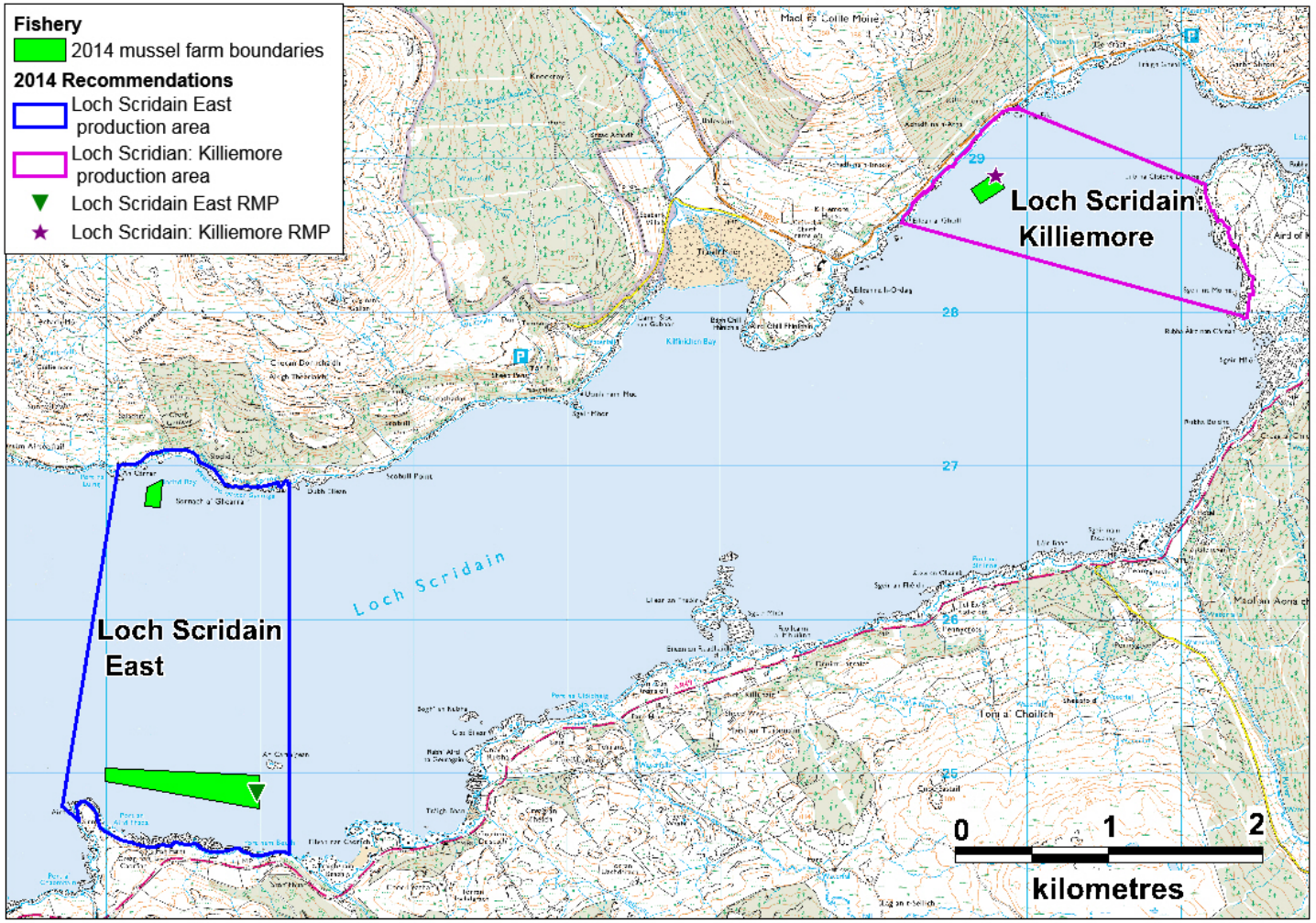

Figure 10.1 Recommended production area boundaries and RMPs for Loch Scridain East and Loch Scridain: Killiemore

11. References

Argyll & Bute Council, 2014. *Planning: Simple Search.* [Online] Available at: http://publicaccess.argyll-bute.gov.uk/publicaccess/ [Accessed 13 01 2014].

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.

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

Hebridean Whale and Dolphin Trust, 2014. *Recent Sightings.* [Online] Available at: http://www.whaledolphintrust.co.uk/sightings-recent-sightings.asp [Accessed 16 10 2014].

JNCC, 2006. *UK SPA data form.* [Online] Available at: http://jncc.defra.gov.uk/pdf/SPA/UK9003311.pdf [Accessed 16 10 2014].

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

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. Demographics, landscape and meterological factors controlling the microbial pollution of coastal waters. *Hydrobiologica,* Issue 460, pp. 185-193.

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.

Oban Sailing Club, 2014. *Round Mull Race.* [Online] Available at: http://www.obansailingclub.org/#/round-mull-race/4566735366 [Accessed 16 10 2014].

Pure Travel, 2010. *The Otter.* [Online] Available at: http://www.puretravel.com/Guide/Travel_writing_competition/Travel_Writing_Competition_2011_Shortlist/The_Otter [Accessed 16 10 2014].

Special Committee on Seals, 2013. *Scientific Advice on Matters Related to the Management of Seal Populations 2013,* St Andrews: St Andrews University; Sea Mammal Research Unit.

Wiuld Future, 2014. *Wildlife & Wild Places, Isle of Mull.* [Online] Available at: http://www.wildfuture.co.uk/index.php/isle-of-mull-wildlife-a-wild-places [Accessed 16 10 2014].

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Appendix 1

Planning Applications

Planning applications expected to change the human population and overall faecal loading to Loch Scridain East are listed in Table 1.

Table 1 Planning applications to areas around Loch Scridain

Location	Date	Ref No	Description	Area
Tiroran	Jul-14	14/01740/PP	Renewal of planning permission 11/01479/PP (conversion of sawmill to residential dwelling)	The Steadings Tiroran Isle Of Mull Argyll And Bute PA69 6ES
	May-14	14/01382/PP	Amended design relative to planning permission 11/02050/PP (Demolition of studio, erection of replacement dwellinghouse, installation of septic tank and formation of vehicular access).	The Bungalow Studio Tiroran Isle Of Mull Argyll And Bute PA69 6ES
Dererach	Sep-10	10/01495/PP	Erection of a dwellinghouse and associated works. (Revised design to planning consent 05/01798/DET)	Dererach Pennyghael Isle Of Mull Argyll And Bute PA70 6HQ
Pennyghael	Feb-10	10/00251/PP	Proposed erection of dwellinghouse and installation of bio-disc treatment plant unit	Land 20 m North East Of Craig Rowan Pennyghael Isle Of Mull Argyll And Bute PA70 6HB
	Feb-11	11/00202/PP	Siting of mobile home for holiday letting	Torbhan Cottage Pennyghael Isle Of Mull Argyll And Bute PA70 6HE
	Apr-11	11/00609/PP	Demolition of existing sheds and erection of dwellinghouse and shed	Kilpatrick croft, Land North East Of Alt Nam Fiadh Pennyghael Isle Of Mull Argyll And Bute PA70 6HF
	Nov-11	11/02182/PP	Erection of dwellinghouse and installation of sewage treatment plant and infiltration area	Garden Ground Of Katrine Cottage Pennyghael Isle Of Mull Argyll And Bute PA70 6HB
	Sep-12	12/02075/PP	Renewal of planning permission reference 07/02028/DET - Erection of detached one and a half storey dwellinghouse	Land South West Of Kinloch Hotel Pennyghael Isle Of Mull Argyll And Bute
	Nov-12	12/02534/PPP	Site for erection dwellinghouse and installation of septic tank	Garden Ground Of Glenleidle Pennyghael Isle Of Mull Argyll And Bute PA70 6HB
	Oct-10	13/02802/PP	Conversion of outbuildings to form dwellinghouse	Outbuildings At Rossal Farm Pennyghael Isle Of Mull Argyll And Bute PA70 6HB

Appendix 2

Private sewage discharge consents

Private discharge consents identified by SEPA from the 2014 Kilfinichen Bay sanitary survey report

Table 2 SEPA consents around Loch Scridain (2014)

Licence Number	NGR	Site Description	Treatment Type	Discharging to	PE
CAR/L/1003491	NM 4970 2600	Pennycross MCFF	Marine Cage Fish Farm	Loch Scridain	NA
CAR/R/1009214	NM 4866 2852	Dwelling, Tiroran	Sewage (Private) Primary	Land	15
CAR/R/1013638	NM 4870 2934	Dwelling, Tiroran	Sewage (Private) Primary	Land	7
CAR/R/1017505	NM 5189 2642	Pennyghael Community Hall & School House Mull	Sewage (Private) Primary	Leidle River	11
CAR/R/1018620	NM 4798 2781	Dwelling, Tiroran, Isle of Mull	Sewage (Private) Primary	Land	5
CAR/R/1032100	NM 4731 2738	Dwelling, Tiroran	Sewage (Private) Primary	Loch Scridain	0
CAR/R/1033085	NM 4274 2675	Dwelling, Tiroran	Sewage (Private) Primary	Soakaway	15
CAR/R/1033369	NM 5287 2449	Dwelling, Pennyghael	Sewage (Private) Primary	Leidle River	9
CAR/R/1036095	NM 4716 2740	Dwelling, Pennyghael	Sewage (Private) Secondary	Allt an Sgaphairt	0
CAR/R/1037269	NM 5344 2828	Dwelling, Pennyghail	Sewage (Private) Primary	Soakaway	0
CAR/R/1038125	NM 4858 2539	Dwelling, Pennyghael	Sewage (Private) Primary	Soakaway	5
CAR/R/1038410	NM 5295 2801	Dwelling, Pennyghael	Sewage (Private) Primary	Loch Scridain	5
CAR/R/1038446	NM 5349 2848	Dwelling, Pennyghael	Sewage (Private) Primary	Loch Scridain	6
CAR/R/1038669	NM 4687 2722	Dwelling, Tiroran	Sewage (Private) Primary	Soakaway	5
CAR/R/1038952	NM 5038 2605	Dwelling, Pennyghael	Sewage (Private) Primary	Soakaway	5
CAR/R/1038955	NM 4881 2932	Dwelling, Tiroran	Sewage (Private) Primary	Soakaway	5
CAR/R/1039682	NM 5155 2968	Dwelling, Pennyghael	Sewage (Private) Primary	Loch Scridain	5
CAR/R/1041564	NM 4677 2439	Dwelling, Isle Of Mull	Sewage (Private) Primary	Soakaway	5
CAR/R/1042230	NM 4725 2744	Dwelling,Tiroran	Sewage (Private) Primary	Underground WC	5
CAR/R/1049233	NM 5180 2641	Dwelling, Pennyghael	Sewage (Private) Primary	Loch Scridain	5

Licence Number	NGR	Site Description	Treatment Type	Discharging to	PE
CAR/R/1063060	NM 5415 2800	Dwelling, Pennyghael	Sewage (Private) Primary	Soakaway	14
CAR/R/1076821	NM 4723 2737	Dwelling, Tiroran	Sewage (Private) Secondary	U/N W/C	6
CAR/R/1087216	NM 5168 2637	Dwelling, Pennyghael	Sewage (Private) Secondary	U/N W/C	6
CAR/R/1100347	NM 4840 2802	Dwelling, Tiroran	Sewage (Private) Primary	Soakaway	5
CAR/R/1100348	NM 4854 2804	Dwelling, Tiroran	Sewage (Private) Primary	Loch Scridain	5
CAR/L/1101522	NM 4340 2647	Ardmeanach MCFF	Marine Cage Fish Farm	Loch Scridain	NA
CAR/R/1115317	NM 5214 2673	Dwelling, Pennyghael	Sewage (Private) Primary	Soakaway	10
CAR/R/1119446	NM 5150 2638	2 Dwellings, Pennyghael, Mull	Sewage (Private) Secondary	UN/WC	10

N/A= not applicable

Appendix 3

Shoreline survey report

Shoreline Survey Report

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

Document Number	B0067_Shoreline 0038

Revision History

Revision	Changes	Date
A	Draft issue for internal review	25/08/2014
B	Second draft issue for internal review	15/09/2014
01	First formal issue to Cefas	19/09/2014
02	Second formal issue to Cefas	10/10/2014

	Name & Position	Date
Author	Lars Brunner, Chris Allen	15/08/2014
Checked	Andrea Veszelovszki	10/10/2014
Approved	Mark Hart	10/10/2014

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

Production area:	Loch Scridain East
Site name:	Loch Scridain
SIN:	AB-314-054-08
Species:	Common Mussels (*Mytilus edulis*)
Harvester:	Dr. Philippe Heineger (Celtic Sea Ltd)
Local Authority:	Argyll & Bute Council
Status:	Existing area
Date Surveyed:	12th – 13th August 2014
Surveyed by:	Lars Brunner, Chris Allen
Existing RMP:	NM 4597 2489
Area Surveyed:	**1.** Shellfish growing sites at Aird Fada, Slochd Bay & Killiemore, by boat **2.** Shoreline area to the north of Slochd Bay **3.** Shoreline area from Aird Fada east to Sron Fhuar **4.** Isolated freshwater samples from Pennyghael & Coladoir River **5.** Aird of Kinloch peninsula **6.** Shoreline from Killiemore House to Traigh Gheal

Weather

In the 48 hours prior to the survey heavy rain had fallen on the survey area.

Tuesday 12th August: Wind W, f4-5, occ. gusting 6, sea state moderate. Cloud cover 100%. Light/moderate rain, with occasionally heavy squalls. Temperature 13°C

Wednesday 13th August: Wind NW/W, f5, reducing f3 later. Sea state moderate, reducing to slight later in the day. Cloud cover 80-90%, intermittent showers, some heavy. Temperature 14°C

Stakeholder engagement during the survey

The site manager for Celtic Sea, Loch Scridain, Mr. Iain Henderson, was contacted prior to the survey and provided advice in the planning of the survey work. Mr. Henderson was extremely helpful during the survey, both in providing access to the mussel farm areas, as well as assisting with boat time to get to some areas of shoreline that would have otherwise been very difficult to access. In addition Mr Henderson provided much information about the current situation, and future plans for the three shellfish sites.

The local authority sampling officer, Mr. Ewan MacDougall, was also present at Aird Fada on Tuesday 12th August. Mr. MacDougall also contacted the survey team prior to the survey, and was very helpful in providing additional information regarding the current state of the site.

Fishery

The fishery in Loch Scridain East consisted of three common mussel (*Mytilus edulis*) cultivation sites; Aird Fada, Slochd Bay, and Killiemore. All of these use long lines for the cultivation process, and were in different states of use.

The Aird Fada site was currently in active use, with most of the harvesting taking place from this site. The site consisted of two sections, each composed of nine long lines running east to west, with each long line approximately 200m long. Droppers extended to around 10m depth, and the *M. edulis* stock was mostly mature and ready for harvest.

The site at Slochd Bay was not currently in use, and had little to no stock present. There were currently four long lines on site, but they were out of alignment and were partially submerged, with many of the droppers tangled. The majority of mussels present were juveniles (between 20 to 50mm in length).

The Killiemore site consisted of 5 x 200m long lines situated at the eastern end of Loch Scridain, away from the other two sites. The lines were currently not being used, as they had been seeded with mussel spat in the last year, and the droppers were currently coiled at the surface. As with Slochd Bay, the majority of mussels present on the lines were juveniles (between 20 to 50mm in length). The RMP noted at the Killiemore site was currently not in use, and the surveyors were not able to establish where the classification samples were being taken from.

The Aird Fada shore base (Waypoint 70) was currently used to service all three sites.

Sewage Sources

The shores around Loch Scridain were sparsely inhabited, the only minor population centre being the small village of Pennyghael. Dispersed houses were present throughout the survey area, the majority of these being situated on the southern shore of the loch. On the survey routes, discharge pipes were noted at Waypoints (WPs) 52 & 69, although neither had any observed discharge at the time of survey.

Seasonal Population

Several groups of tourists were observed around the survey area, with larger groups on coaches passing through in addition to smaller walking groups. There was a hotel present at Pennyghael, with several self-catering properties also present in the area. No caravan site or camp site was noted on survey, although several small car parks were present in the area for visitor use, similar to that seen in WP 55.

Boats/Shipping

The only piers/ slipways noted on the survey were the slipway at the Celtic Sea shore base at Aird Fada (WP 70) and a small pier and rough slipway on the northern shore below Killiemore House (WP 29). Isolated moorings were noted through the survey area, with two moorings both occupied by small pleasure craft seen close to the pier at WP 29, and one unoccupied mooring at WP 57. Six moorings were seen to the east of Aird of Kinloch (WP 64), with two occupied by small pleasure craft.

Farming and Livestock

Livestock were observed at several places during the survey. These observations included nine cows and three sheep at Slochd Bay (WPs 23 & 25 respectively), seventeen sheep at Killiemore (WP 32), four sheep at Allt na Coille Moire (WP 50), ten sheep at Traigh Gheal (WP 55), and seven sheep by Coladoir River (WP 60). A total of sixty six sheep were seen on the Aird of Kinloch peninsula (twenty at WP 61, forty at WP 63 & six at WP 64). In addition five chickens were noted at Pennyghael (WP 68).

A cattle feeding station (WP 45) was noted on the shoreline immediately adjacent to the Killiemore farm site. This was located on the MHWS line, and consisted of three feed troughs. The feeding station appeared to have been recently used based on tracks and prints present, although no livestock was present at the time of survey.

Land Use

The land use around Loch Scridain was predominantly rural. On the northern side of the loch there were large areas of plantation spruce forestry, with the remaining land near the shore being wild, or used for rough grazing. To the east of the loch, the land was largely moor and bog, with the sole usage appearing to be rough grazing. The Aird of Kinloch peninsula had some improved grazing areas for sheep. The southern section of the loch, from Kinloch westwards, had large areas of plantation forestry and rough ground to the shoreline. This area did not appear to be in active use for agriculture.

Land Cover

To the north of the loch, the predominant land cover was plantation spruce forestry, with some rough ground and heath present on the shore. To the east of the loch there were large areas of heath and bogland, with rough upland heath present further back from the shore. The Aird of Kinloch peninsula consisted of bog on the eastern side, with a mixture of rough and improved grassland on the western and northern sides. The southern area of the loch generally consisted of plantation spruce forestry, and rough ground/heathland nearer the shore.

Watercourses

The major watercourse in the area is the Coladoir River (WP 59), which discharged into the east of the loch, followed by the Leidle River, which discharged into the bay at Pennyghael (WP 67), and the Beach River (WP 78), which enters the loch at Traigh nam Beach. These three watercourses were required sampling locations. There was one other watercourse of a similar size to the three sampled rivers listed above, Abhainn nan Torr, located between Beach River and Leidle River. This river was not a required sampling point, and did not occur within any sections of the shoreline walked. Numerous smaller watercourses were observed during the survey within the sections of shoreline walked, and these were recorded in the shoreline observations in Table 1.

Wildlife/Birds

Birds were observed at four points during the survey. Singular grey herons were recorded on the shoreline at WPs 31 and 48. At Leidle River (WP 68), eighty seven ducks, fourteen gulls and eight oystercatchers were recorded. Sixteen gulls and two ducks were also observed at the mouth of Beach River (WP 78)

The specific observations made at each WP can be found in Table 1, with each of the WP locations displayed in Figures 1 and 2.

Figure 1. Loch Scridain Waypoints, western half of survey area

Figure 2. Loch Scridain Waypoints, eastern half of survey area

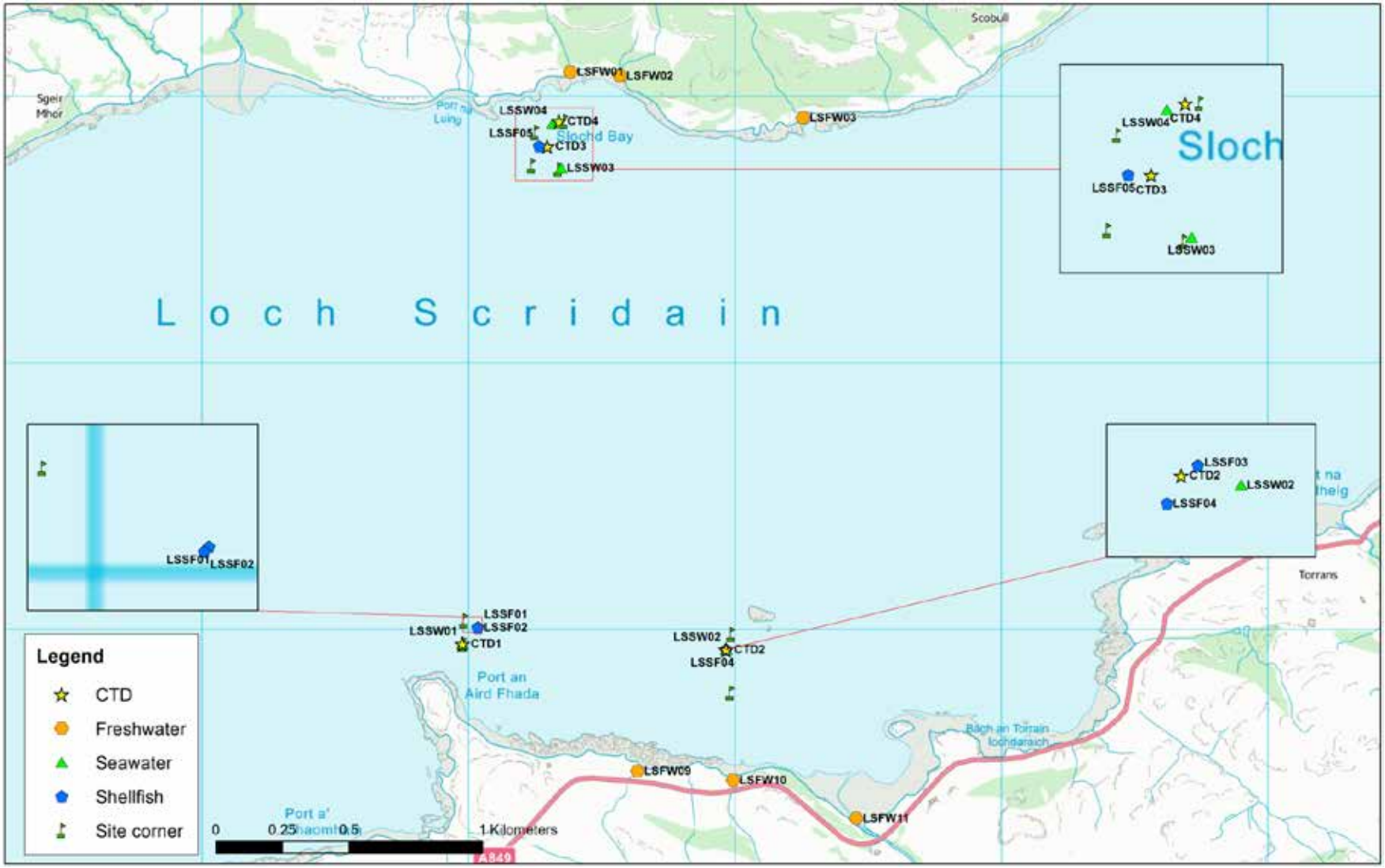

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Figure 3. Loch Scridain sample positions, western half of survey area

Figure 4. Loch Scridain sample positions, eastern half of survey area

Table 1. Shoreline Observations by waypoint (WP) number.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	12/08/2014	9:23	NM 44978 24945	144978	724946			Start of survey on 12/08/14. SW Corner Aird Fada mussel farm.
2	12/08/2014	9:23	NM 44977 24945	144978	724946		LSSW01	Planned seawater sample.
3	12/08/2014	9:24	NM 44977 24945	144977	724946			CTD1 profile taken.
4	12/08/2014	9:30	NM 44983 25032	144983	725033			NW corner Aird Fada mussel farm.
5	12/08/2014	9:32	NM 45035 25008	145035	725008		LSSF01	Planned shellfish sample of mussels from top of rope - lines 10m in length; western end of shellfish farm.
6	12/08/2014	9:33	NM 45033 25006	145034	725007	Fig. 5	LSSF02	Planned shellfish sample of mussels from bottom of rope - lines 10m in length; western end of shellfish farm.
7	12/08/2014	9:42	NM 45985 24981	145986	724981			NE corner Aird Fada mussel farm.
8	12/08/2014	9:45	NM 45967 24924	145967	724924		LSSF03	Planned shellfish sample of mussels from top of rope - lines 10m in length; south eastern corner of shellfish farm.
9	12/08/2014	9:45	NM 45966 24923	145966	724924		LSSF04	Planned shellfish sample of mussels from bottom of rope - lines 10m in length; south eastern corner of shellfish farm.
10	12/08/2014	9:47	NM 45967 24924	145968	724924		LSSW02	Planned seawater sample.
11	12/08/2014	9:49	NM 45966 24924	145967	724924			CTD2 profile taken.
12	12/08/2014	9:51	NM 45982 24761	145983	724762			SE corner Aird Fada mussel farm.
13	12/08/2014	11:11	NM 45237 26740	145237	726740			SW corner Slochd Bay mussel farm - not actively farmed site.
14	12/08/2014	11:12	NM 45336 26726	145337	726726			SE corner Slochd Bay mussel farm.
15	12/08/2014	11:12	NM 45347 26731	145348	726731		LSSW03	Planned seawater sample; northern side.
16	12/08/2014	11:17	NM 45295 26813	145295	726813			CTD3 profile taken.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
17	12/08/2014	11:21	NM 45265 26813	145265	726813		LSSF05	Planned shellfish sample of mussels at top of line; no mussel found at bottom of lines (10m length). The majority of mussels were juveniles (between 20-50mm in length).
18	12/08/2014	11:23	NM 45250 26864	145250	726865			NW corner Slochd Bay mussel farm.
19	12/08/2014	11:24	NM 45315 26898	145315	726898		LSSW04	Planned seawater sample; north-eastern side.
20	12/08/2014	11:25	NM 45339 26906	145340	726907			CTD4 profile taken.
21	12/08/2014	11:28	NM 45358 26906	145358	726907	Figs. 6 & 7		NE corner Slochd Bay mussel farm.
22	12/08/2014	11:40	NM 45382 27092	145383	727092		LSFW01	Planned freshwater sample - unnamed watercourse, western part of Slochd Bay.
23	12/08/2014	11:40	NM 45383 27091	145383	727091			Observations associated with WP22 - Width: 1m 35cm; Depth: 14cm; Flow: 0.874 m/s; 0.076 SD. Shoreline around Slochd Bay inaccessible by foot, transit along section by boat. No human habitation or activity seen. Nine cows observed above shoreline.
24	12/08/2014	11:48	NM 45568 27076	145569	727077		LSFW02	Planned freshwater sample - unnamed watercourse, mid-Slochd Bay.
25	12/08/2014	11:48	NM 45566 27079	145566	727080			Observations associated with WP24 - flow splits into two around rock. **A)** Width: 70cm; Depth: 17cm; Flow: 0.583 m/s; 0.019 SD. **B)** Width: 85cm; Depth: 11cm; Flow: 0.333 m/s; 0.020 SD. Three sheep on shoreline, sheep carcass adjacent to stream.
26	12/08/2014	12:01	NM 46255 26919	146256	726920		LSFW03	Planned freshwater sample - Alltan na Drochaid, eastern end of Slochd Bay.
27	12/08/2014	12:01	NM 46255 26919	146256	726920			Observations associated to WP26 - Total Width: 2m 10cm; Depth1: 24cm; Flow1: 1.479 m/s; 0.069 SD; Depth2: 20cm; Flow2: 0.821 m/s; 0.045 SD. End of survey section around Slochd Bay.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
28	12/08/2014	13:23	NM 49724 28361	149724	728361			Start of survey section around Killiemore.
29	12/08/2014	13:24	NM 49821 28307	149821	728308	Fig. 8		Small stone pier with pontoon, small wooden shed present above shoreline. Two moorings in bay, both with small pleasure craft.
30	12/08/2014	13:27	NM 49882 28357	149883	728358			Small stream running from forested uninhabited area. Not sampled – no habitation or livestock present .
31	12/08/2014	13:34	NM 50030 28516	150030	728517	Fig. 9		Small stream running from forested uninhabited area. Not sampled – no habitation or livestock present. One grey heron spotted on mid-shore.
32	12/08/2014	13:38	NM 50152 28627	150152	728627			Small stream running from forested uninhabited area. Not sampled. Seventeen sheep visible on far hill behind shoreline.
33	12/08/2014	13:42	NM 50227 28699	150228	728700			Small stream running from forested uninhabited area. Not sampled – no habitation/ livestock present.
34	12/08/2014	14:03	NM 50792 28921	150793	728922	Fig. 10		Joined harvester to survey Killiemore mussel farm. No RMP present, farm has not been harvested in years. NE corner of Killiemore mussel farm.
35	12/08/2014	14:04	NM 50791 28917	150791	728917		LSSW05	Planned seawater sample; northern side of shellfish farm.
36	12/08/2014	14:05	NM 50792 28918	150792	728919		LSSF06	Planned shellfish sample of mussels from Killiemore. Coiled ropes along whole site, so mussels only taken from surface. The majority of mussels were juveniles (between 20-50mm in length).
37	12/08/2014	14:06	NM 50794 28917	150794	728917			Photos of mussel farm taken. CTD struggling to find satellite connection.
38	12/08/2014	14:12	NM 50620 28800	150621	728801			NW corner Killiemore mussel farm.
39	12/08/2014	14:13	NM 50682 28706	150683	728706			SW corner Killiemore mussel farm.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
40	12/08/2014	14:14	NM 50841 28811	150842	728811			SE corner Killiemore mussel farm.
41	12/08/2014	14:16	NM 50791 28916	150791	728916			CTD5 profile taken, associated with WP36 & 37; retuned to shore to continue on foot shoreline survey around Killiemore.
42	12/08/2014	14:34	NM 50370 28851	150371	728851		LSFW04	Planned freshwater sample – Allt Achadh na h-Innseig, western end of Killiemore Bay
43	12/08/2014	14:34	NM 50371 28851	150371	728851			Observations associated with WP42 - Total Width: 1m 65cm; **Depth1**: 9cm; Flow1: 0.267m/s; 0.039 SD; **Depth2**: 20cm; Flow2: 0.638 m/s; 0.074 SD.
44	12/08/2014	14:38	NM 50391 28869	150391	728869			Small stream running from forested uninhabited area. Not sampled – no habitation/ livestock present.
45	12/08/2014	14:41	NM 50424 28907	150425	728908	Fig. 11		Feeding station at top of shore. Two sets of feeders, appear to be relatively recently used (obvious livestock tracks in mud).
46	12/08/2014	14:48	NM 50649 29128	150649	729128		LSFW05	Planned freshwater sample – Allt Achadh na h-Atha, mid-Killiemore Bay.
47	12/08/2014	14:48	NM 50649 29128	150649	729129			Observations associated with WP46 - Width 1m 10cm; Depth: 16cm; Flow; 0.636 m/s; 0.026 SD.
48	12/08/2014	14:53	NM 50829 29318	150830	729318			One grey heron observed on shore.
49	12/08/2014	15:00	NM 51163 29533	151164	729534	Fig. 12	LSFW06	Planned freshwater sample – Allt na Coille Moire, eastern end Killiemore Bay.
50	12/08/2014	15:00	NM 51164 29533	151164	729533			Observations associated with WP49. Total Width 3m 50cm; Depth1: 17cm; Flow1: 0.908 m/s; 0.032 SD; Depth2: 27cm; Flow2: 0.963 m/s; 0.032 SD; Depth3: 26cm; Flow3: 1.039 m/s; 0.056 SD. Four sheep observed just above extreme high water line.
51	12/08/2014	15:11	NM 51473 29659	151473	729659			Small stream running from forested uninhabited area. Not sampled – no habitation or livestock present.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
52	12/08/2014	15:13	NM 51554 29652	151555	729653	Fig. 13		Concrete septic tank seen at roadside with overflow pipe running offshore across beach. Pipe was 10cm diameter, cast iron. No discharge observed.
53	12/08/2014	15:17	NM 51617 29695	151617	729695			Small stream running from forested uninhabited area. Not sampled – no habitation or livestock present.
54	12/08/2014	15:19	NM 51850 29759	151851	729759			Small stream running from forested uninhabited area. Not sampled – no habitation or livestock present.
55	12/08/2014	15:21	NM 51920 29755	151921	729755			Small car park, no vehicles present. Ten sheep visible on hillside above, probably more behind crest.
56	12/08/2014	15:24	NM 51940 29732	151940	729732			Small stream running from forested uninhabited area. Not sampled – no habitation or livestock present.
57	12/08/2014	15:26	NM 52066 29641	152067	729641			Small stream running from forested uninhabited area. Not sampled. One red mooring buoy with no attached vessel in bay. End of shoreline survey section around Killiemore.
58	12/08/2014	15:48	NM 54620 29117	154620	729118	Fig. 14	LSFW07	Planned freshwater sample – Coladoir River, at A849 road bridge, slightly to south of junction with B8035.
59	12/08/2014	15:48	NM 54620 29117	154620	729118			Observations associated with WP58. Wide river, flow assessed at road bridge. Split into three sections from N to S. **Width section A):** 6.2m. Depth1: 7cm; Flow1: 0.430 m/s; 0.028 SD; Depth2: 8 cm; Flow2: 0.499 m/s; 0.021 SD; Depth3: 1m 50cm; Flow3: 0.525 m/s; 0.041 SD. **Width section B)**: 8.4m; Flow estimated using floating stick method. 20 s to cover 6m 60cm = 0.33 m/s; **Width section C):** 7m; Depth: 1m 25cm; Flow: 0.553 m/s; 0.054 SD.
60	12/08/2014	15:48	NM 54619 29116	154620	729117			Photos of river and area around bridge associated with WP58 & 59; seven sheep observed in fields next to river.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
61	12/08/2014	16:11	NM 53640 28308	153641	728309			Start of shoreline section around Aird of Kinloch headland; twenty sheep visible in field.
62	12/08/2014	16:15	NM 53373 28341	153373	728342			Disused hotel (Kinloch Hotel).
63	12/08/2014	16:35	NM 52411 28489	152411	728489	Fig. 15		West side of Aird of Kinloch. Two small houses & one caravan, forty sheep in field above shoreline.
64	12/08/2014	16:44	NM 52561 28878	152561	728878			Path taken around shoreline altered due to boggy ground. Six sheep observed above shoreline; six moorings in bay to the east, two in use (one yacht, one pleasure craft). End of survey section; end of survey day 12/08/14.
65	13/08/2014	10:42	NM 51867 26406	151868	726406			Start of survey day 13/08/14. At Pennyghael bridge for single freshwater sample.
66	13/08/2014	10:43	NM 51873 26408	151873	726409		LSFW08	Planned freshwater sample – Leidle River, Pennyghael.
67	13/08/2014	10:43	NM 51872 26409	151873	726409			Observations associated with WP66. Total Width: 3m; **Depth1**: 18cm; Flow1: 0.305 m/s; 0.036 SD; **Depth2**: 1m 50cm; Flow2: 0.420 m/s; 0.092 SD.
68	13/08/2014	10:55	NM 51842 26415	151843	726416			Five chickens above shoreline; eighty seven ducks, fourteen gulls and eight oystercatchers in river on lower shore.
69	13/08/2014	10:56	NM 51850 26443	151850	726444	Fig. 16		Concrete septic tank with 10cm diameter cast iron pipe; no discharge. Pennyghael Village Hall, tearoom and four houses.
70	13/08/2014	11:18	NM 45309 24480	145309	724480	Fig. 17		Start of shoreline survey section above Aird Fada. At Celtic Sea shore base site. Slipway, and storage shed present.
71	13/08/2014	11:27	NM 45634 24467	145635	724468		LSFW09	Planned freshwater sample – unnamed watercourse, east of Celtic Sea base site.
72	13/08/2014	11:27	NM 45634 24468	145635	724468			Observations associated with WP71 - Width: 95cm; Depth: 16cm; Flow 0.143 m/s; 0.021 SD.

WP No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
73	13/08/2014	11:31	NM 45656 24460	145657	724460			Small stream running to shore from bracken covered hillside. No habitation visible. Not sampled.
74	13/08/2014	11:41	NM 45993 24433	145994	724434		LSFW10	Planned freshwater sample – unnamed watercourse, Port nam Beach.
75	13/08/2014	11:41	NM 45994 24433	145995	724434			Observations associated with WP74 - Width: 1m 5cm; Depth: 16cm; Flow: 0.143 m/s; 0.031 SD.
76	13/08/2014	11:46	NM 46071 24472	146071	724473			Impossible to follow shoreline further on foot due to large impassable rocks and state of tide. Continued by foot along road to next sample point and observed shoreline from distance - trees running to waterline, no human habitation or activity seen.
77	13/08/2014	12:09	NM 46456 24291	146456	724291	Fig. 18	LSFW11	Planned freshwater sample – Beach River, Traigh nam Beach.
78	13/08/2014	12:09	NM 46456 24289	146456	724290			Observations associated with WP77 - Total Width 24m; **Depth1**: 15cm; Flow1: 0.422 m/s; 0.022 SD; **Depth2**: 31cm; Flow2: 0.475 m/s; 0.037 SD; **Depth3**: 32cm; Flow3: 0.362 m/s; 0.048 SD; **Depth4**: 20cm; Flow4: 0.657 m/s; 0.014 SD; **Depth5**: 25cm; Flow5: 0.702 m/s; 0.022 SD. Sixteen gulls & two ducks observed on shoreline.
79	13/08/2014	12:24	NM 46522 24183	146523	724183			End of survey section. Loch Scridain survey completed.

Photographs referenced in the table can be found attached as Figures 5-18.

Sampling

Seawater and freshwater samples were collected at the sites marked in Figures 3 and 4. A total of five seawater samples and eleven freshwater samples were collected from around the survey area. These samples represented all of the planned water samples, excluding a freshwater sample from an outlet of the Coladoir River to Loch Beg, as the water course could not be found.

Six common mussel (*Mytilus edulis*) samples were collected. Four samples were collected from the Aird Fada site, from the top and bottom of 10m dropper lines at the western end and south-eastern corner of the farm. At both Slochd Bay and Killiemore only a single mussel sample was collected from the top of the dropper lines. At Slochd Bay mussels were only present at the top of the lines. At Killiemore the dropper lines were coiled, so mussels were again only available at the top. At both Slochd Bay and Killiemore the majority of mussels sampled were juveniles (i.e. shell length between 20 – 50mm).

All samples were transferred to a Biotherm 30 box with ice packs and posted to Glasgow Scientific Services (GSS) for *E. coli* analyses. All samples collected during the survey were received by GSS within 48 hours of collection. This extended sample submission deadline was agreed prior to survey commencement. Sample temperature on arrival at GSS was between 1.8°C and 4.7°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:

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

The bacteriological sample results for the freshwater and seawater samples are detailed below in Table 2, whilst Table 3 shows the shellfish sample results.

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	*E. coli* (cfu/100ml)	Salinity (ppt)
1	12/08/14	LSSW01	NM 44977 24945	Seawater	2	35.23
2	12/08/14	LSSW02	NM 45967 24924	Seawater	1	35.59
3	12/08/14	LSSW03	NM 45347 26731	Seawater	3	34.87
4	12/08/14	LSSW04	NM 45315 26898	Seawater	17	34.69
5	12/08/14	LSFW01	NM 45382 27092	Freshwater	170	-
6	12/08/14	LSFW02	NM 45568 27076	Freshwater	160	-
7	12/08/14	LSFW03	NM 46255 26919	Freshwater	360	-
8	12/08/14	LSSW05	NM 50791 28917	Seawater	400	24.21
9	12/08/14	LSFW04	NM 50370 28851	Freshwater	720	-
10	12/08/14	LSFW05	NM 50649 29128	Freshwater	90	-
11	12/08/14	LSFW06	NM 51163 29533	Freshwater	200	-
12	12/08/14	LSFW07	NM 54620 29117	Freshwater	260	-
13	13/08/14	LSFW08	NM 51873 26408	Freshwater	60	-
14	13/08/14	LSFW09	NM 45634 24467	Freshwater	20	-
15	13/08/14	LSFW10	NM 45993 24433	Freshwater	60	-
16	13/08/14	LSFW11	NM 46456 24291	Freshwater	60	-

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref.	Type	Sample Depth (m)	*E. coli* (MPN/100g)
1	12/08/14	LSSF01	NM 45035 25008	common mussels	0 (surface)	330
2	12/08/14	LSSF02	NM 45033 25006	common mussels	10	330
3	12/08/14	LSSF03	NM 45967 24924	common mussels	0 (surface)	230
4	12/08/14	LSSF04	NM 45966 24923	common mussels	10	1100
5	12/08/14	LSSF05	NM 45265 26813	common mussels	0 (surface)	790
6	12/08/14	LSSF06	NM 50792 28918	common mussels	0 (surface)	9200

Salinity Profiles

Five CTD casts were taken during the survey at the locations where the five seawater samples were collected. Two were taken at Aird Fada shellfish farm, one from the western end and one from the south-eastern corner. Two CTDs were also taken from Slochd Bay, one from the western side, and one from the north-eastern corner. The final CTD cast was taken from the northern end of the Killiemore site.

The gathered data will be sent to Cefas as agreed previously on a separate Excel spreadsheet.

Photographs – Loch Scridain East

Figure 5: Western section of Aird Fada mussel lines. Photo looking east, and taken slightly to the west of WP 6.

Figure 6: Slochd Bay mussel lines, looking west. Photo taken from WP 21.

Figure 7: Photo of Slochd Bay, taken from WP 21. The boat was used to gain access to the shore at this location, as access via land was difficult.

Figure 8: Pier below Killiemore House, WP 29.

Figure 9: Small, un-sampled stream and shoreline on northern shore, looking S to southern shore of Loch Scridain. Taken from WP 31.

Figure 10: Killiemore mussel lines, looking west. Taken from WP 34.

Figure 11: Site of feeding troughs on shoreline at Killiemore (WP 45).

Figure 12: Allt na Coille Moire River in spate, sampled as LSFW06 (WP 49)

Figure 13: Discharge pipe below property near Killiemore, no flow present (WP 52).

Figure 14: Modern road bridge carrying A849 road over the Coladoir River. Site of LSFW07 (WP 58).

Figure 15: Two small houses and caravan above shoreline, western side of Aird of Kinloch. Grassland area with grazing sheep present to the right of image (WP 63).

Figure 16: Discharge pipe on foreshore at Pennyghael (WP 69). Building on the right hand side of photo is Pennyghael Village Hall.

Figure 17: Celtic Sea shore base at Aird Fada, with Aird Fada mussel long lines visible in background (WP 70).

Figure 18: Beach River, with A849 road bridge partially visible. Site of LSFW11 sample (WP 77).

Appendix 4

Loch Scridain CTD data
Data obtained during the shoreline survey. The locations of the casts are shown in Figure A6.1.

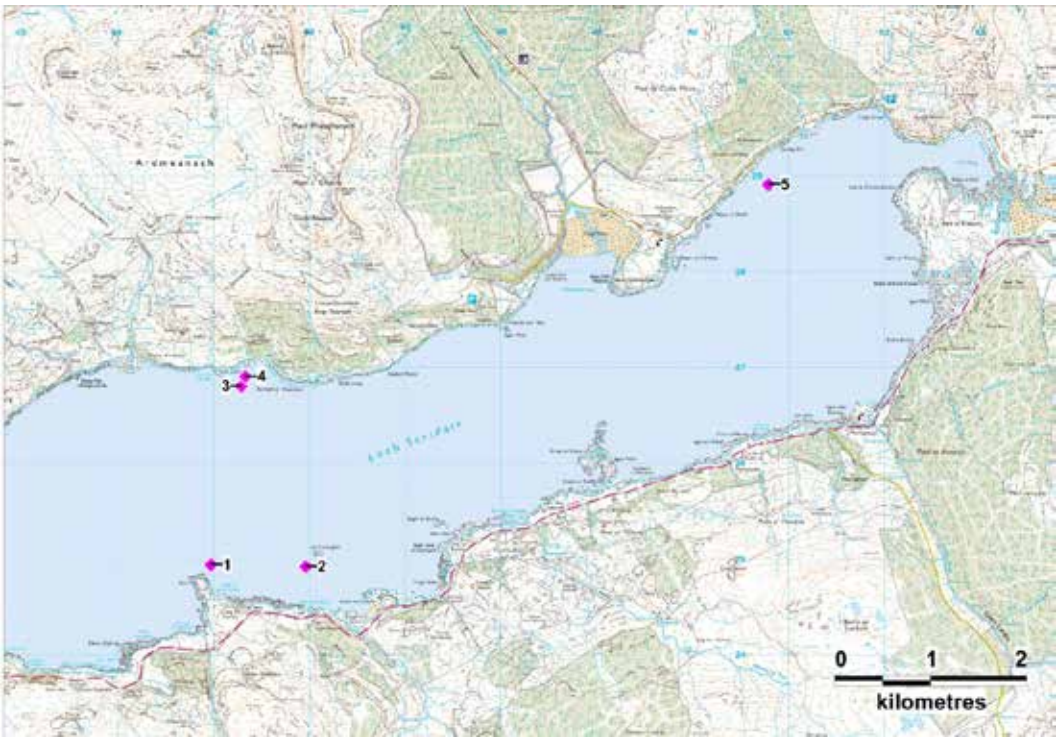

Figure A6.1 Location of CTD cast

CAST 1

Data Header

% Device	10G100653
% File name	10G100653_20140812_082629
% Cast time (local)	12/08/2014 09:26
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.3479179
% Start longitude	-6.1289776
% Start GPS horizontal error(Meter)	63.36000061
% Start GPS vertical error(Meter)	3.779999971
% Start GPS number of satellites	6
% Cast duration (Seconds)	93
% 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)
0.149053313	14.65831532	33.9531974
0.447141694	14.65823169	33.95512268
0.745236491	14.66021775	33.94638854
1.043333718	14.65866887	33.93061329
1.341434447	14.66008074	33.91216558
1.639538207	14.65892605	33.90069078
1.93764456	14.65850008	33.88565808
2.235749742	14.65798459	33.90790654
2.5338527	14.65815814	33.9024382
2.831955141	14.65807869	33.90958755
3.13005666	14.65872613	33.90786385
3.428157839	14.65822128	33.9096981
3.726257833	14.658404	33.91538768
4.024356391	14.65750772	33.9193476
4.32245511	14.6588499	33.91112428
4.620554326	14.65868345	33.91228137
4.918653138	14.65883315	33.91176621
5.216752109	14.65773223	33.9076439
5.514852114	14.65906511	33.89965617
5.812951598	14.65886516	33.90964713
6.111049004	14.65956578	33.91536762
6.409145277	14.65858491	33.91671535
6.707241648	14.65891277	33.9113613
7.005337266	14.65806631	33.92032165
7.303431156	14.65773782	33.92350166
7.601525609	14.65704081	33.91204458
7.899624401	14.65822007	33.88198911
8.197726398	14.65816651	33.88081686
8.495828841	14.65787821	33.87496148
8.78695951	14.65889362	33.85931931
0.149053313	14.65831532	33.9531974
0.447141694	14.65823169	33.95512268
0.745236491	14.66021775	33.94638854

CAST 2

Data Header

% Device	10G100653
% File name	10G100653_20140812_084830
% Cast time (local)	12/08/2014 09:48:30
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.3482901
% Start longitude	-6.113024
% Start GPS horizontal error(Meter)	2.730000019
% Start GPS vertical error(Meter)	2.900000095
% Start GPS number of satellites	5
% Cast duration (Seconds)	50.8
% 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)
0.149063748	14.65757976	33.8602132
0.447173661	14.66115638	33.85537264
0.745288865	14.65965981	33.86410702
1.043402986	14.66088075	33.86199259
1.341517252	14.65970432	33.85986878
1.639631181	14.65816297	33.86128252
1.937745265	14.66180479	33.85611441
2.235859984	14.66087863	33.85342544
2.533974307	14.66037908	33.8562859
2.832087846	14.66091764	33.85747391
3.130201438	14.66344201	33.85370493
3.428315288	14.66341789	33.85291762
3.726428418	14.66313184	33.85708004
4.024541061	14.66320829	33.8542408
4.322653722	14.66368324	33.85412003
4.620765859	14.66391753	33.85615499
4.918878106	14.66347068	33.85011785
5.216990457	14.66313706	33.85205899
5.51510222	14.66302243	33.85228051
5.715179406	14.66310859	33.84690286

CAST 3

Data Header

% Device	10G100653
% File name	10G100653_20140812_101741
% Cast time (local)	12/08/2014 11:17
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.3648247
% Start longitude	-6.1256866
% Start GPS horizontal error(Meter)	1.909999967
% Start GPS vertical error(Meter)	2.869999886
% Start GPS number of satellites	7
% Cast duration (Seconds)	72.2
% 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)
0.149080138	14.74111146	33.73419167
0.447223996	14.74798766	33.72761011
0.745374087	14.74924495	33.72879586
1.043524065	14.74993697	33.72620801
1.341673711	14.75214511	33.72960723
1.639823401	14.75453135	33.72414328
1.937973366	14.74986848	33.72355701
2.236122646	14.74852341	33.72562193
2.534271311	14.74943566	33.72595746
2.832419861	14.75162134	33.72455802
3.130568469	14.75671991	33.72451753
3.428716932	14.76043874	33.72536209
3.726865159	14.75947099	33.72442375
4.025013269	14.76294614	33.72415453
4.323161116	14.76488487	33.7253275
4.621308117	14.76404452	33.72904684
4.919457629	14.7677994	33.70078813
5.21761134	14.76990685	33.69028639
5.515761174	14.77446609	33.73426558
5.813906115	14.78063017	33.73396891
6.112050792	14.77935966	33.73503288
6.410194876	14.78059357	33.73628917
6.708338331	14.78100247	33.73814298

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
7.006482625	14.78330661	33.72661005
7.304626108	14.78415319	33.74329854
7.602766086	14.78511113	33.75542701
7.900903115	14.78511549	33.76690716
8.19903677	14.78083203	33.78137063
8.497169301	14.78143123	33.77293992
8.795300745	14.78327523	33.78879871
9.093423655	14.77167997	33.84336881
9.355551436	14.76846867	33.84179657

CAST 4

Data Header

% Device	10G100653
% File name	10G100653_20140812_102541
% Cast time (local)	12/08/2014 11:25
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.365731
% Start longitude	-6.1251062
% Start GPS horizontal error(Meter)	3.660000086
% Start GPS vertical error(Meter)	4.869999886
% Start GPS number of satellites	6
% Cast duration (Seconds)	109.6
% 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)
0.149077532	14.74574934	33.7585678
0.447215442	14.74183825	33.75585906
0.745358884	14.74253646	33.75615543
1.043501937	14.74076838	33.75607069
1.341645375	14.74194014	33.74960459
1.63978882	14.74038726	33.7529359
1.937931502	14.73922991	33.75269938
2.236074026	14.73874123	33.75092657
2.534216148	14.7399264	33.75351207
2.832358253	14.74081403	33.74871575
3.130499787	14.74100801	33.75593613
3.428641238	14.74394595	33.7473785

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
3.726782852	14.74426705	33.75243378
4.024923494	14.74434996	33.7532099
4.323063359	14.74424268	33.7563871
4.621203615	14.74664331	33.74741389
4.919343093	14.74491891	33.76055425
5.217480938	14.74494756	33.75854408
5.515617691	14.74258794	33.76669387
5.813753114	14.74208217	33.76663563
6.111887887	14.73990406	33.76879611
6.410021306	14.73756228	33.77448127
6.708152312	14.73517469	33.78604224
7.006280258	14.73147117	33.79711188
7.304404631	14.72596325	33.81238201
7.602526298	14.725146	33.81652391
7.90064674	14.72182708	33.81919474
8.198765523	14.72320664	33.82781507
8.496880998	14.72239647	33.84590443
8.794992645	14.7214324	33.85850803
9.093100279	14.72314227	33.87894973
9.485858366	14.72378319	33.887426

CAST 5

Data Header

% Device	10G100653
% File name	10G100653_20140812_131629
% Cast time (local)	12/08/2014 14:16:29
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.3866094
% Start longitude	-6.0389481
% Start GPS horizontal error(Meter)	1.720000029
% Start GPS vertical error(Meter)	2.470000029
% Start GPS number of satellites	7
% Cast duration (Seconds)	98.6
% 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)
0.149964924	14.56929078	25.82738971

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
0.449678376	14.65243125	27.62531711
0.748829899	14.80272725	30.91410153
1.047519499	14.88569297	31.78744649
1.346078019	14.89353289	32.10260163
1.644585486	14.86230599	32.23257607
1.943068765	14.86207994	32.3063221
2.241538116	14.86260032	32.35373566
2.539996845	14.86682068	32.39929288
2.838447262	14.86659665	32.42591499
3.136890933	14.86544568	32.45603611
3.435328899	14.86719197	32.47393603
3.733762971	14.8642014	32.48742049
4.032192768	14.8636584	32.50806787
4.330618019	14.86423329	32.52495768
4.629038681	14.86890469	32.54745629
4.927454224	14.87050898	32.5693422
5.225866299	14.88116205	32.57880017
5.524274019	14.88880912	32.61027814
5.822676951	14.89613717	32.62267372
6.121076478	14.90365131	32.64178357
6.41947312	14.91051477	32.64943187
6.717868202	14.91064413	32.65467567
7.016262282	14.9077303	32.65462506
7.314654986	14.90779766	32.66316561
7.61304343	14.92435578	32.69428142
7.91141035	14.95117009	32.86415676
8.209749002	14.96516445	32.95471767
8.508055239	14.96998132	33.15547175
8.806326825	14.96503334	33.2606915
9.104576385	14.9586193	33.34575722
9.40280589	14.94806957	33.43181886
9.724634285	14.94148144	33.49129066