Scottish Sanitary Survey Review

Lynn of Lorn: Sgeir Liath

AB 318-068-13

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Cefas

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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 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 2007/2008 for Lynn of Lorn: Sgeir Liath. 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 shoreline for this area was conducted in 2007.

The output of the sanitary survey included a report and a recommended sampling plan for the production area. This is 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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APPENDICES

1. PLANNING APPLICATIONS
2. SHORELINE SURVEY REPORT

Sampling Plan – Lynn of Lorn: Sgeir Liath

	2008 Report	2014 review		Changes
PRODUCTION AREA	Lynn of Lorn: Sgeir Liath	Lynn of Lorn: Sàilean Ruadh	Lynn of Lorn: Sàilean Sligeanach	Additional production area defined to accommodate planned changes to fishery. Existing area renamed to avoid confusion
SITE NAME	Sgeir Liath	Sàilean Ruadh	Sàilean Sligeanach	
SIN	AB-318-068-13	AB-318-068-13	TBD	
SPECIES	Pacific oyster			
TYPE OF FISHERY	Trestle based aquaculture			
NGR OF RMP	NM 8716 3899	NM 8716 3889	NM 8786 3980	Existing RMP maintained as in classification listing. Additional RMP defined for new production area
EAST	187160	187160	187860	
NORTH	738990	738890	739800	
TOLERANCE (M)	10			No changes
DEPTH (M)	N/A			
METHOD OF SAMPLING	Hand			
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	Area bounded by lines drawn between NM 8700 3891 and NM 8700 3902 and between NM 8700 3902 and NM 87053902 and between NM 8715 3902 and NM 8736 3902 extending to MHWS	Area bounded by lines drawn between NM 8700 3891 and NM 8700 3902 and between NM 8700 3902 and NM 87053902 and between NM 8715 3902 and NM 8736 3902 extending to MHWS	Area bounded by a line drawn between NM 8758 3973 and NM 8758 3955 extending to MHWS	Boundaries defined for new production area

1. Area Description and Fishery

Lynn of Lorn: Sgeir Liath is located on the west coast of Scotland. The location is shown in Figure 1.1.

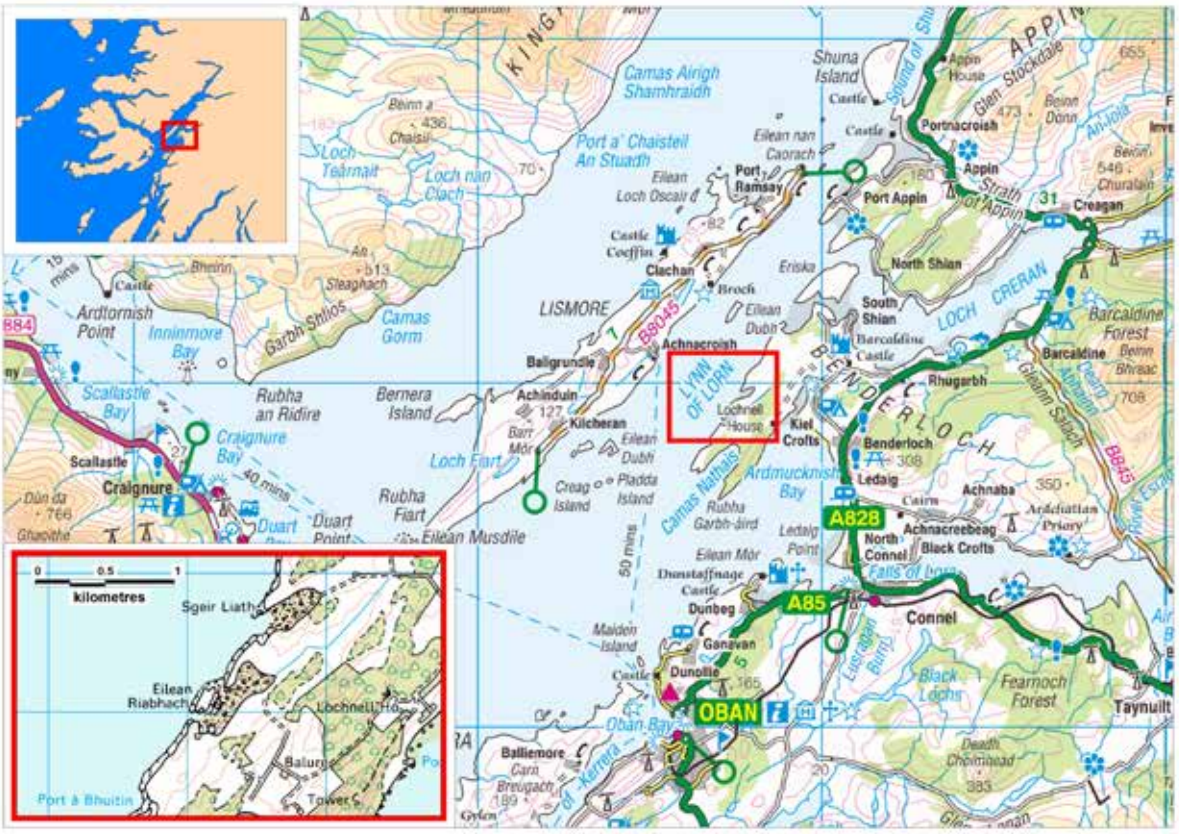

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Figure 1.1 Location of Lynn of Lorn: Sgeir Liath

The original sanitary survey report for this area was published in 2008, and based in part on a shoreline survey undertaken in 2007.The currently classified fishery at Lynn of Lorn: Sgeir Liath consists of a Pacific oyster aquaculture operation, details of which are listed in Table 1.1.

Table 1.1 Currently monitored fishery operating in Lynn of Lorn: Sgeir Liath

Production area	Site	SIN	Species	RMP
Lynn of Lorn: Sgeir Liath	Sgeir Liath	AB-318-068-13	Pacific oysters	NM 8716 3889

The 2007 shoreline survey found little in the way of oyster production. Two small areas of trestles were observed (approximately 100 m north of the production and an area located within the production area), with a total of three oyster bags. The site

had been declassified in 2006 but sampling recommenced in 2007 to support reclassification due to an intention to reinstate commercial production in 2008. It was subsequently noted by the local authority that 30-40 bags of oysters had been placed on the trestles located within the production area, but that these would not have been visible at the time of the 2007 shoreline survey as they would have been covered by water. The RMPs and production areas used in a fast track application in 2007, as well as those recommended in the 2008 sampling plan and specified in the current FSAS classification document are listed in Table 1.2. The current production area given by FSAS remains the same as that recommended in the 2008 report but the location of the RMP is slightly different.

Table 1.2 Historical and current production areas and RMPs for the Lynn of Lorn: Sgeir Liath fishery

Classification	Site	RMP	Production area
2007 Fast Track Application	Sgeir Liath	NM 8724 3919 (provisional)	Area bounded by lines drawn between NM 8769 4021 and NM 8700 3900 and between NM 8700 3900 and NM 8700 3890 extending to MHWS
2008 recommendations		NM 8716 3899	Area bounded by lines drawn between NM 8700 3891 and NM 8700 3902 and between NM 8700 3902 and NM 87053902 and between NM 8715 3902 and NM 8736 3902 extending to MHWS
2014/2015 classification listing		NM 8716 3889	Area bounded by lines drawn between NM 8700 3891 and NM 8700 3902 and between NM 8700 3902 and NM 87053902 and between NM 8715 3902 and NM 8736 3902 extending to MHWS

The 2014 shoreline survey found a large increase in the extent of the fishery and its production. There are two main areas of cultivation which lie within the production area. These are displayed in Figure 2.1. These areas were a mixture of lines of Ortac boxes (see photos in Appendix 2) and trestles, as well as individual trestles and boxes. The harvester (Mr Hamilton) stated that current stock consisted of 15,000 marketable sized oysters and 40,000 juveniles between 2 and 25 grams.

At the time of the 2014 survey, an additional 60,000 Pacific oysters and 630,000 Native oysters were being stocked in the two main cultivation areas. It was identified that the native oysters were to remain on the site until October 2014, when 620,000 of them will be transferred to a site in Jersey and 10,000 will remain for growth comparisons. The harvester intends to obtain classification for native oysters and sea urchins at the start of 2015. Of the additional Pacific oysters, the harvester intends to deploy 10,000 at Sailean Sligeanach Bay, with the others going to the southeastern side of Eilean Riabhach, within the present production area.

During the survey, the biotoxin monitoring point was observed to consist of two bags of mussels located to the southwest of the production area. A trestle consisting of five bags of oysters, two bags of mussels and a further two bags of empty cockle shells in the sand were noted at the current microbiological RMP (NM 8716 3889). The harvester stated he used the mussels and cockles for personal consumption.

The locations of trestle areas present in June 2008 and at the time of the March 2014 shoreline survey are shown in Figure 1.2, together with previous and current RMPs and the production area as given in the FSAS 2014/2015 classification document.

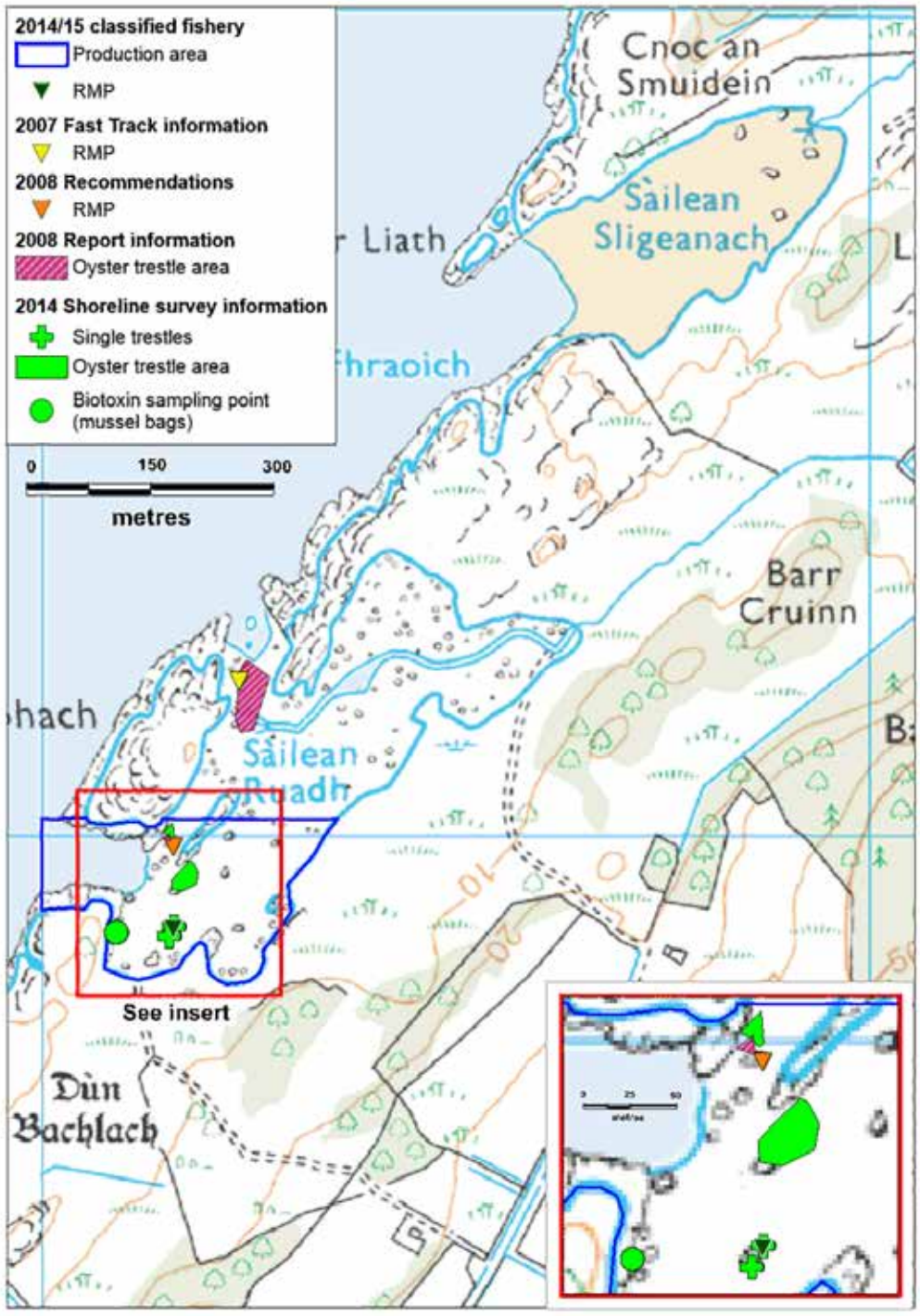

Figure 1.2 Lynn of Lorn: Sgeir Liath fishery

2. Population and Human Sewage Impacts

2.1 Population

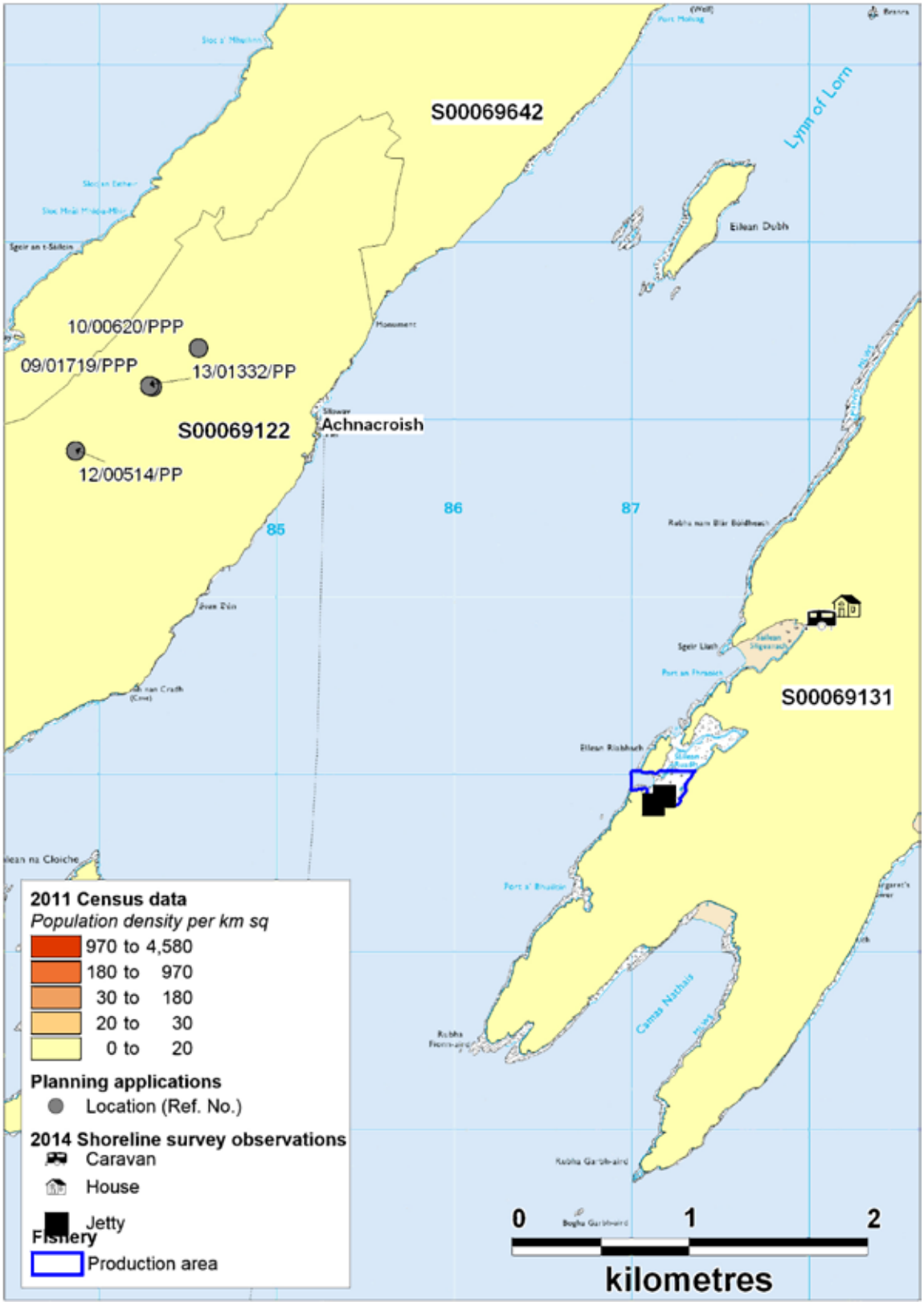

Figure 2.1 Current distribution of human population around Lynn of Lorn: Sgeir Liath

Population data from the General Register Office for Scotland from both the 2001 and 2011 censuses are shown in Table 2.1. The island of Lismore comprised one output area for the 2001 census but was split into two for the 2011 census.

Table 2.1 Scottish Government Census data for years 2001 and 2011

2001 Census data		2011 Census data	
Output area	**Population**	**Output area**	**Population**
60QD000707	94	S00069131	110
60QD000573	146	S00069122	87
		S00069642	105
Total	**240**	***Total***	**302**

Overall, the population around Sgeir Liath has increased between census years 2001 and 2011. However, the population density remains low in the three output areas, with the east area around Sgeir Liath showing a density of 10.9 persons/km^2 and the two areas on the Isle of Lismore to the west showing 6.4 and 11.2 persons/km^2 respectively.

Since the 2008 report, four planning applications were found for two areas located on the Isle of Lismore, >2 km to the west of Sgeir Liath. These applications were downloaded from the Argyll and Bute Council Planning portal (Argyll & Bute Council, 2014) in April 2014; full details are presented in Appendix 1. General locations have been inferred from the mapping information provided within individual applications and these locations are displayed in Figure 2.1.

All applications were for new dwelling houses, or extensions to houses. Two applications identified the use of a rotating biological contactor (RBC or “disc” plant) or septic tank (ST), one application identified other private drainage arrangements, such as a composting or chemical toilet, though no further information could be found on the agreed facilities, and lastly the fourth application lacked any foul drainage facility plans.

No boat traffic was reported in the 2007 shoreline survey. During the 2014 shoreline survey, three fishing vessels were noted, close to the shores of the Isle of Lismore. A small jetty by a rocky outcrop and a floating jetty were noted south of the Sgeir Liath production area, with a small boat noted onshore by the floating jetty. Two small boats, one in poor condition were also noted onshore to the northeast of the production area in Sàilean Sligeanach. The pier in Achnacroish (2 km west) is used by ferries which link the Isle of Lismore with Port Appin and Oban. Yacht traffic would be expected during the summer months as the general area is a popular cruising location (Anon., 2014). However, no estimates of seasonality and occurrence were found.

2.2 Sewage Discharges

The 2008 sanitary survey report identified that there were six consented discharges located further east of Sgeir Liath, around the Ardmucknish Bay area, over 5 km east from the Sgeir Liath fishery. One discharge pipe was observed in the Ardmucknish Bay during the 2007 shoreline survey,. The 2008 sanitary survey report concluded that these discharges were too far away to pose as a significant contamination source to the Sgeir Liath fishery.

No sewage related observations were recorded around the Sgeir Liath area during the 2014 shoreline survey. However, human waste associated with the use of the house and caravan noted in the Sàilean Sligeanach area is likely to enter the environment and may impact on the water quality in the bay depending on the treatment and discharge arrangements. The Lynn of Lorn shellfish growing water (SGW) report (SEPA, 2011) indicated that Scottish Water was consented to discharge raw sewage from the settlement of Achnacroish located 2 km west of the fishery.

The SGW report also indicated that there was a fish farm with a permitted biomass of 999 tonnes located approximately 2 km west of Sgeir Liath. Aerial photography indicated that this is located just off the island of Lismore and approximately 1 km south of Achnacroish.

Conclusions

Human sewage is not expected to have a significant impact on the Sgeir Liath fishery. However, if discharges from boats do occur then they could cause localised contamination in the area of the fishery.

3. Farm Animal Population and Agricultural Impacts

No farm census data was provided by Scottish Government for the original sanitary survey report, as there were too few farms in the relevant parishes to ensure that farm specific data could not be ascertained. The report therefore primarily considered the observations of the 2007 shoreline survey. For this review, additional information on agricultural based contamination sources has been obtained through a shoreline survey conducted in 2014. An internet search did not return any additional information on farming practices in the surrounding areas. Shoreline survey observations only relate to the time of the surveys undertaken in August 2007 and March 2014. Figure 3.1 displays the locations of farm animal related observations recorded during the 2014 survey.

During the 2007 shoreline survey, livestock feeding stations were noted on the shoreline around Saliean Sligeanach, though no livestock were there at the time of the survey. Seventy sheep and two cows were observed in Ardmucknish Bay, but this is located on the opposite side of the peninsula to Sgeir Liath.

The 2014 shoreline survey recorded 20 highland cattle and one sheep around two feeding stations on the foreshore in Sàilean Sligeanach, with cow droppings also observed to the southeast of this inlet. The cattle and sheep appeared to have easy access to the shoreline, with cow droppings also prevalent around the feeding area. No agricultural observations were made in the area immediately around the fishery.

Conclusions

Agricultural practices on land adjacent to the Sgeir Liath fishery are not expected to have altered significantly since the 2008 report. However, if the harvester follows plans to put some trestles within Saliean Sligeanach, it is expected that these oysters would be significantly impacted by contamination from the cattle on the foreshore. It should also be noted that owing to the absence of livestock on the shoreline during the 2007 shoreline survey, it is expected that the livestock may not be kept on the shoreline for the entire year. If so, this may result in seasonal differences in contamination levels.

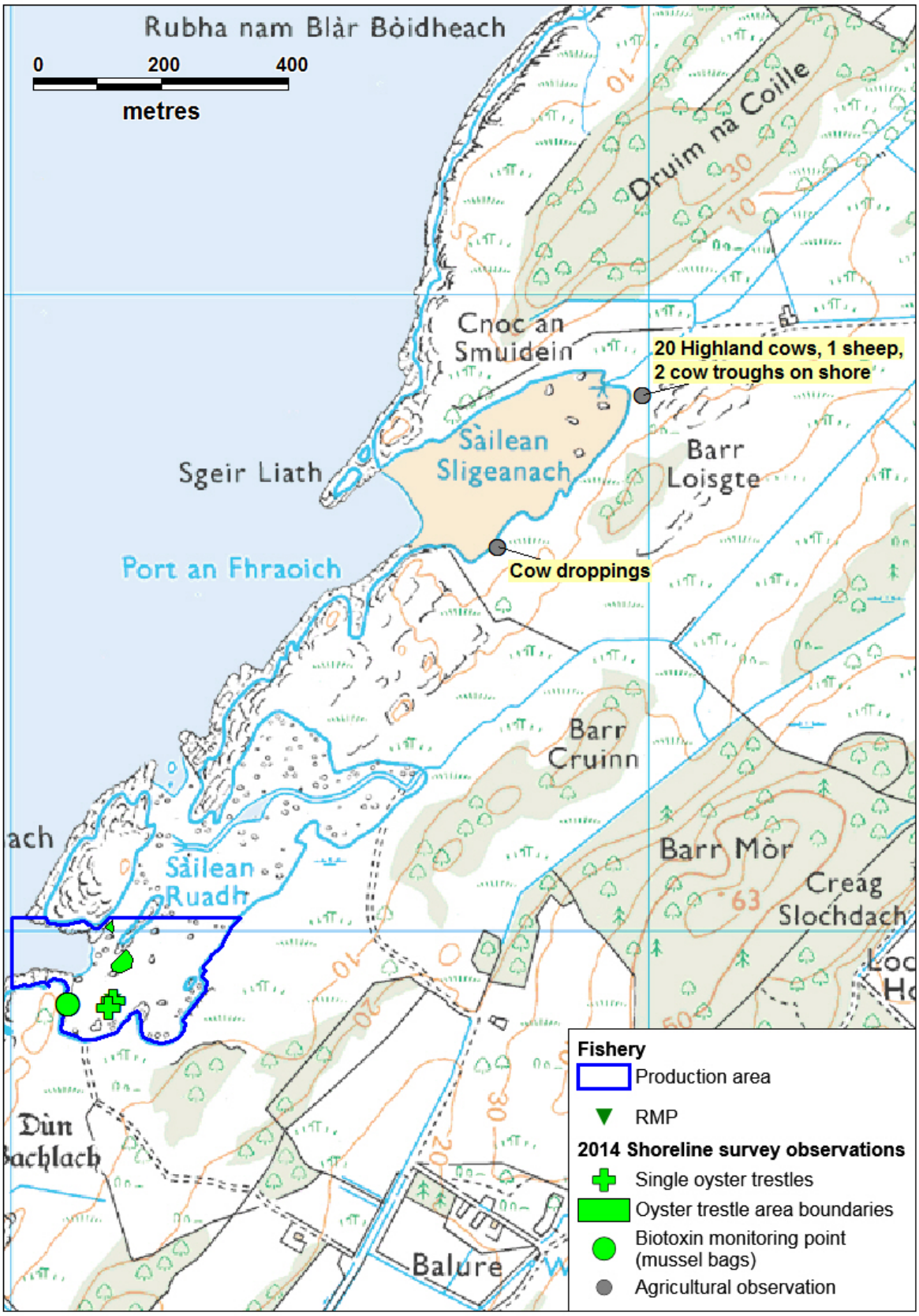

Figure 3.1 Map of farm animal and associated observations made during the 2014 shoreline survey

4. Wildlife

The 2008 sanitary survey report concluded that birds, seals, deer and potentially otters were anticipated to be the most significant wildlife contributors of faecal contamination at the oyster farm, but overall the impact from wildlife was unpredictable and would be of minor significance.

For this review, information on potential wildlife pollution sources was obtained from the JNCC collated seabird colony dataset (JNCC, 2014), 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 August 2007 and March 2014. Wildlife observations from the 2014 survey and the JNCC dataset are displayed in Figure 4.1.

Pinnipeds

A special area of conservation for common seals (*Phoca vitulina*) is located at the Isle of Lismore and is referred to as Eileanan agus Sgeiran Lios mór. It consists of five groups of offshore islands and skerries that are regularly used as haul out sites (JNCC, 2011). The Special Committee on Seals 2013 Report identified that, in August between the years of 2007 and 2012, approximately 250 common seals were observed within the Lynn of Lorn area. Over the same period up to five grey seals (*Halichoerus grypus*) were also observed on the west coast of the Isle of Lismore. The report also stated that common seal populations on the west coast of Scotland were stable between 2000 and 2010. Whilst no updates on grey seal pup production have been made since 2010, it was expected that mainland Scotland grey seal colonies would also remain stable.

Cetaceans

One sighting of a porpoise was reported to the Whale and Dolphin Trust, just at the head of the Lynn of Lorn in 2010 (Hebridean Whale and Dolphin Trust, 2014). There are also anecdotal accounts of porpoise in Loch Linnhe (Isleoflismore.com, 2012). It is therefore expected that porpoises, and potentially other cetaceans, may be present in the general area.

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 is varied, with some recorded as unknown, estimated, whilst some come from reliable detailed surveys such as those carried out for the Seabird 2000 report by Mitchell *et al*., (2004). Observations for the Eilean Dubh area, 2.8 km northwest of the fishery, are presented in Table 4.1 and displayed in Figure 4.1.

Table 4.1 Seabird data for Eilean Dubh from 2009

Common name	Species	Date	NGR	Count*	Accuracy	Qualifier
European shag	*Phalacrocorax aristotelis*	10-Jul-09	NM 8718 4184**	12	Estimate	Occupied nests
Great cormorant	*Phalacrocorax carbo*	29-May-09		13	Estimate	Occupied nests
Common gull	*Larus canus*			2	Accurate	Occupied nests
Lesser black-backed gull	*Larus fuscus*			1	Estimate	Occupied territory
Great black-backed gull	*Larus marinus*			4	Estimate	Occupied territory
Herring gull	*Larus argentatus*			121	Accurate	Occupied nests

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

**This NGR plots at the southwestern extent of the island: the area covered by the survey is not stated but has been assumed to encompass the whole island.

The island of Eilean Dubh is host to a significant breeding colony of herring gulls. Relatively small numbers of other types of gull as well as shags and cormorants also use Eilean Dubh as a breeding area, though they are present in much lower numbers than herring gulls.

Approximately 62 geese were seen in the area during the 2014 shoreline survey, with goose droppings and foot prints also noted within a riverbed at the head of Sgeir Liath. The harvester was reported as saying that geese were particularly prevalent at this site. Other birds observed included oyster catchers, gulls and pheasants, with two of the oystercatchers resting on oyster trestles.

Deer

No population data was available on deer around the Sgeir Liath fishery. However, there are anecdotal reports of deer on the Isle of Lismore (Isleoflismore.com, 2013).

Otters

There are anecdotal accounts of the European otter (*Lutra lutra*) in the Lynn of Lorn area (SeaKayakPhoto.com, 2008), but no specific information relating to the area around the fishery.

Conclusions

It is expected that the most significant contamination input from wildlife will be associated with the large numbers of geese that can be found around the intertidal area where the Sgeir Liath fishery is situated. Other birds were less common, with their contribution expected to vary spatially and temporally. Otters, cetaceans, seals and deer are also expected to contribute to background levels of contamination from time to time. Overall, the extent of contamination from wildlife is expected to have remained unchanged since the 2008 sanitary survey report.

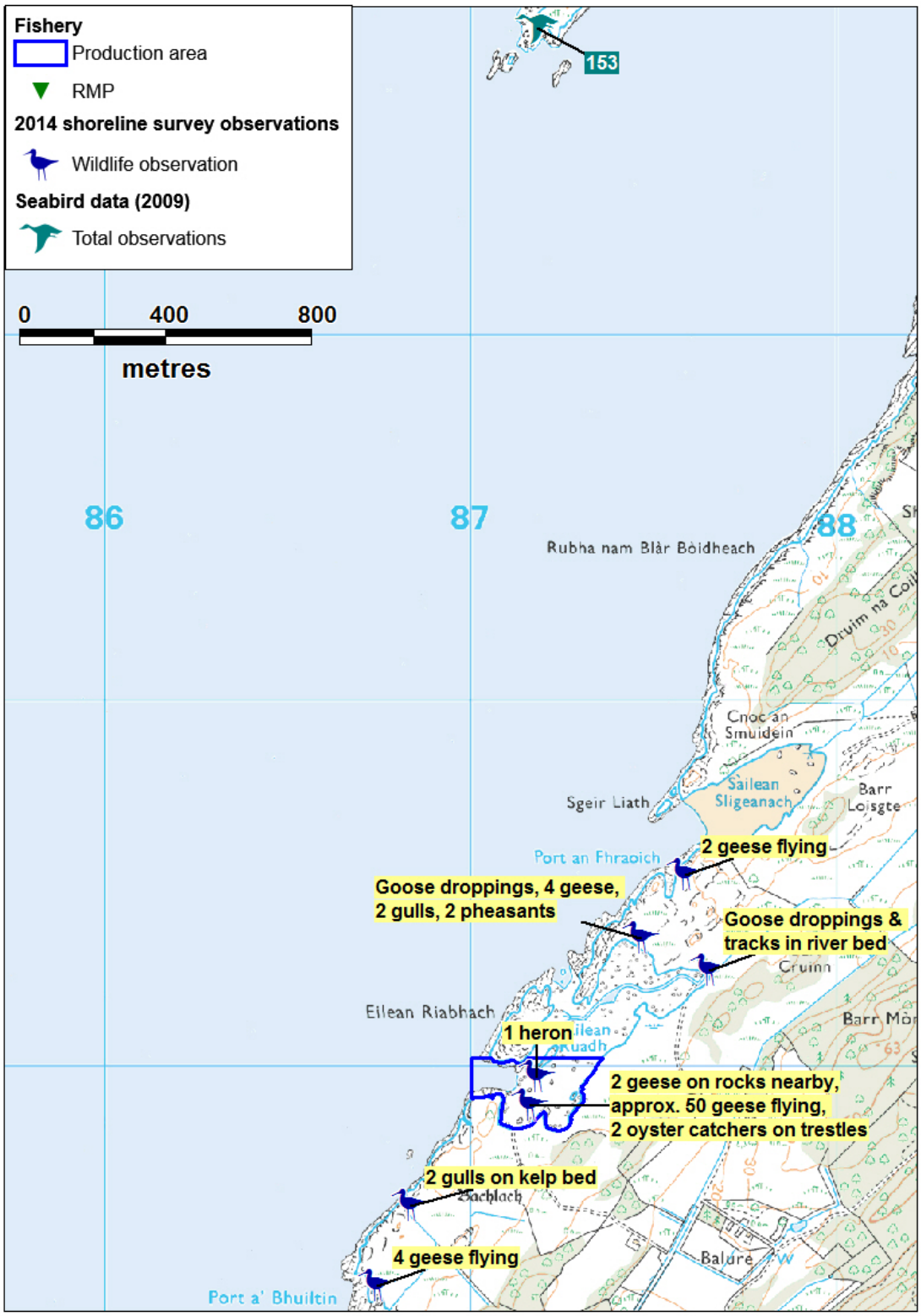

Figure 4.1 Map of wildlife around Lynn of Lorn Sgeir Liath, including observations made during the 2014 shoreline survey

5. Watercourses

There are no gauging stations on watercourses that enter into the Sgeir Liath area. The only information on watercourse flows and loadings therefore relate to the shoreline surveys undertaken in 2007 and 2014. The weather during both surveys was dry.

A comparison of watercourse loadings estimated on the basis of the 2007 and 2014 shoreline survey measurements and *E. coli* concentrations are displayed in Table 5.1. In total, eight watercourses were measured and sampled in the 2007 survey, three of which were re-sampled in 2014. Sampling locations and estimated loadings from the 2014 shoreline 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 2.

Table 5.1 Watercourse loadings to Lynn of Lorn: Sgeir Liath taken during the 2007 and 2014 shoreline surveys

No.	Description	NGR	2007 Loading (*E. coli* / day)	2014 Loading (*E. coli* / day)
1	Unnamed watercourse	NM 8765 3926	1.4×10^{9}	$<9.3 \times 10^{7}$
2	Unnamed watercourse	NM 8680 3836	$<5.2 \times 10^{8}$	$<6.2 \times 10^{6}$
3	Unnamed watercourse	NM 8798 3988	$<2.6 \times 10^{8}$	1.90×10^{10}

*These loadings were originally calculated using 50 *E. coli* cfu/100 ml, due to the original sample returning a result of <100. The values given here have been recalculated using the limit of detection, as has been doen for the 2014 shoreline survey results.

The loadings calculated for watercourses 1 and 3 differed markedly between the two shoreline surveys. At the time of the 2014 shoreline survey, the watercourse with the highest estimated *E. coli* loading was that located >1 km northwards of Sgeir Liath, at the head of the Saliean Sligeanach inlet. This area was noted to contain livestock (cattle and a sheep) at the time of the 2014 survey. It is unlikely to have a significant impact on the main oyster stock. However, it is expected to pose a significant source of contamination to trestles that were due to be installed at the Sàilean Sligeanach area in May 2014.

Watercourse No. 1, located at the head of the intertidal area where the current Sgeir Liath fishery is located, is expected to have a lower level of impact on the fishery. However, the loading estimated from the 2007 shoreline survey measurements highlight that this watercourse may at times pose a moderate contamination source to the main fishery.

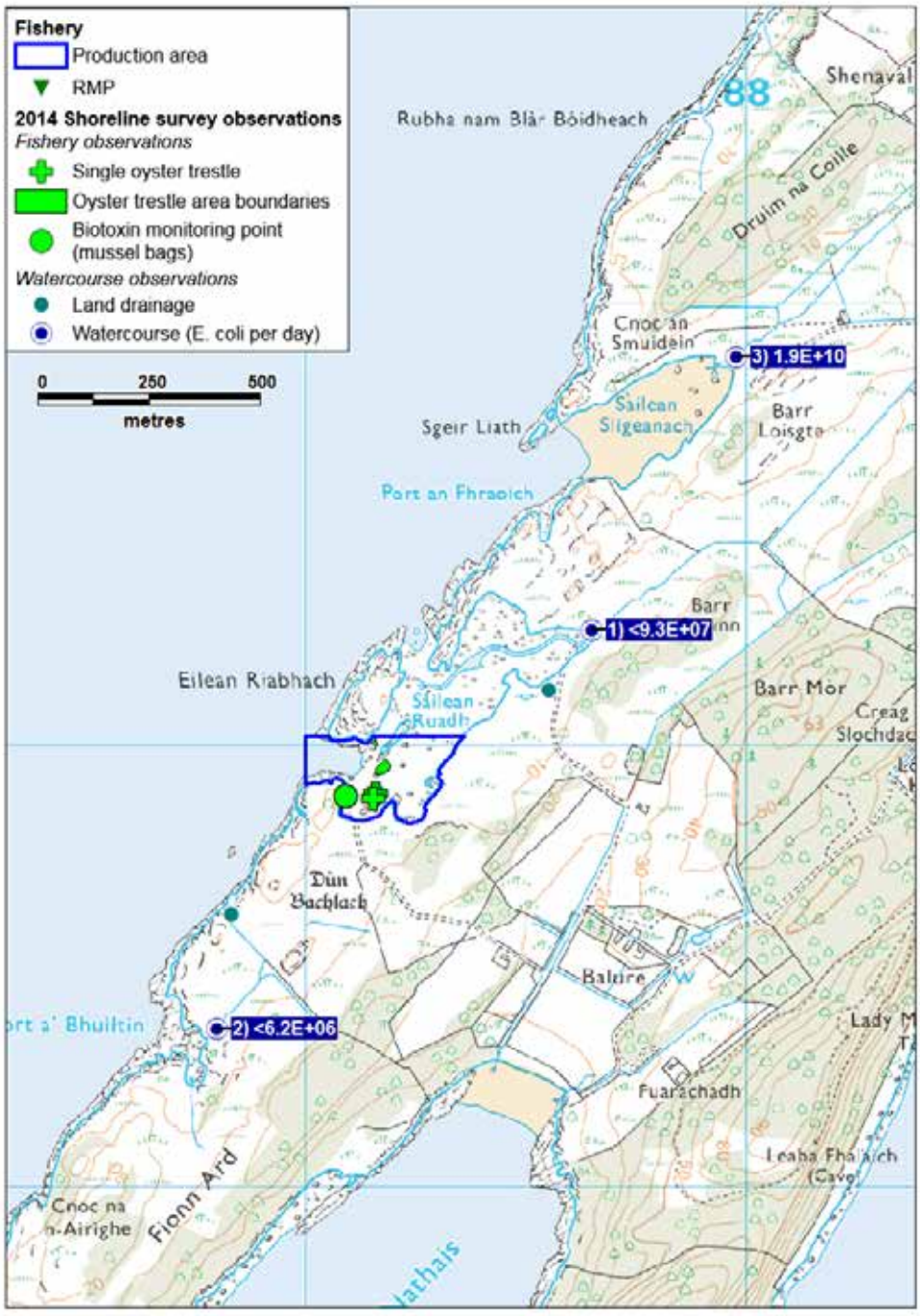

Figure 5.1 Watercourse loadings at Lynn of Lorn Sgeir Liath, 2014 shoreline survey

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 Forth Lynn of Lorn: Sgeir Liath Sanitary Survey Report. Rainfall boxplots for 2003-2006 period were presented in that report and have not been reproduced here. Rainfall was recorded in total daily rainfall (mm) were taken from the Tiree weather station, which lies 87 km west of the Sgeir Liath production area. 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 Tiree was available for 99% 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 Tiree weather station rainfall dataset for 2007-2013 is presented by year in Figure 6.1 and by month in Figure 6.2.

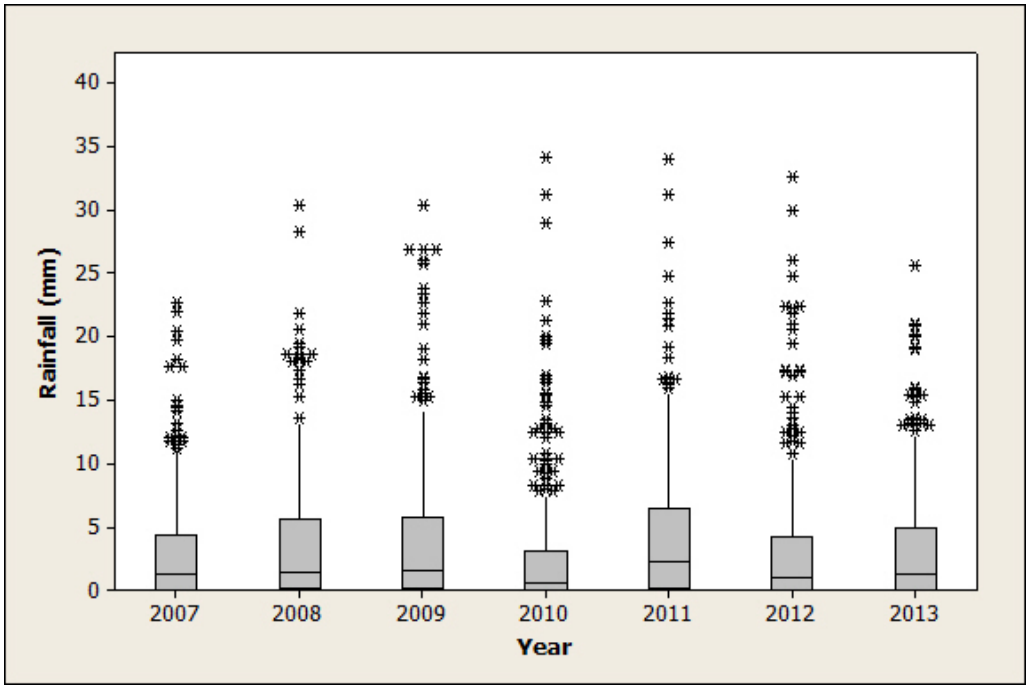

Figure 6.1 Boxplot of daily rainfall at Tiree by year (2007-2013)

The bulk of the observations remain <10 mm rainfall/day. In the 2008 sanitary survey report, rainfall exceeding 30 mm per year was identified as having occurred in 2004 and 2006, with the highest rainfall recorded >50 mm. In the present dataset, rainfall >30 mm rainfall/day occurred in five out of the seven years analysed, but no repeat episode of >50 mm/day occurred, with the highest rainfall being <35 mm/day.

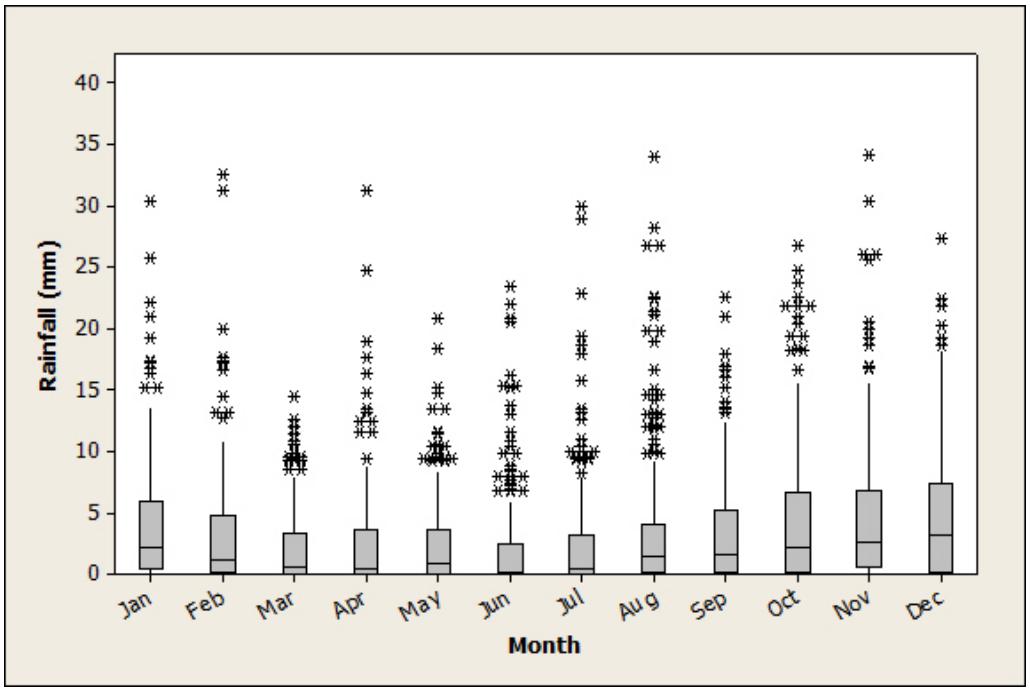

Figure 6.2 Boxplot of daily rainfall at Tiree by month (2007-2013)

In the 2008 sanitary survey report, the months of September to January were stated to be the wettest, with February and June the driest. Rainfall events >30 mm rainfall/day occurred in September and October. Figure 6.2 highlights that months October to January were the wettest in the 2007-2013 dataset, with June driest. Rainfall events of >30 mm/day occurred in January, February, April, August and November.

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 Sgeir Liath may result in differing wind patterns to those shown in the wind roses (Tiree is located approximately 87 km west of the Sgeir Liath fishery). Wind data between 1998 and 2007 was presented in the 2008 sanitary survey report allowing for comparisons with the data presented here.

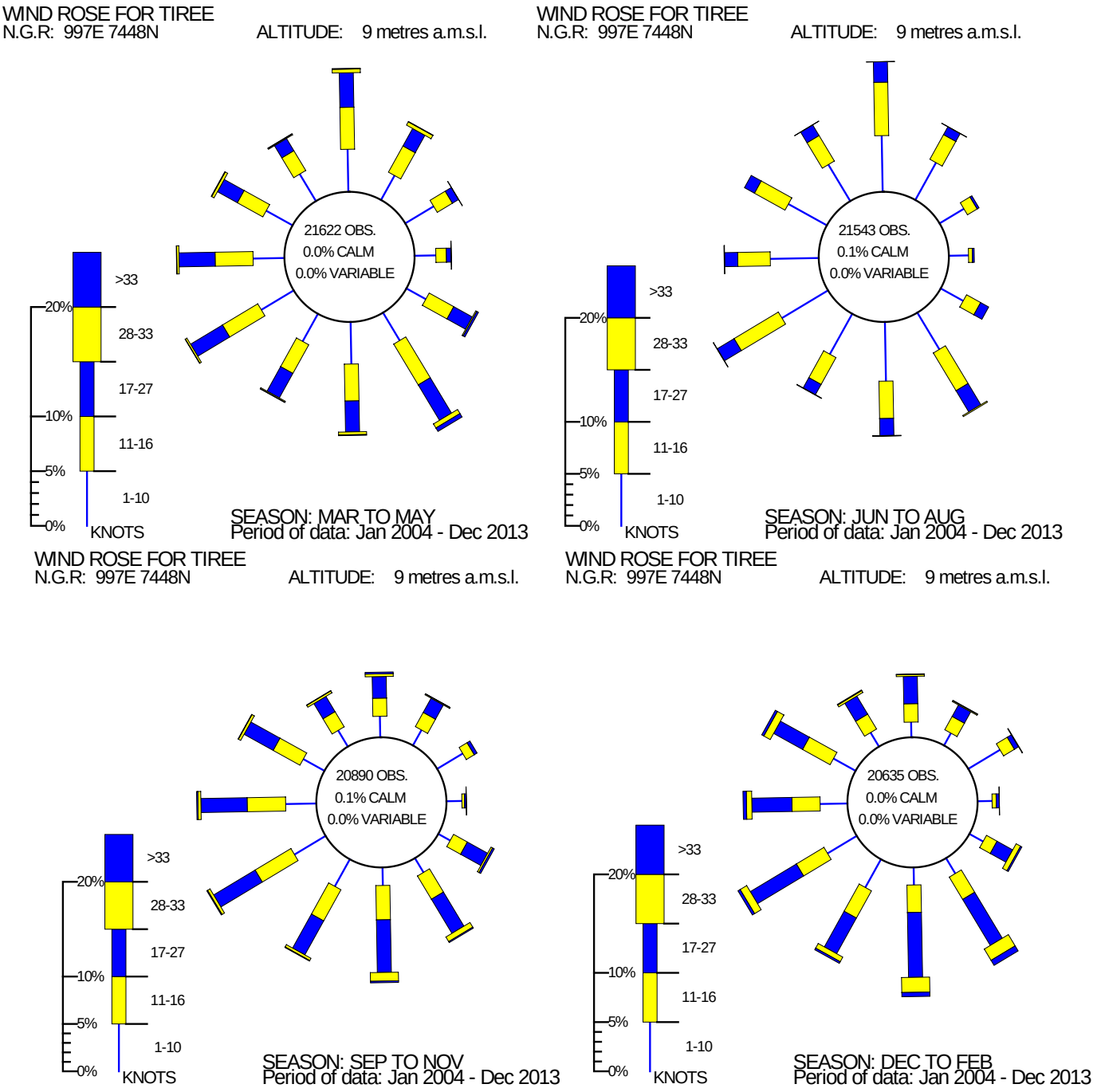

Figure 6.3 Seasonal wind roses for Tiree (2004-2013)

Prevailing winds throughout all four seasons appear to have varied between seasons. In spring and summer, highest winds were from the northerly, west-southwest and south-easterly directions, whilst in autumn and winter the northerly winds abate with west south-westerly, south and south-easterly winds prevailing. Summer has the lightest winds, whilst the strongest winds are noted in winter. There are slight variations between years and seasons, but this trend was seen in both datasets.

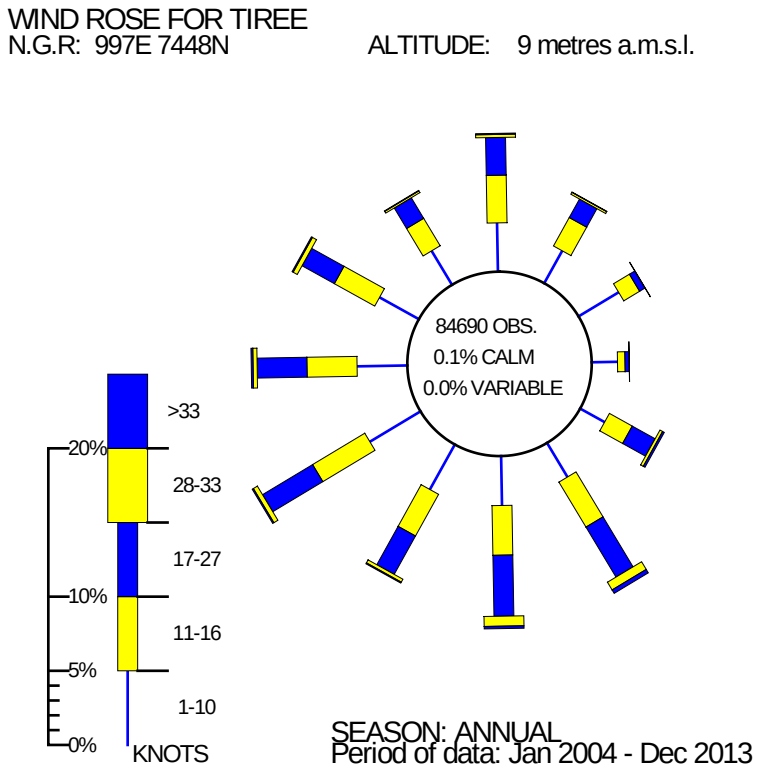

Figure 6.4 Annual wind rose at Tiree (2004-2013)

The wind rose in Figure 6.4 shows that the overall prevailing annual wind direction ranged between south-southeast and west-northwest while northerly winds also occurred over a significant proportion of the time. In the Lynn of Lorn, the local topography is likely to modify the wind direction to give a predominant southwesterly wind.

7. Historical *E. coli* Data

Results of samples assigned to the Lynn of Lorn: Sgeir Liath production area and taken between 01/01/2007 and 28/04/2014 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 from the database in April 2014. Historical *E. coli* data used in the 2007 report had already been extracted and validated. For the purposes of this report, samples pre-dating 2002 were excluded. 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 for the purposes of statistical evaluation and graphical representation.

Three samples were reported as rejected and were excluded from further analysis. A further two samples whose reported location lay >100 m outside of the production area and one sample with a void *E. coli* result were also excluded. The remaining 80 results were from samples collected and received within 48 hours of collection, with all box temperatures 8^{o}C or less.

7.1 Summary of microbiological results

Summary results for Lynn of Lorn: Sgeir Liath are displayed in Table 7.1.

Comparisons are complicated due to the large difference in numbers of samples recorded in the 2007-2014 sampling period versus the 2002-2006 period. This is partly due to the length of the two periods and the fact that no samples were taken during 2006. However, a lower proportion of results >1000 *E. coli* MPN/100 g, and no results >4600 *E. coli* were recorded in the 2007-2014 sampling period. Nearly half of the samples taken during this period yielded a result of <20 *E. coli* MPN/100 g.

Table 7.1 Sampling summary results for Lynn of Lorn: Sgeir Liath fishery 2002-2014

Sampling Summary				
Production area	Lynn of Lorn: Sgeir Liath			
Site	Sgeir Liath			
Species	Pacific oysters			
SIN	AB-318-068-13			
Location	Various			
Years	2002-2006		2007-2014	
Total no. of samples	39		80	
	2002	22	2007	6
	2003	24	2008	11
	2004	24	2009	12
	2005	8	2010	11
	2006	0	2011	12
			2012	12
			2013	12
			2014	4
Minimum	<20		<20	
Maximum	>18000		1700	
Median	110		50	
Geometric mean	121		53	
90 Percentile	860		420	
95 Percentile	2220		689.5	
No. Exceeding 230/100g	12 (31%)		11 (14%)	
No. Exceeding 1000/100g	4 (10%)		1 (1%)	
No. Exceeding 4600/100g	1 (3%)		0	
No. Exceeding 18000/100g	1 (3%)		0	

7.2 Geographical patterns of results

The locations of samples assigned to Lynn of Lorn: Sgeir Liath are displayed in Figure 7.1, with the size of symbol graduated proportional to the magnitude of the *E. coli* result. Most of the reported sampling locations lay in close vicinity to each other and no apparent pattern is evident in the locations yielding the highest results. During the 2007-2014 period, no samples were recorded as having been taken at the Sàilean Sligeanach site.

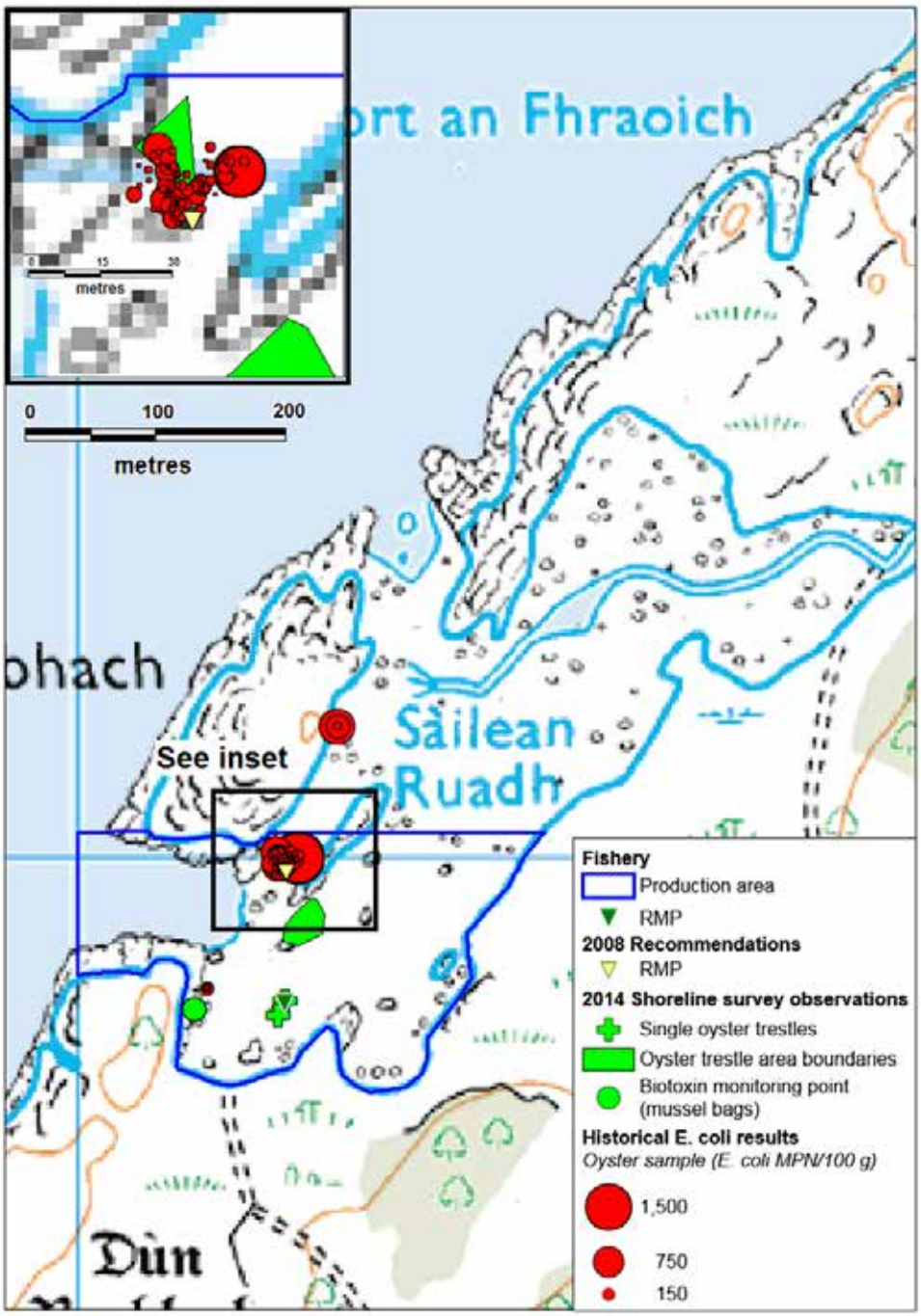

Figure 7.1 Sample results and locations from Lynn of Lorn: Sgeir Liath Pacific oyster fishery

7.3 Temporal patterns of results

The trends of *E. coli* sampling results for Lynn of Lorn: Sgeir Liath have been analysed for the years between the previous sampling period (2002-2006) 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 on the statistical software package Minitab:

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.

The temporal trend for Lynn of Lorn: Sgeir Liath is displayed in Figure 7.2, followed by results from the t-test, Chi-squared test and Fisher's Exact Test.

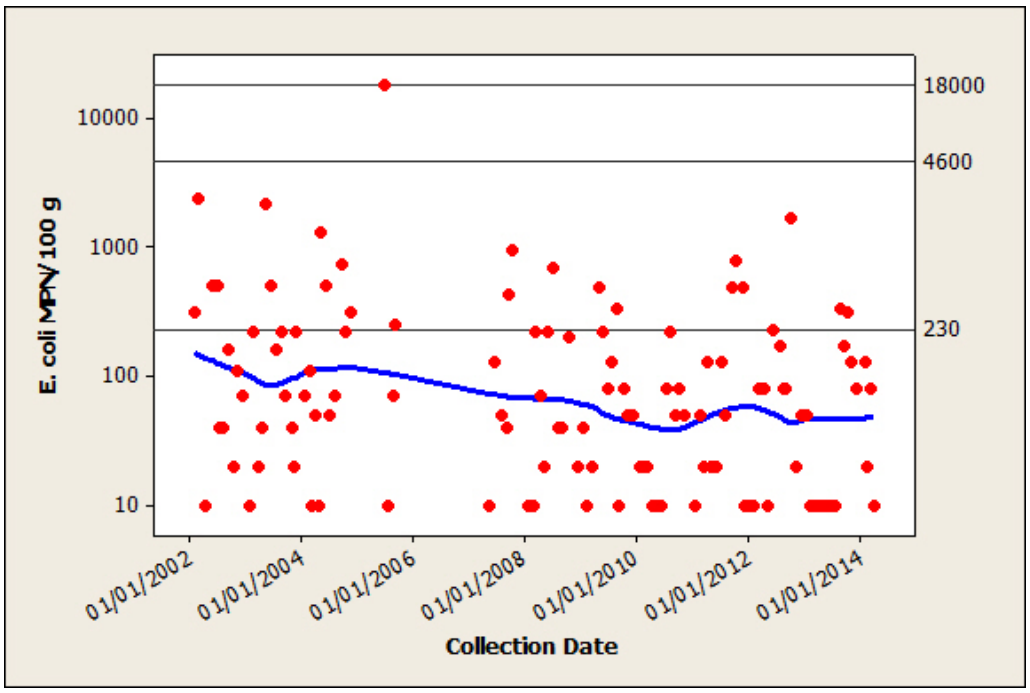

Figure 7.2Scatterplot of Lynn of Lorn: Sgeir Liath *E. coli* results by date (2002-2014), with a lowess line

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

A statistically significant difference was found between Lynn of Lorn: Sgeir Liath Pacific oyster log transformed *E. coli* results from the two survey periods (Two sample t-test, t = 2.53, DF = 62, p = 0.014).

Table 7.2 Results above and below 230 E. coli MPN/100 g and above and below 1000 *E. coli* MPN/100 g for Lynn of Lorn: Sgeir Liath

		***E. coli* MPN/100g**		**Total**	***E. coli* MPN/100g**		**Total**
		≤230	>230		≤1000	>1000	
2002-2006	Observed	27	12	39	35	4	39
2007-2014	Observed	69	11	80	79	1	80
	Total	96	23	119	114	5	119

A statistically significant difference was found between sampling results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Chi Squared Test, Chi = 4.871, DF = 1, p = 0.027).

A statistically significant difference was found between sampling results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.039).

Conclusions

The sample results are shown statistically to have decreased over the two sampling periods, with fewer results >230 and >1000 *E. coli* MPN/100 g between 2007 and 2014. This may be explained by the sampling location, as the highest results in the 2002-2006 period were taken in Sàilean Sligeanach, north of the current sampling location.

8. Movement of contaminants

The main conclusions of the 2008 sanitary survey report with respect to movement of contaminants were as follows:

- Currents are weaker at the northern end of the Firth of Lorn than the south, causing slow flushing times during ebb tides in the vicinity of the fishery
- Water is flushed completely from the fishery upon each tidal cycle
- The seabed falls away steeply from the intertidal shoreline, facilitating dilution of contaminants
- Water flows in a north-east or south-west direction depending on the tidal state
- It was unclear whether tides might transport contaminants into the production area from identified discharges located in villages to the northeast and southeast. It was deemed unlikely owing to the sea-borne distance being more than 7 km

Current meter studies were undertaken at four locations in the Lynn of Lorn in support of deployment of an artificial reef (Wilding & Sayer, 2002). These locations were situated off the isle of Lismore, to the west of the fishery.

Table 8.1 Summary current meter data for the Lynn of Lorn (from Wilding & Sayer, 2002)

Station	DirectionResidual (°magnetic)	Speed (cm/s)		
		Residual	Maximum	Mean
M1	181	2.18	32.1	4.42
M2	251	1.68	20.1	3.39
M4	230	2.48	35.9	4.73
M6	210	3.64	38.4	7.33

This indicates that the currents to be aligned with the shore. At the maximum reported speed, the estimated particle transport distance is approximately 5.5 km.

The Royal Commission on the Ancient and Historical Monuments of Scotland identifies that there is a fish trap that comprises a stony bank extending in a shallow arc across the sandy bay of Sàilean Sligeanach from the north shore (http://canmore.rcahms.gov.uk/en/site/310944/details/Sàilean+sligeanach/; accessed 17/06/14). This structure will modify the tidal flows into and out of Sàilean Sligeanach.

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

Little change is noted in potential human sewage impacts to the fishery. Although there have been population increases in the general area, the population density remains low and no sewage discharges have been identified that are expected to impact significantly on the fishery. The small amount of sewage associated with the use of a house and a caravan at Sàilean Sligeanach may impact at that site and localised intermittent pollution from boat discharges may occur.

Sources of contamination on the isle of Lismore are unlikely to impact at the fishery given the available information on currents in the Lynn of Lorn.

Agricultural impacts

The identified agricultural sources of contamination relate to cattle and sheep that frequent the shoreline at Sàilean Sligeanach, where there are two feeding stations. The feeding stations were also observed during the 2007 shoreline survey and therefore it is not expected that impacts to the fishery will have significantly changed. The presence of livestock may explain the high watercourse loading seen at Sàilean Sligeanach in the 2014 shoreline survey and also the geographical (from the 2008 sanitary survey report) and temporal (from this review) differences identified in the *E. coli* monitoring data.

Wildlife Impacts

Although additional information on the presence of geese was obtained at the time of the 2014 shoreline survey, this is not expected to constitute an actual change in the extent of contamination at the site.

Seasonal Variation

Seasonal variations are expected in the occurrence of livestock on the shoreline and the presence of wildlife, particularly birds. However, no explicit data was available to support an estimate of the extent, or timing, of such variations. Rainfall levels were highest October to January, potentially yielding a greater risk of land run-off, but high rainfall events in the summer and autumn months may result in a greater level of contamination.

Watercourses

Freshwater contamination is expected to continue to be localised. The highest impact is expected in the Sàilean Sligeanach area, which is a significant consideration in light of the proposed new trestle area at that site. Contamination

from the watercourse entering the main Sgeir Liath fishery area may continue to pose a source of contamination to that fishery.

Movement of contaminants

New information has identified that, within the Lynn of Lorn, currents are expected to broadly follow the shoreline with a maximum particle transport distance (ignoring any effect of wind) of approximately 5.5 km. Within the two intertidal areas contamination arising at, or above, the shoreline, will be taken across the fisheries on the outgoing tide. The fish trap at Sàilean Sligeanach will modify tidal movement within the bay and may result in any contamination being retained for a longer period.

Analysis of Results

Historical *E. coli* results

Historical *E. coli* results have decreased between the two sampling periods, with a significantly lower proportion of results >230 and >1000 *E. coli* MPN/100 g from 2007-2014 than from 2002-2006. This may be due to the fact that the earlier samples were taken from within Sàilean Sligeanach.

Shoreline Survey results

Both shellfish samples taken in the 2014 survey returned results of 20 *E. coli* MPN/100 g. One sample was taken near the location of the RMP recommended in 2008 and the other was taken towards the middle of the main trestle area reported in the 2014 shoreline survey. Accompanying seawater samples both returned results of 0 *E. coli* cfu/100 ml.

Three additional seawater samples returned varying results. One, taken along the coastline between Sàilean Sligeanach and Sàilean Ruadh returned a result of 5 *E. coli* cfu/100 ml, indicating background levels of contamination. The second was taken southwest of the production area, returning a result of 0 *E. coli* cfu/100 ml. Thirdly, a seawater sample taken in the Sàilean Sligeanach inlet returned a high result of 95 *E. coli* cfu/100 ml: however, this was taken from an intertidal pool and is not considered to be representative of the coastal seawater at that location.

Conclusions

The conclusions from the 2008 report indicated that the following were the main potential sources of faecal contamination to the fishery at Lynn of Lorn: Sgeir Liath:

- Agricultural sources; livestock numbers are expected to vary seasonally and be highest during the spring-summer when calves and lambs are being born.
- Freshwater loading is expected to be a significant localised impact, particularly from areas with agricultural land in their catchment area.

- The bay at Sàilean Sligeanach is likely to experience the highest levels of contamination.

Conclusions from this review are as follows:

- Agricultural sources continue to represent a significant contamination source of contamination to the fishery. Whilst impacts are expected to be low on the main fishery, they will be higher at the proposed new area of trestles Saliean Sligeanach. A moderately contaminated freshwater input enters at Sàilean Sligeanach, which is expected to be a significant contributor to contamination levels entering across the proposed new oyster trestle area.

- Sewage associated with the use of a house and a caravan at Sàilean Sligeanach may impact at that site.

- Geese and other wildlife including seabirds, deer, seals and otters are all expected to have some level of impact on the fishery, with this affecting both sites.

Therefore, faecal contamination at Sgeir Liath is expected to be low and mainly associated with wild animals. At Sàilean Sligeanach, contamination is likely to arise from wild animals, farm animals and potentially from localised human habitation.

10. Recommendations

In view of the harvester's proposals to use the Sàilean Sligeanach area, as well as the present Sgeir Liath site, and that the former is expected to be impacted by higher levels of contamination, it is recommended that the two sites be defined as separate production areas with separate RMPs. The alternative would be to have a single RMP at Sàilean Sligeanach and this could affect the classification of the existing fishery.

Lynn of Lorn: Sàilean Ruadh (presently Lynn of Lorn: Sgier Liath)

The promontory named Sgeir Liath is located on the northern side of Sàilean Sligeanach. It is therefore recommended that the present production area is renamed Sàilean Ruadh in order to avoid confusion. It is recommended that the production area boundaries RMP and tolerance remain as defined at present.

Production area: Area bounded by lines drawn between NM 8700 3891 and NM 8700 3902 and between NM 8700 3902 and NM 8705 3902 and between NM 8715 3902 and NM 8736 3902 extending to MHWS.

RMP: NM 8716 3889

Tolerance: 10 m, as the samples will be hand-picked from trestles

Depth: Not applicable

Lynn of Lorn: Sàilean Sligeanach

The recommended production area boundaries encompass the intertidal area at this site.

Production area: Area bounded by a line drawn between NM 8758 3973 and NM 8758 3955 extending to MHWS.

RMP: NM 8786 3980

The location and extent of the new trestles is not known. If the location of the recommended RMP does not fall on the trestles, then one or other of the following approaches is recommended:

a. A trestle be placed at the RMP location for the purposes of sampling. Any new stock placed on that trestle should be *in situ* for at least two weeks prior to sampling to ensure that it has taken on the microbiological characteristics of the location.

b. A new location be identified that does fall on the trestles and that is the nearest in a straight line to the recommended location.

Tolerance: 10 m

Depth: Not applicable

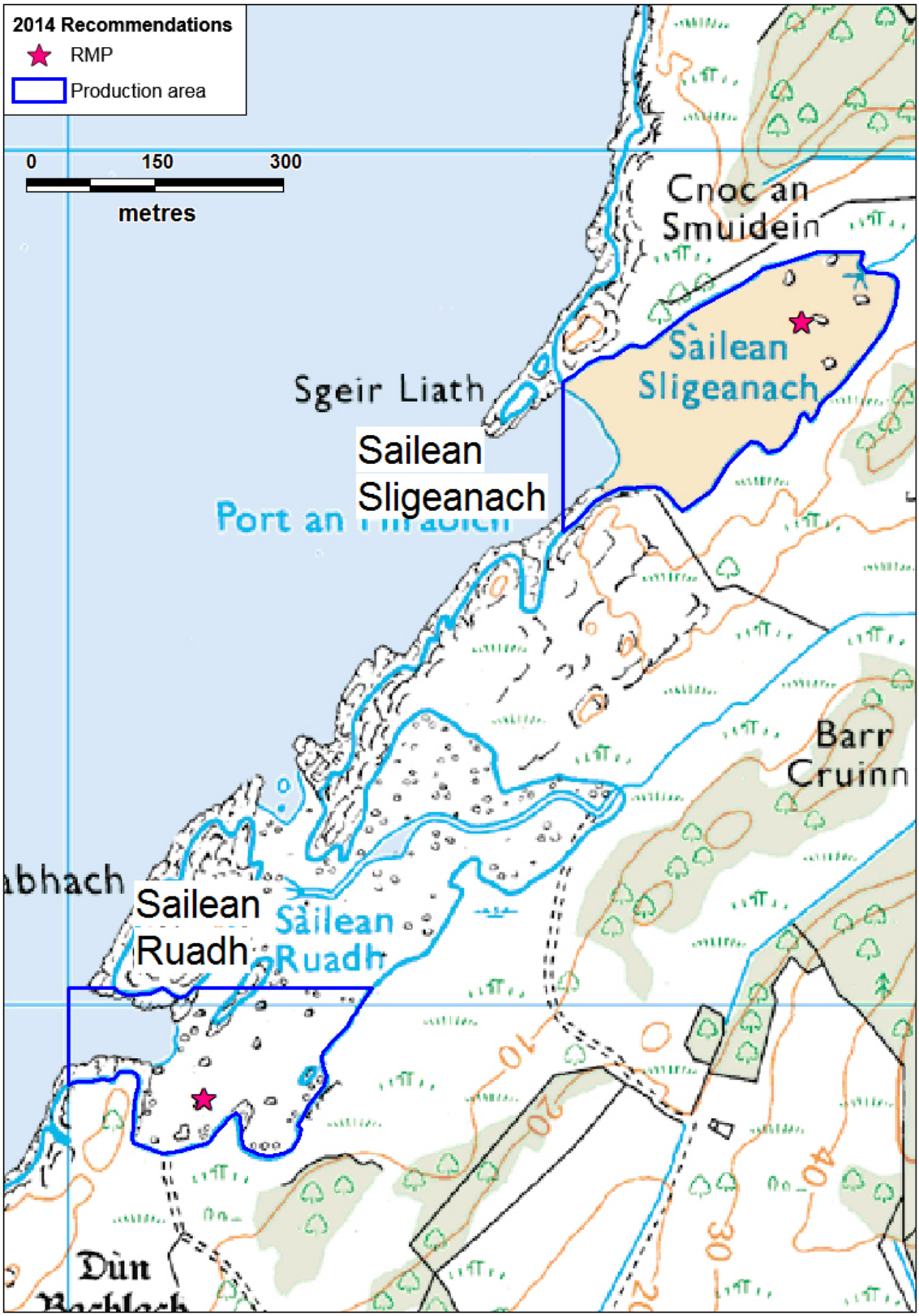

Figure 10.1 Recommended production area boundaries and RMPs for Lynn of Lorn: Sàilean Ruadh and Lynn of Lorn: Sàilean Sligeanach

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12. List of Figures and Tables

Appendices

1. List of planning applications
2. Shoreline Survey Report 2014

Appendix 1

Planning Applications

Planning applications expected to change the human population and overall faecal loading to Lynn of Lorn: Sgeir Liath is listed in Table 1.

Table 1 Planning applications to the areas Baligrundle and Achnacroish

Ref. No.	Date	NGR	Description	Sewage provisions
Baligrundle				
12/00514/PP	05-Mar-12	NM 8387 4083	Alterations and erection of a single storey extension to the existing dwellinghouse	None stated
Achnacroish				
09/01719/PPP	13-Nov-09	NM 8430 4119	Site for the erection of a dwelling house	Single ST / biodisc
10/00620/PPP	15-Apr-10	NM 8456 4141	Site for erection of dwelling house - renewal of consent 07/00481/0UT	Single ST / biodisc
13/01332/PP	17-Jun-13	NM 8428 4119	Erection of a dwellinghouse and detached garage	Other private drainage arrangement: chemical toilet or composting toilets

Appendix 2

Shoreline Survey Report

Report Title	Lynn of Lorn Shoreline Survey Report
Project Name	Shellfish Sanitary Surveys
Client/Customer	Cefas
SRSL Project Reference	00561_B0067

Document Number	B0067_Shoreline 0028

Revision History

Revision	Changes	Date
A	Issue for internal review	08/04/2014
B	Second version for internal review/approval	23/04/2014
01	First formal issue to Cefas	25/042014
02	Second issue to Cefas incorporating comments and correction from Issue 01	09/05/2014
03	Third issue to client	12/05/2014
04	Fourth issue including clarifications from harvester	03/06/2014

	Name & Position	Date
Author	Colin Abernethy, Andrea Veszelovszki	08/04/2014
Checked	Andrea Veszelovszki	12/05/2014
Approved	Andrea Veszelovszki	03/06/2014

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

Production area:	Lynn of Lorn: Sgeir Liath
Site name:	Sgeir Liath
SIN:	AB-318-068-13
Species:	Pacific oysters
Harvester:	Mr John Hamilton
Local Authority:	Argyll and Bute Council
Status:	Existing area/Survey review
Date Surveyed:	31-March-2014
Surveyed by:	Colin Abernethy, Andrea Veszelovszki
Existing RMP:	NM 8716 3899

Area Surveyed

The shoreline from the top of Sàilean Sligeanach bay to the small bay by Port a' Bhuiltin.

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

Weather

There was no rainfall recorded in the 48 hrs prior to survey.

On the day of the survey the weather was dry and mostly sunny with some clouds and haze. Temperature ranged between 9 to 11 degrees Celsius with wind speed of F3-4 of easterly direction. Sea state: slight to slight-moderate.

Stakeholder engagement during the survey

Prior to survey, during the preparation both the harvester, Mr Hamilton, and the local sampling officers, Mr Fraser Anderson and Mr Ewan McDougall, were very helpful and provided information.

On the survey day the team met up with the harvester, Mr Hamilton, on-site and he provided further detailed information about the site's past and future, and current, ongoing works.

Unfortunately Mr McDougall was not available to meet the team on-site, during the survey.

Fishery

The fishery at Sgeir Liath is an oyster fishery cultivating Pacific oysters (*Crassostrea gigas*), currently at two main locations or in two fairly distinct clusters within the production area, the two are being close to one another (Figure 2).

Mr Hamilton has owned this site for 10 years, with substantial work being undertaken at the moment to increase the size of the production site and the number of stock. The current or original stock is made up of about 15,000 *C. gigas* of marketable size and about 40,000 of the size of between 5-25 grams. These can be found at both locations.

As the production area is currently undergoing extension, there is also an additional 630,000 native oysters, *Ostrea edulis* and 60,000 Pacific oysters, *Crassostrea gigas* are in the process of being added to the site(s). Out of these, the *O.edulis* will remain on site until October 2014 when they will be taken to another shellfish growing area on Jersey, with the possibility of keeping 10,000 on site for direct comparison of growth to the Jersey stock. The *C. gigas* will remain on the site for another 2-3 years.

The harvester confirmed plans for an additional 30,000 *C.gigas* (size 6-8 mm) and 10,000 *O.edulis* (size 2-6 mm) also to be introduced to Sàilean Sligeanach Bay. These are most likely to be added somewhere to the inner shore of the bay in May 2014. He is planning to keep them there for about two years to see how they grow in comparison with other areas.

A further four trestles are also to be added in the north end of the bay at Eilean Riabhach, where there is one trestle at present (mentioned in waypoint (WP) 28).

The remainder of the newly arriving 60,000 of *C. gigas* will be kept at the main site.

The reason for splitting the stock was explained by the assumed and expected different growth rates at the different locations both within the production area and out with the production area at present, and also to compare growth rates of local stocks with stocks growing at the Jersey site.

The site is currently classified for the production of *Crassostrea gigas* with additional classification for production of *Ostrea edulis* planned starting next year with the additional application for spiny sea urchins.

There are some *Ostrea edulis* on site at the moment, however they are currently not of harvestable size.

Mr Hamilton informed us that his production area would be part of a UK wide Coastal Communities Fund initiative, including around 40 farms, looking at introducing upwards of 200,000 native oysters (*O. edulis*) on each site.

Sewage Sources

The shellfish farm lies off a bay approximately 2.5km to the west of Ardmucknish Bay, the section of shore is largely uninhabited.

With site expansion into Sàilean Sligeanach Bay planned for this year, the cottage shown in Figure 3 will be within 200 meters of the proposed expansion area.

Shenavallie farm to the north, Balure and Lochnell House are situated to the south and east of the fishery, respectively, all within a 1-1.5km radius of the production area.

The surveyed shore was largely undisturbed from its natural state beyond its use as a production site, with no evidence of sewage outflows discovered during the survey.

Seasonal Population

Tralee Bay Caravan Park is situated approximately 2.5km to the east of the production area. Shenavallie farm offers B and B accommodation northeast of the production site. The Isle of Eriska Hotel is located about 5 km north of the production area and the village of Benderloch is approximately 4km east of the site, this was not visited as part of the survey.

Boats/Shipping

On the day of the survey two small fishing vessels were observed out towards the island of Lismore, west/northwest of the production site.

Two small boats were observed (WP 7) lying on the shore, one of which was damaged and not sea-worthy.

A small jetty was observed (WP 20); no boats were situated around it.

A floating jetty and small boat were on ground beside the shore at the south end of the production area (WP 38 and Fig 13).

Farming and Livestock

The local farmer from Sàilean Sligeanach Cottage has approximately 20 Highland cattle grazing/being fed permanently on the area around this bay, with cow excrement in evidence on grassy areas above the shoreline and around the watercourse running to the shore at waypoints 52 and 53.

A sheep was also seen grazing around Sàilean Sligeanach bay at the north of the survey area (WP 4) with a mound of manure just behind the animals, about 10 metres from the shore.

No further livestock were observed but geese and sheep droppings were found at various points on the survey and waypoints were taken to document these (Table 1).

Land Use

The grassland around the northern end of the survey route is, as mentioned above utilised for grazing of livestock (Fig 4).

Other grazing lands can also be found in the area with Shenavallie farm located to the northeast and Lochnell House and its grounds lie to the east of the production area.

Land Cover

The shore itself is comprised of steep slippery rock, with many sections impassable and it was necessary to bypass these on the day of the survey.

The land directly surrounding the survey area is a mixture of unutilised uneven tussock grassland and patches of natural forest.

Watercourses

Five unnamed watercourses were displayed on the survey map, out of which four were required to be sampled during the survey Three of these were observed and sampled successfully, (WPs 52, 47 and 15) with one of the planned sampling points found to have no established flow or no obvious signs of any flow at all (WP 45, Fig13-14). There were no other watercourses observed during the survey.

Wildlife/Birds

Many geese (>50) were observed throughout the survey and further evidence of them (droppings and tracks) were also observed. Due to this heavy presence of geese at and around the production area the harvester Mr Hamilton is also trying to negotiate with SNH to get permission to cull or to use bird scarers to keep the birds away.

Oyster catchers, seagulls, pheasants and a heron were also observed along the survey route.

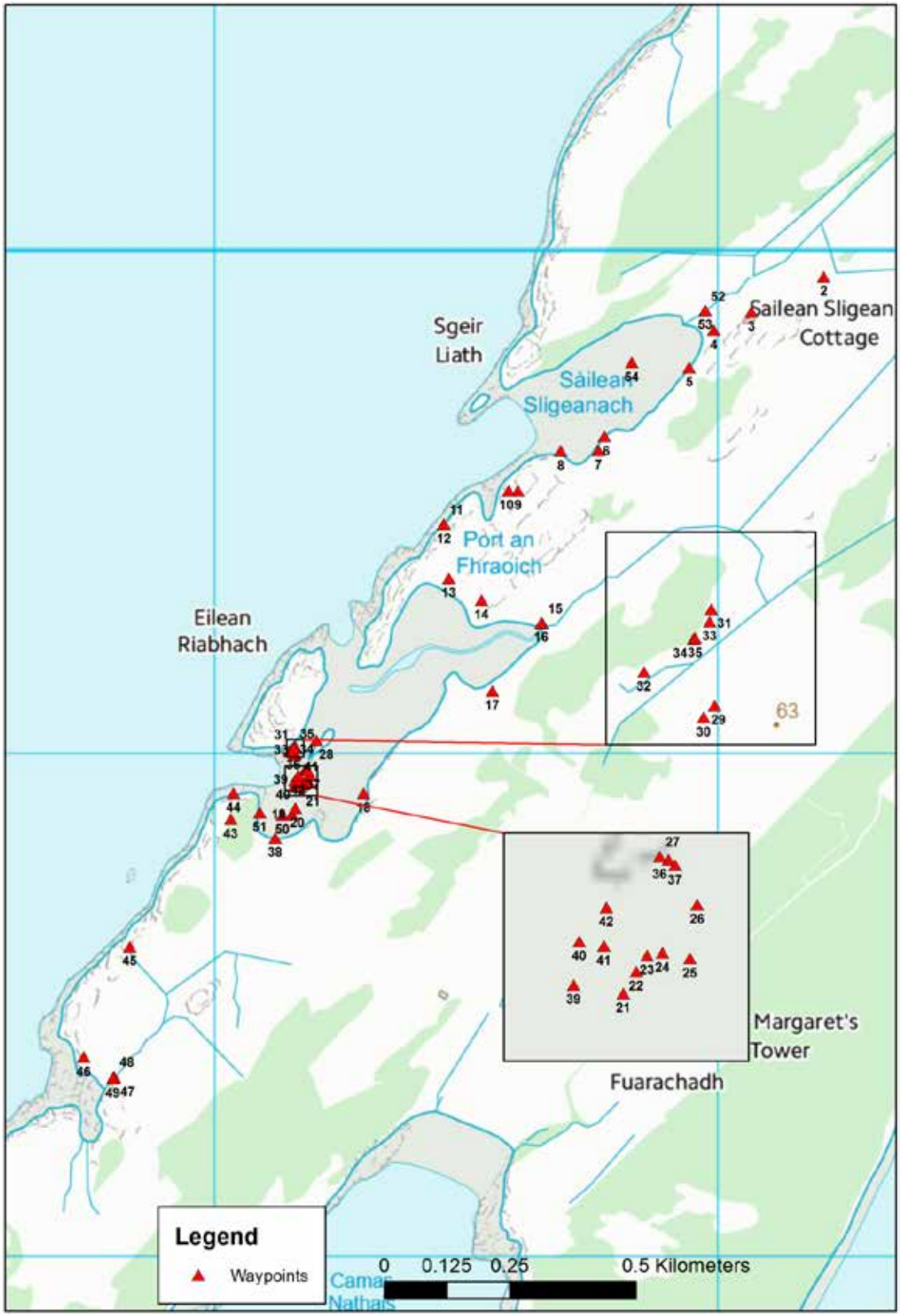

Figure 1. Lynn of Lorn waypoints

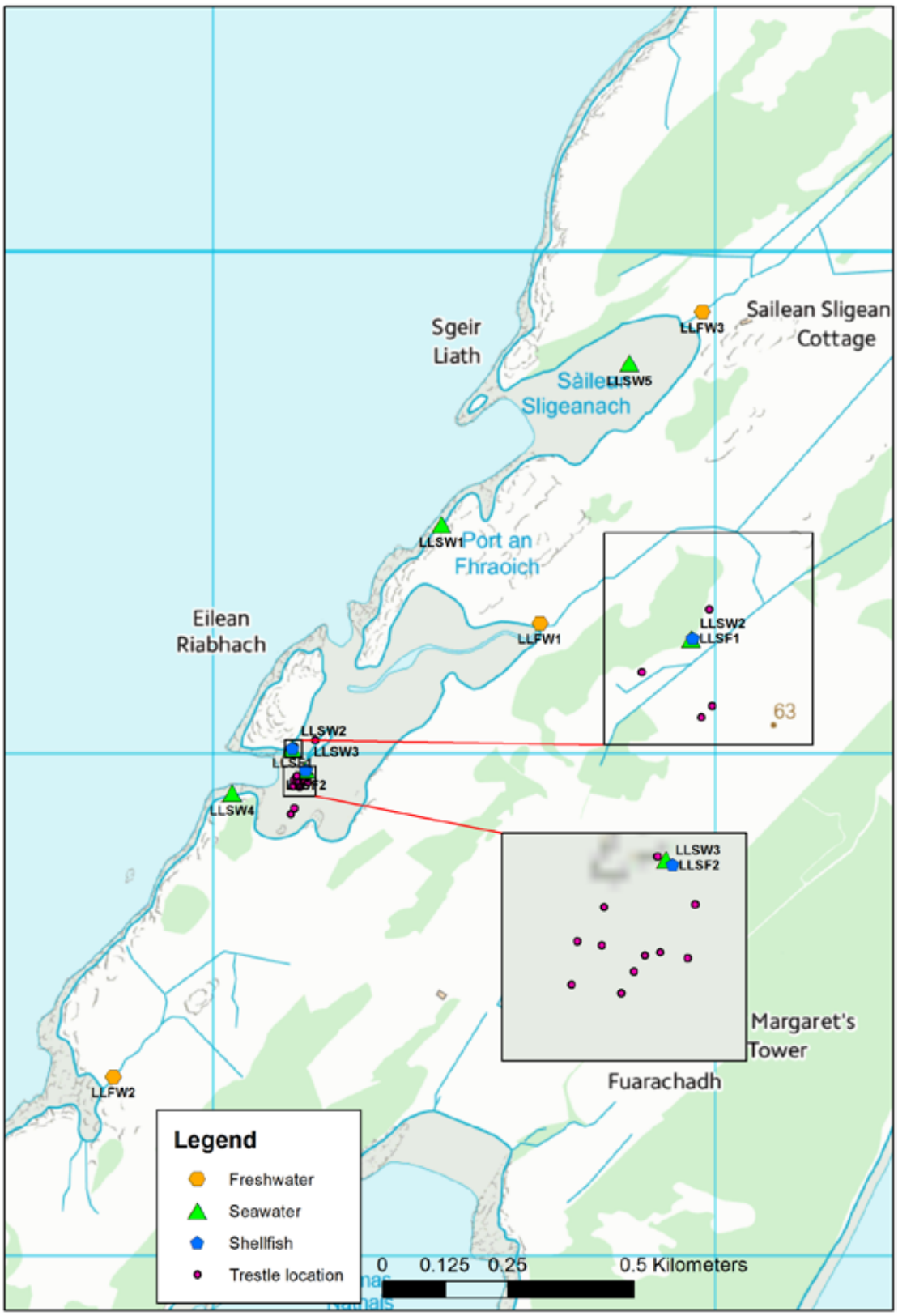

Figure 2. Lynn of Lorn samples

Table 1 Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	31/03/2014	9:50	NM 88508 39971	188509	739971			Start of survey. No immediate access to start of survey route.
2	31/03/2014	9:56	NM 88209 39947	188210	739948	Fig 3		Small cottage (Sàilean Sligeanach Cottage) on the side of the road near the start of the survey route.
3	31/03/2014	9:59	NM 88066 39877	188066	739878			Caravan approx. 60 metres from shore.
4	31/03/2014	10:04	NM 87991 39841	187991	739841	Fig 4		Start of survey route. Twenty Highland cows and one sheep just above shoreline. Two feeders for cows on shore. Tide is dropping.
5	31/03/2014	10:08	NM 87943 39767	187943	739767			Steep shoreline, walking along level covered at high tide. No passable terrain higher above shore.
6	31/03/2014	10:18	NM 87774 39630	187774	739630			Steep, slippery shore. Difficult underfoot.
7	31/03/2014	10:20	NM 87762 39602	187763	739603			Small inlet, two boats one of which is damaged, lying just above shoreline. No watercourses visible. Cow droppings on ground above shore.
8	31/03/2014	10:25	NM 87687 39601	187687	739601			Unsafe to continue on steep and slippery rocks on shoreline.
9	31/03/2014	10:30	NM 87602 39522	187603	739522	Fig 5		High fence set back above shoreline. Climbing over it was necessary to continue survey.
10	31/03/2014	10:31	NM 87584 39522	187584	739522			Small inlet with no signs of watercourses. Two geese flew by.
11	31/03/2014	10:41	NM 87455 39455	187455	739456		LLSW1	Planned seawater sample taken. LLSW1
12	31/03/2014	10:42	NM 87455 39455	187456	739456			General observations of sampling location: Slippery rocks with poor access to sampling site. Small fishing vessel sailing southwards on the east side of Lismore.
13	31/03/2014	10:48	NM 87465 39348	187465	739348			Multiple geese droppings on grass above shore. Four geese, two gulls and two pheasants around.
14	31/03/2014	10:50	NM 87530 39304	187531	739305			Large buoy on grass above shore. Other scattered rubbish around. A pheasant call heard from undergrowth.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
15	31/03/2014	10:54	NM 87650 39259	187651	739259	Fig 6	LLFW1	Planned freshwater sample LLFW1 from un-named watercourse at north end of Sàilean Ruadh bay, north of production area. Sample associated with observations at waypoint 16.
16	31/03/2014	10:55	NM 87649 39260	187649	739260			Watercourse measurements - Width: 3 m; Depth: 10cm; Flow: 0.036 m/s; SD: 0.003. Geese droppings and geese tracks in river bed.
17	31/03/2014	11:03	NM 87552 39124	187552	739125			Small watercourse trickling towards shore, almost stagnant. Depth approx. 1cm; Width: ~30 cm, no flow measurement possible.
18	31/03/2014	11:10	NM 87296 38920	187296	738921	Fig 7		Northeast side of production area. Fishing vessel across at Lismore. A trestle in small bay north of main trestle site. Photo taken from here to show the general layout of production area with trestles. No trestles located at this location.
19	31/03/2014	11:31	NM 87153 38879	187154	738879	Fig 8		A trestle with twenty bags of oysters (6-10cm) closest to the south shore of production area. Photo also taken of general view of production area from south end of bay.
20	31/03/2014	11:32	NM 87160 38891	187161	738891			Trestle with seven bags, 5 with oysters and 2 with mussels. Two bags of empty cockle shells in sand. The harvester indicated that he kept mussels and cockles for personal consumption. Two geese on rocks nearby. Approx. 50 geese flying by, 2 oyster catchers on or near to trestles. Small jetty on outcrop to the southwest of site, no boats around.
21	31/03/2014	11:35	NM 87170 38932	187171	738933	Fig 9		Corner of trestles with new Ortac oyster growing box system. Sixteen trestles in this area with an average of 20 boxes per trestle.
22	31/03/2014	11:38	NM 87173 38938	187174	738939			Trestle boundary.
23	31/03/2014	11:39	NM 87176 38942	187177	738943			Trestle boundary.
24	31/03/2014	11:39	NM 87180 38943	187181	738944			A trestle located about 5 metres from this waypoint. Not possible to access as water was still high. The trestle was kitted with older but same system of boxes. Behind this further to the west was another older trestle with bags.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
25	31/03/2014	11:41	NM 87187 38942	187188	738942			Waypoint taken in the middle of three trestles, one with new boxes, two with old boxes containing oysters about 5 cm in size.
26	31/03/2014	11:43	NM 87189 38956	187190	738956			Northeast corner of trestles site 1. Trestles were about 7 m away from waypoint.
27	31/03/2014	11:44	NM 87180 38968	187180	738969	Fig 10		Corner of trestle site. Two trestles with nine bags on each. One trestle with seven bags and two trestles with 22 boxes (5 trestles in total). One heron seen.
28	31/03/2014	11:51	NM 87202 39026	187202	739027			Photo taken of a single outlier trestle on north end of the bay. Trestle is about a 100 m from waypoint.
29	31/03/2014	11:53	NM 87159 38999	187160	738999	Fig 11.		Corner of second trestle site, north-northwest of main site. Seven trestles with bags and boxes containing oysters of around 5 cm in size, 15 crates scattered around with oysters. Photo taken from small island dividing site 1 and site 2, looking west- southwest.
30	31/03/2014	11:54	NM 87158 38997	187158	738997			Waypoint taken about 1.5 m from trestle. No access due to high water.
31	31/03/2014	11:55	NM 87159 39014	187159	739015			Corner of trestle site.
32	31/03/2014	11:57	NM 87148 39004	187149	739005			Corner of trestle site.
33	31/03/2014	11:58	NM 87159 39012	187159	739013			Waypoint taken by accident.
34	31/03/2014	11:59	NM 87156 39009	187157	739010	Fig 12	LLSW2	Unplanned seawater sample taken at second trestle site northwest of main trestle site. LLSW2. At the time of sampling, it was assumed to be the location of the RMP based on revised survey plan (V3), noting that the Regulatory Services Officer could not attend on the survey day to confirm the actual location. Later during the survey, the harvester confirmed the sampling location as being in the vicinity of the RMP location.
35	31/03/2014	12:00	NM 87156 39009	187157	739010		LLSF1	Unplanned shellfish sample taken at second trestle site northwest of main trestle site. LLSF1
36	31/03/2014	12:08	NM 87182 38967	187182	738968		LLSW3	Planned seawater sample taken. LLSW3

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
37	31/03/2014	12:09	NM 87184 38966	187184	738967		LLSF2	Planned shellfish sample taken. LLSF2
38	31/03/2014	12:15	NM 87120 38832	187120	738832	Fig 13		Floating jetty and small boat on ground by shore at south end of production area.
39	31/03/2014	12:17	NM 87157 38935	187158	738935			Corner of trestle site, southwest corner.
40	31/03/2014	12:18	NM 87159 38946	187159	738947			Furthest two trestles on the west.
41	31/03/2014	12:19	NM 87165 38945	187166	738945			Northwest corner of trestles with new boxes.
42	31/03/2014	12:19	NM 87166 38955	187166	738956			Two old trestles with 9 bags on each, oysters around 6 cm within bags.
43	31/03/2014	12:26	NM 87031 38869	187032	738870			Photo taken of inaccessible shoreline.
44	31/03/2014	12:28	NM 87037 38921	187037	738921		LLSW4	Planned seawater sample LLSW4 taken just outside of production area to the southwest.
45	31/03/2014	12:44	NM 86831 38616	186831	738616	Fig 14, 15		Suspected site of watercourse, no evidence of established flow in area apart from some green algae growing in pool of freshwater gathered on rocky shoreline. Ground dangerously inaccessible to continue on shoreline. Small fishing vessel sailing northward close to Lismore. Two gulls on kelp bed near shore.
46	31/03/2014	12:54	NM 86739 38396	186740	738397			Four geese spotted flying nearby.
47	31/03/2014	12:59	NM 86801 38356	186801	738356	Fig 16	LLFW2	Planned freshwater sample at the north side of Port a' Bhuiltin bay - misinterpreted sample location. Sample associated with observations and measurements at waypoint 48.
48	31/03/2014	13:00	NM 86799 38357	186799	738358			Watercourse measurements - Width: 1 m; Depth: 8 cm; Flow rate: 0.009 m/s; SD: 0.005
49	31/03/2014	13:02	NM 86797 38353	186797	738354			South end of survey route at Port a' Bhuiltin.
50	31/03/2014	13:26	NM 87134 38877	187135	738878			Met up with harvester after returning to production area. Harvester arrived on-site at around 13:30.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
51	31/03/2014	13:40	NM 87089 38882	187090	738883			Shellfish sampling location on rocky shore containing mussels. Two bags attached to rope to be pulled up at high tide when stock cannot be accessed due to high waters.
52	31/03/2014	14:34	NM 87974 39879	187974	739879	Fig 17	LLFW3	Planned freshwater sample LLFW3. Sample associated with watercourse measurements taken at waypoint 53.
53	31/03/2014	14:36	NM 87975 39881	187975	739881			Measurements - Width: 2.5m; Depth: 7 cm; Flow: 0.204 m/s; SD: 0.006
54	31/03/2014	14:40	NM 87828 39777	187829	739777		LLSW5	Additional seawater sample taken at the north end of survey route in Sàilean Sligeanach. Tide was far out at this point therefore sample was taken from a large pool of seawater trapped in low lying area in the middle of the bay.

Photographs referenced in the table can be found attached as Figures 3-17.

Sampling

Seawater and freshwater samples were collected at the sites marked in Figure 2.

One additional seawater sample was taken at Sàilean Sligeanach bay in the vicinity of the highland cattle.

One of the planned freshwater sampling points had no flow (WP 45).

Two Pacific Oyster shellfish samples were taken (WP35, 37) in accordance with the agreed sampling protocols.

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

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

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

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	*E. coli* (cfu/100ml)	Salinity (ppt)
1	31/03/2014	LLSW1	NM 87455 39455	Seawater	5	30.35
2	31/03/2014	LLFW1	NM 87650 39259	Freshwater	<10	
3	31/03/2014	LLSW2	NM 87156 39009	Seawater	0	31.25
4	31/03/2014	LLSW3	NM 87182 38967	Seawater	0	32.16
5	31/03/2014	LLSW4	NM 87037 38921	Seawater	0	30.71
6	31/03/2014	LLFW2	NM 86801 38356	Freshwater	<10	
7	31/03/2014	LLFW3	NM 87974 39879	Freshwater	600	
8	31/03/2014	LLSW5	NM 87828 39777	Seawater	95	13.57

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	*E. coli* (MPN/100g)
1	31/03/2014	LLSF1	NM 87156 39009	Pacific Oysters	20
2	31/03/2014	LLSF2	NM 87184 38966	Pacific Oysters	20

Photographs – NOTE that camera clock was still set to GMT at time of survey therefore time printed on photos is an hour behind real time.

Figure 3. Sàilean Sligeanach Cottage near the start of survey route on the north. Waypoint 2.

Figure 4. General view from the north tip of Sàilean Slieganach bay with cows on shore. Waypoint 4.

Figure 5. High fence on shoreline. Unable to pass below it therefore climbing over was necessary. Waypoint 9.

Figure 6. Unnamed watercourse at north end of Sàilean Ruadh bay, photo taken looking south-southwest. Waypoint 15. Location of sample LLFW1.

Figure 7. General layout of production area with trestles. View from the northeast corner of production area. Waypoint 18.

Figure 8. General view of the production area from the south end of Sàilean Ruadh bay. Waypoint 19.

Figure 9. Corner of trestles with new Ortac box system at the middle of shellfish site. Waypoint 21.

Figure 10. Oyster site corner looking south toward the south end of the production area. Waypoint 27.

Figure 11. View of second, smaller site from small island, looking west, southwest. Waypoint 29.

Figure 12. Assumed location of RMP to the northwest of the main trestle site. Location of samples LLSW2 and LLSF1. Waypoint 34.

Figure 13. Floatable jetty and boat at south end of production area. Waypoint 38.

Figure 14. Suspected location of watercourse with no evidence of flow. Waypoint 45.

Figure 15. Green algae growing in pool on rocky shore. Photo taken at same location as Figure 13. Waypoint 45.

Figure 16. Unnamed watercourse flowing from north side of bay at Port a' Bhuitin. Misinterpreted sample location. Waypoint 47. Sample location of LLFW2.

Figure 17. Unnamed watercourse at the north end (beginning) of survey route Sàilean Sligeanach bay. Waypoint 4 and 52. Location of sample LLFW3.