Scottish Sanitary Survey Review

Loch Fyne: Stonefield and Loch Fyne: Stonefield Oysters

AB-154-043-15 and AB-435-840-13

April 2015

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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 2009 for Loch Fyne: Stonefield. 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 area. The associated shoreline survey was undertaken in autumn 2008.

The output of the sanitary survey included a report and recommended sampling plans for two species (Pacific oysters and queen scallops). 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 2009 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 2009 sanitary survey report.

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Sampling Plan – Loch Fyne: Stonefield

	2009 report	2015 review	Changes
Production Area	Loch Fyne: Stonefield		No change
Site Names	North Bay		
SIN	AB-154-043-15		
Species	Queen scallops		
Type of Fishery	Lantern net		
NGR of RMP	NR 8648 7225		
East	186480		
North	672250		
Tolerance (M)	10	40	Changed to allow for movement of net lines
Depth (M)	10		No change
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	Christine McLachlan, William MacQuarrie, Ewan McDougall, Allison Hardie, Heather Harley	Change in personnel
Local Authority Liaison Officer	Christine McLachlan	Ewan McDougall	
Recommended Production Area	Area bounded by lines drawn between NR 8646 7352 and NR 8700 7352 and between NR 8700 7352 and NR 8700 7183 extending to MHWS		No change

Sampling Plan – Loch Fyne: Stonefield Oysters

	2009 report	2015 review	Changes
Production Area	Loch Fyne: Stonefield Oysters		No change
Site Names	North Bay Oysters		
SIN	AB-435-840-13		
Species	Pacific oysters		
Type of Fishery	Lantern net		
NGR Of RMP	NR 8648 7225		
East	186480		
North	672250		
Tolerance (m)	10	40	Changed to allow for movement of net lines
Depth (m)	10		No change
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	Christine McLachlan, William MacQuarrie, Ewan McDougall, Alison Hardie, Heather Harley	Change in personnel
Local Authority Liaison Officer	Christine McLachlan	Ewan McDougall	
Recommended Production Area	Area bounded by lines drawn between NR 8646 7352 and NR 8700 7352 and between NR 8700 7352 and NR 8700 7183 extending to MHWS		No change

1. Area Description and Fishery

The Loch Fyne: Stonefield production area is located on the western side of Loch Fyne just to the north of East Loch Tarbert. The location is shown in Figure 1.1.

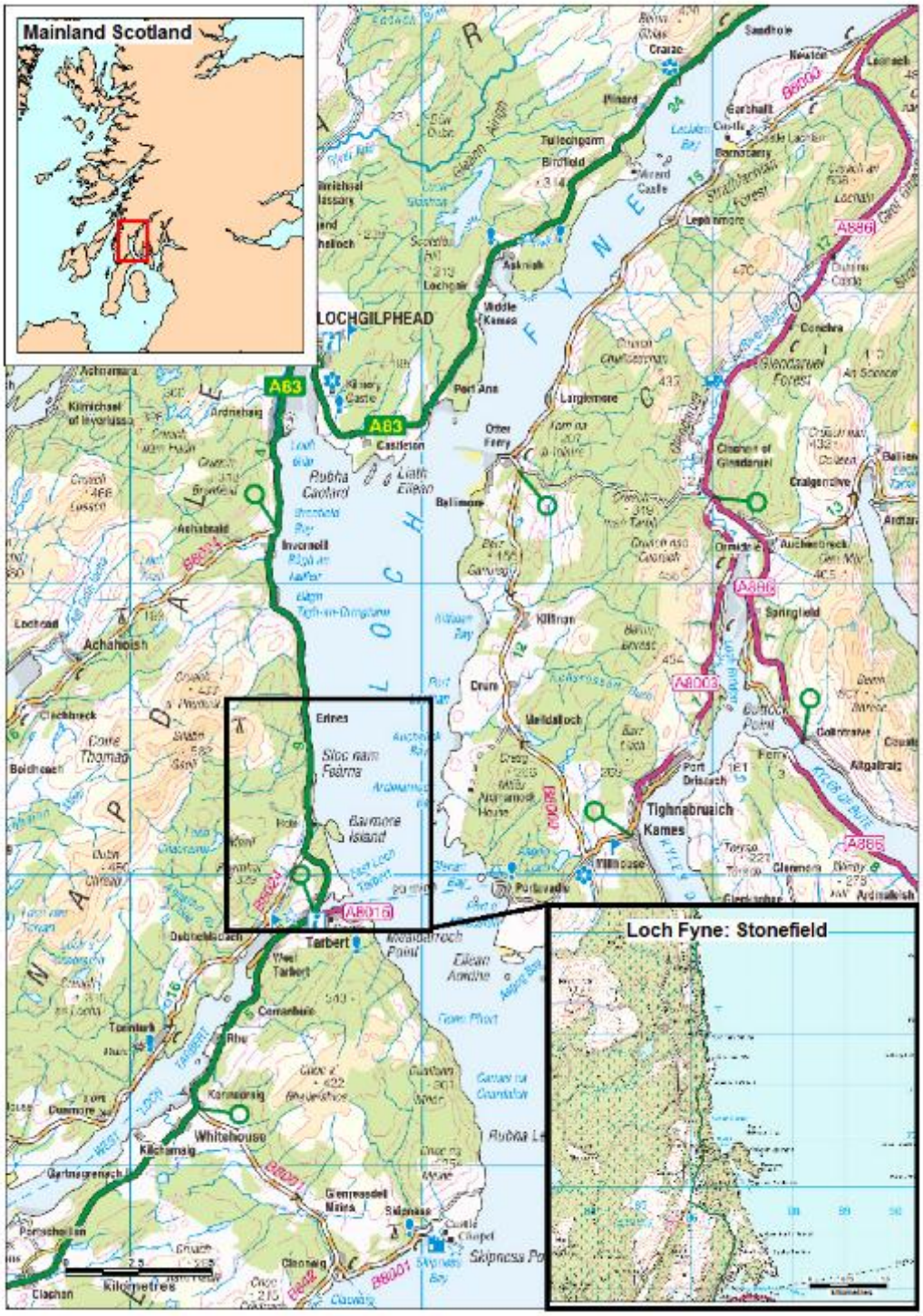

Figure 1.1 Location of Loch Fyne: Stonefield

Three sites are given in the 2014/15 classification listing. These are given in Table 1.1.

Table 1.1 Currently monitored fisheries operating in Loch Fyne: Stonefield

Production area	Site	SIN	Species	RMP
Loch Fyne: Stonefield	North Bay	AB-154-043-15	Queen scallops	NR 8648 7225
	South Bay	AB-154-044-15		
Loch Fyne: Stonefield Oysters	North Bay Oysters	AB-435-840-13	Pacific oysters	

The production area boundaries given in the classification listing for both Loch Fyne: Stonefield and Loch Fyne: Stonefield Oysters are as follows: the area bounded by lines drawn between NR 8646 7352 and NR 8700 7352 and between NR 8700 7352 and NR 8700 7183 extending to MHWS.

The current production area boundaries and RMP locations remain the same as those recommended in the 2009 sanitary survey report. These, together with the fishery locations recorded during the 2008 and 2014 shoreline surveys, are displayed in Figure 1.2. The South Bay site was excluded from the recommended production area as it was only used for the collection of queen scallop spat.

The 2008 survey reported that the North Bay site had consisted of two blocks of lantern nets; a smaller site to the north and a larger site to the south. Argyll and Bute Council subsequently advised that the northerly block of lines had been destroyed in storms during the consultation period for the 2009 report. Both queen scallops and Pacific oysters continue to be grown at the North Bay site located north of Barmore Island, while only juvenile queen scallops were present at the South Bay site. Harvesting was reported to be undertaken year-round when stock was of the correct size. At the time of the 2014 shoreline survey, the northerly North Bay site had not been re-installed and one of the ten lines at the southerly block had also been lost during more recent storms. The harvester subsequently stated that he had not reinstalled the northerly site due to poor spat settlement over previous years. However, settlement had improved in 2014 which had convinced him to replace the lost lines in the near future.

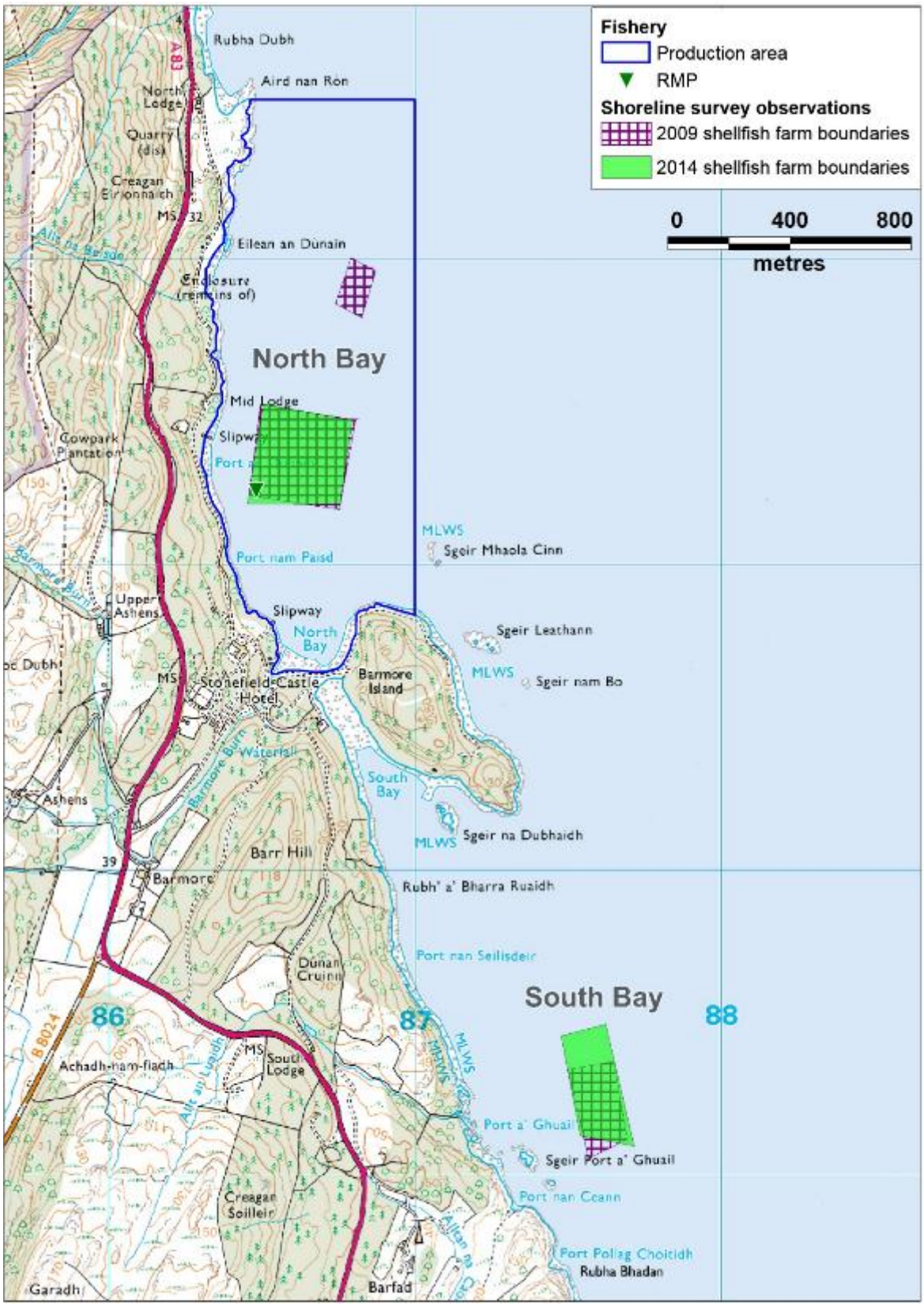

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Figure 1.2 Loch Fyne: Stonefield and Loch Fyne: Stonefield Oyster fisheries

2. Population and Human Sewage Impacts

2.1 Population

Census output areas from the General Register Office for Scotland are shown in Figure 2.1 with shading graduated in proportion to the population density determined from the 2011 census data. Owing to this distance more than 5 km northwards, the 2011 output for the As output census area 60QD000688 area is more than 5 km north of the fishery, the data for this area have not been included.

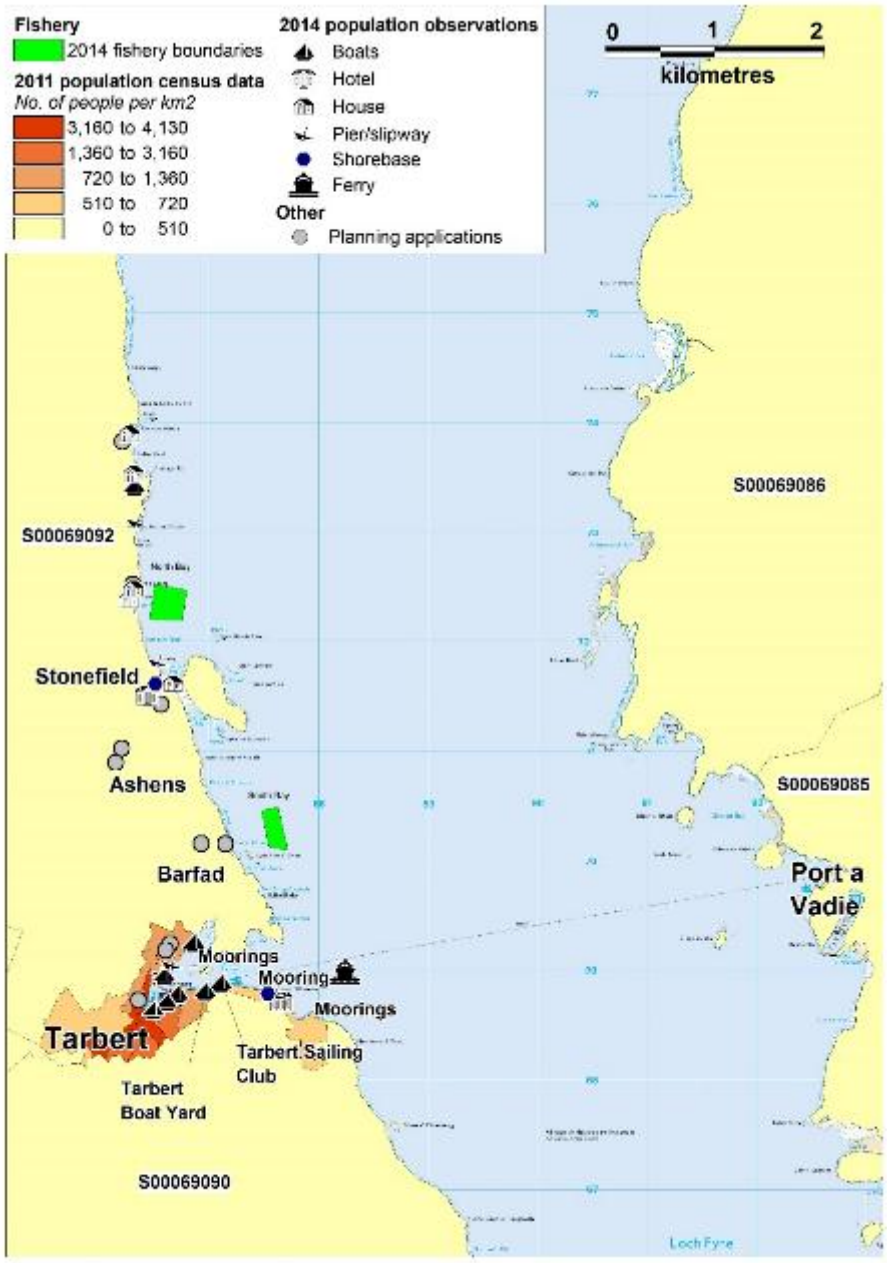

Figure 2.1 Distribution of human population around Loch Fyne: Stonefield

The majority of the population in the vicinity of the shellfish farm is centred on the large village of Tarbert, with low population density in areas outside of this (<1-4

people/km^2). Overall, there has been a small increase in human population between census years. The total population in Tarbert has decreased from 1504 to 1179 between census years although there has been a slight increase in population in the areas outside of this.

Tarbert remains popular as an overnight destination for people visiting the nearby islands and for visitors to the village itself (Tarbertlochfyne.com, 2015). Guest house accommodation remains largely centred in Tarbert, with Stonefield Castle Hotel located just south of the North Bay site. Numbers of visitors to the area peak over the summer months, with particularly high numbers expected during Tarbert Seafood Festival in July and Tarbert Music Festival in September.

Since the 2009 report, 12 planning applications have been submitted for the areas around Loch Fyne: Stonefield, one of which is pending approval. These applications were downloaded from the Argyll and Bute Council Planning portal (Argyll & Bute Council, 2014) in January 2015. A list is given in Appendix 1. Locations relating to the properties concerned in these planning applications are shown on the map in Figure 2.1.

Nine of the applications related to new dwelling houses and were predominantly for the Stonefield and Tarbert areas, with one in Barfad. Six of the applications related to single houses, whilst the remaining three related to multiple houses; one application was for two houses in the Ashens area, one was for four houses in the Stonefield area, and the last was eight units (five flats and three houses) in Tarbert. All applications for locations within Tarbert identified an intention to connect to the public sewage network, whilst the applications outside of Tarbert identified an intention to install new STs to soakaways.

The other three applications were for a new summer house with biodisc sewage treatment plant in Stonefield, change of use from commercial premises to a holiday letting in Tarbert and a new boathouse in the Barfad area.

Several houses were seen along the shoreline north of Barmore Island during the 2014 shoreline survey. This included a house being built adjacent to the North Bay site, located in the vicinity of a site that was identified in a planning application for a new summer house. A shore base was noted south of the North Bay site and a possible shellfish depuration facility was noted near the mouth of East Loch Tarbert.

Tarbert continues to receive high levels of boat traffic from residential and visiting yachts. There are regular ferry services to the nearby islands and a modest local fishing fleet. There is a new 230 berth marina and associated facilities at Port a Vadie (Portavadie Estates LTD, 2015). The marina is advertised as state of the art and is expected to attract a large number of visiting yachts to the area. It has pump-out facilities, toilets and a private sewerage system. Boating activity at Port a Vadie and Tarbert is expected to highest from May to September, with the annual Scottish

Series (Britain's second largest yachting regatta) held at Tarbert in May (Tarbertlochfyne.com, 2015).

The 2014 survey reported a large number of boats in East Loch Tarbert. Pontoons adjacent to Tarbert Yacht Chandlery contained 73-75 boats, whilst several fishing boats, small vessels and the CalMac ferry were moored alongside Tarbert Quay. Five boats and 10 moorings were also noted in a sheltered bay to the northeast of the loch.

2.2 Sewage Discharges

The 2009 report included information from Scottish Water on four community sewage discharges and six private sewage discharge consents provided by SEPA. Full details of these can be found in the 2009 report: the locations are displayed in Figure 2.2. Overall it was concluded in the 2009 sanitary survey report that impacts from Tarbert community sewage network would be more likely at the South Bay site than the North Bay site, and that private STs were not expected to have a significant impact at either site.

No upgrades or information on the public sewage network was found during internet searches carried out for this review. Sewage related observations made during the 2014 shoreline survey are listed in Table 2.2 and displayed in Figure 2.2. The majority of the 2014 sewage-related observations were made in the Tarbert area. They included two toilet blocks; one adjacent to the pontoons (waypoint 9) and the other east of Tarbert Harbour Street pumping station (PS) (waypoint 10); manhole covers assumed to be associated with the sewage network along both shorelines and several pipes.

Table 2.1 Sewage discharge-related observations around Loch Fyne: Stonefield from the 2014 shoreline survey

No	NGR	Description
1	NR 8628 7399	ST and outfall on north bank of river, 5 m upstream from the bridge
2	NR 8627 7387	Brown plastic 100 mm diameter soil pipe with outlet under water. Leak at joint sampled (SFFW8) returned a result of 900000 *E. coli* cfu/100 ml
3	NR 8631 7355	North Lodge dwelling house mainland side of the roadway with septic tank on lawn seaward of the roadway
4	NR 8631 7249	3x metal drain covers on lawn in front of building construction site
5	NR 8642 7177	Large concrete septic tank about 30 m from the hotel. Approximate size 2.4 x 4.8 m and with three manhole covers
6	NR 8681 6924	Large unnamed watercourse heavily flowing with pipe next to it. Houses behind and Scottish Water structures above
7	NR 8673 6914	Septic tank and iron outflow pipe. Pipe diameter - 10 cm; flow - 30 ml / 1 sec. Freshwater sample (SFFW22) result <1000 *E. coli* cfu/100 ml
8	NR 8668 6909	Metal manhole cover on road
9	NR 8659 6897	Toilet and shower block with laundry facilities next to harbour office
10	NR 8661 6872	Toilet block mainland roadside
11	NR 8685 6882	Metal manhole cover on road
12	NR 8735 6884	Plastic pipe 150 mm diameter, water width - 8 cm, depth - 1 cm, flow approximately - 1.8 L/min (measured by sample bottle 30 ml in 1 sec). Freshwater sample (SFFW17) result <1000 *E. coli* cfu/100 ml
13	NR 8753 6880	Ceramic pipe next to possible shellfish depuration site on pier beside road. Pipe diameter - 150 mm, water width - 8 cm, depth - 1 cm, flow - 0.098 m/sec, SD - 0.400. Loose pipe and leaking water underneath pier but inaccessible to sample. Freshwater sample (SFFW16) result 80 *E. coli* cfu/100 ml
14	NR 8759 6878	Scottish water pumping station. Seawater sample (SFSW7) result 34 *E. coli* cfu/100 ml
15	NR 8759 6876	Broken pipe emerging from old brickwork block on shore about 3 m east of Scottish Water pumping station close to pier. Pipe internal diameter 48 cm, water flow width - 14 cm, depth - 2, flow - 1.096 m/sec, SD - 0.167. Sample (SFFW15) result 20 *E. coli* cfu/100 ml
16	NR 8763 6875	Metal manhole cover
17	NR 8764 6875	Concrete manhole cover
18	NR 8765 6874	Two metal manhole covers on road. Possibly part of Scottish Water communal system
19	NR 8771 6867	Double manhole cover on road shore side, houses mainland side. Possibly part of Scottish Water communal system
20	NR 8781 6855	Ceramic soil pipe 12 cm diameter in culvert but with no flow
21	NR 8784 6856	Two metal manhole covers on road above iron pipe below. Pipe leads underground with another manhole cover in the ground. Pipe diameter 18 cm, house behind on mainland side of road

Five sewage related observations were made outside of Tarbert and included the four private STs noted during the 2008 survey. A ST discharging to a watercourse (Abhainn Strathainn) returned a low result of 30 *E. coli* cfu/100 ml. A plastic pipe to sea was found to be leaking raw sewage and returned a result of 900000 *E. coli* cfu/100 ml, indicating marked faecal contamination. This location was more than one north of the current North Bay shellfish site but closer to the site that was destroyed by storms (and thus perhaps more relevant if those lines are replaced). An ST was observed on the lawn of a house adjacent to the North Bay site was observed: where

several additional inspection covers were also noted in the vicinity. The Stonefield Castle Hotel ST and associated manhole covers were also noted: information was obtained during the 2008 shoreline survey that this was pumped out rather than discharging. The harvester stated that there was a pipe running from the ST to sea by the adjacent slipway, but this pipe was not observed during the survey.

Conclusion

Human population remains centred in the village of Tarbert and is sparse on land adjacent to the production area. Several planning applications have been made for properties along the shore adjacent to the production area: this may have slightly increased the population. A number of sewage discharges, including intermittent discharges associated with pumping stations, are located within East Loch Tarbert and will be expected to have a potential impact at the South Bay shellfish site and not necessarily at the North Bay site. The main Tarbert Barfad discharge is located to the northeast of the South Bay shellfish site although analysis of historical monitoring data undertaken for the 2009 sanitary survey report did not support a significant impact of the discharge at either the South Bay or North Bay shellfish sites. Several private STs are located along the shoreline of the production area.

Visitor numbers to the area are still expected to peak in the summer, mainly in the Tarbert area, with some increase expected at the Stonefield Castle Hotel located to the south of the North Bay site. Boating activity will also increase over the summer months, but particularly in May when there is a large regatta in Tarbert. Pleasure boat activity in the general area may have increased since 2009, following the completion of the new marina at Port a Vadie.

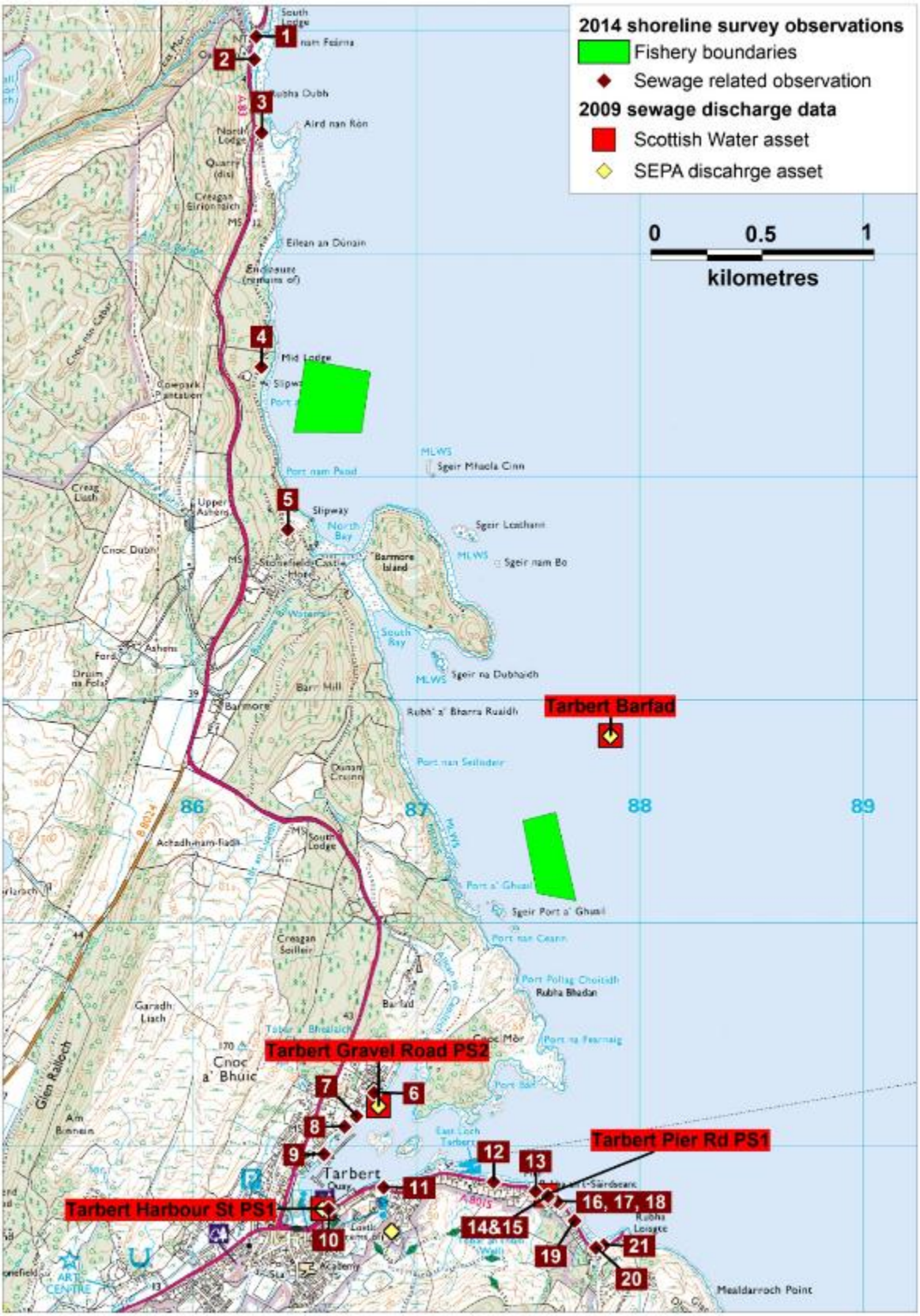

Figure 2.2 Map of sewage discharges in the vicinity of Loch Fyne: Stonefield

3. Farm Animal Population and Agricultural Impacts

Agricultural farm census data from 2008 was provided by the Scottish Government Rural and Environment Research Analysis Directorate for the parishes of South Knapdale and Kilfinan in support of the 2009 sanitary survey report. This indicated that cattle and sheep were reared in high numbers on land to the east of the Loch Fyne: Stonefield and also on land to the west of the opposite shore. However, areas of pasture and numbers of livestock noted during the shoreline survey on the 30th September and 1st October 2008 were limited. It was therefore concluded that parish information was not applicable to the areas immediately adjacent to the fisheries and that overall agricultural inputs would be minor and would mostly contribute to background levels of contamination.

No livestock or areas of pasture were observed during the 2014 shoreline survey. However, two peacocks were noted near to the shore adjacent to the present North Bay shellfish site and are thought to be kept as pets (two peacocks were observed close to the same location during the 2008 shoreline survey).

Conclusions

Overall the agricultural impacts on the North Bay site continue to be minor and have not considered to have changed since the 2009 report.

4. Wildlife

The 2009 sanitary survey report concluded that deer, seals, waterbirds, dolphins and possibly otters may impact the shellfishery, although impacts are anticipated to be minor and difficult to predict temporally and geographically.

For this review, information on pollution sources from wildlife has been obtained from the JNCC dataset, through the shoreline survey conducted in 2014, and through a desk-based internet search. Shoreline survey observation information only relates to the time that the survey was undertaken on on the 20-22nd October 2014. Wildlife observations recorded during the shoreline survey are displayed in Figure 4.1.

Pinnipeds

The Special Committee on Seals report (SCOS, 2013) noted approximately 10 harbour seals within a 10 km radius of the North Bay site during August aerial surveys between 2007 and 2011. Harbour seal populations around the southwest coast of Scotland have remained relatively constant over this period. Comparatively only 1-5 grey seals were noted during similar surveys conducted over the same time period. Grey seal population estimates are not available. Grey seal pup production across mainland Scotland has however remained high and in 2010 was at 3299 pups/annum. One seal was observed in East Loch Tarbert during the 2014 shoreline survey.

Cetaceans

Since the 2009 report there have been regular sightings of harbour porpoise and small to large pods of dolphins within Loch Fyne and East Loch Tarbert (Hebridean Whale and Dolphin Trust, 2015). 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 North Bay site are listed in Table 4.1.

Table 4.1 JNCC seabird data for 5 km around Loch Fyne: Stonefield

Common name	Species name	Count*	Qualifier	Accuracy
Herring Gull	*Larus argentatus*	59	Occupied nests and territory	Unknown, estimate and accurate
Great Black-Backed Gull	*Larus marinus*	18	Occupied nests and territory	Estimate and accurate
Black-Headed Gull	*Chroicocephalus ridibundus*	1	Occupied nests	Unknown
Common Gull	*Larus canus*	1	Occupied nests	Unknown
Lesser Black-Backed Gull	*Larus fuscus*	1	Occupied nests	Unknown
Common Tern	*Sterna hirundo*	1	Occupied territory	Unknown
Great Cormorant	*Phalacrocorax carbo*	65	Occupied nests	Unknown

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

The JNCC seabird data indicates that the largest breeding colonies are located approximately 3 km east of the production area, on the islands of Eilean Buidhe and Eilean a' Bhuic. These two islands are important nesting areas for cormorants and herring gulls, with smaller colonies of other gull species also present. The extent of any impact at Loch Fyne: Stonefield will depend on the feeding range of the birds.

Birds were the most common wildlife observed during the 2014 shoreline survey. Species included gulls, eider ducks, herons, oystercatchers, great tits, robins and a buzzard. Birds were predominantly noted around East Loch Tarbert, with several, including 18 eider ducks, also noted around the North Bay site.

Birds recorded in the vicinity of the production area will have a potential effect on water quality in that location.

Otters

There are records from JNCC dated 1991-1995 of Eurasian otters (*Lutra lutra*) within 100 m of the southern shoreline of East Loch Tarbert and at the unnamed watercourse near Barr Hill in Stonefield (National Biodiversity Network, 2015). No otters were observed during the 2014 shoreline survey.

Deer

There is no new information relating to deer populations around the production area since the 2009 report. Deer are anticipated to remain concentrated in the wooded areas.

Conclusions

There continues to be potential contamination associated with wildlife. Contributing wildlife will be predominantly birds but with additional inputs from deer, cetaceans and otters. The effects are expected to be localised and largely unpredictable.

Figure 4.1 Map of wildlife around Loch Fyne: Stonefield

5. Watercourses

There are no gauging stations on watercourses that enter into the Loch Fyne: Stonefield area.

A comparison of watercourse loadings estimated on the basis of the 2008 and 2014 shoreline survey measurements and *E. coli* concentrations are displayed in Table 5.1. In total 12 watercourses were measured and sampled in the 2008 survey, seven of which were re-sampled in 2014. Additional watercourses were measured and sampled during the 2014 shoreline survey. Sample locations from the 2014 survey, annotated with the estimated loadings, 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.

Weather conditions during the shoreline surveys were similar. In 2008, very heavy rain preceded the survey, with rain reported during both survey days. In 2014, heavy rain was reported in the 48 hrs prior to the survey, with rain increasingly heavy showers over the survey days.

Table 5.1 Estimated watercourse loadings

No.[1]	Description	NGR	2008 Loading (*E. coli*/day)	2014 Loading (*E. coli*/day)
1	Barmore Burn	NR 8651 7159	$3.6x10^{6}$	$9.9x10^{10}$
2	Unnamed watercourse	NR 8640 7189	-	$2.1x10^{8}$
3	Unnamed watercourse	NR 8632 7220	$1.2x10^{5}$	$2.9x10^{9}$
4	Unnamed watercourse	NR 8627 7244	$9.8x10^{5}$	$1.8x10^{9}$
5	Unnamed watercourse	NR 8633 7267	-	Not determined
6	Allt na Béisde	NR 8630 7283	$3.8x10^{5}$	$1.1x10^{9}$
7	Unnamed watercourse	NR 8628 7287	$9.9x10^{5}$	$2.8x10^{9}$
8	Unnamed watercourse	NR 8629 7299	-	Not determined
9	Unnamed watercourse	NR 8627 7383	$6.6x10^{4}$	$7.8x10^{8}$
10	Unnamed watercourse	NR 8627 7391	-	$3.5x10^{8}$
11	Abhainn Strathainn	NR 8628 7398	$3.9x10^{6}$	$5.3x10^{10}$
12	Unnamed culverted watercourse	NR 8781 6855	-	$1.6x10^{10}$
13	Unnamed culverted watercourse	NR 8776 6858	-	$2.4x10^{8}$
14	Piped land drainage	NR 8775 6861	-	$<1.5x10^{9}$
15	Unnamed culverted watercourse	NR 8766 6873	-	$<8.1x10^{7}$
16	Piped land drainage	NR 8735 6884	-	$<2.6x10^{7}$
17	Unnamed watercourse	NR 8734 6884	-	Not determined
18	Unnamed culverted watercourse	NR 8725 6886	-	$5.9x10^{8}$
19	Unnamed watercourse	NR 8696 6882	-	$8.2x10^{10}$
20	Unnamed watercourse	NR 8640 6865	-	$5.3x10^{13}$
21	Unnamed watercourse	NR 8662 6903	-	$2.0x10^{10}$
22	Unnamed watercourse	NR 8681 6924	-	$2.6x10^{9}$

[1]Numbers relate to those given in the labels in Figure 5.1. < equates to sample results of <10 or <1000 and therefore calculated loadings equate to their maximum calculated loading.

Where the same watercourses had been measured and sampled, the 2014 estimated loadings were markedly higher than those from 2008. Recorded watercourses were located principally around East Loch Tarbert and along the shoreline of the production area. However, it should be noted that the shoreline survey route did not include South Bay. The watercourse with the highest estimated loading was located at the head of East Loch Tarbert while the watercourse with the second highest estimated loading was located at the southern end of the production area.

Conclusion

Freshwater loadings as estimated from the 2014 shoreline survey measurements and results were much greater than those estimated for the same watercourses for the 2009 sanitary survey report. Although rainfall fell prior to, and during, both shoreline surveys, it may be that rainfall at the time of the 2014 shoreline survey was heavier. The daily rainfall values around the time of the 2014 shoreline survey were not available for assessment and so this is only a hypothesis.

The watercourses situated around East Loch Tarbert have a very high combined loading which will affect the water quality in that area and potentially that at the South Bay site. There are several watercourses with predominantly moderate loadings along the shoreline of the production area: that with the highest loading was situated at the southern end. Impacts are likely to be greatest on the western side of the shellfish farm.

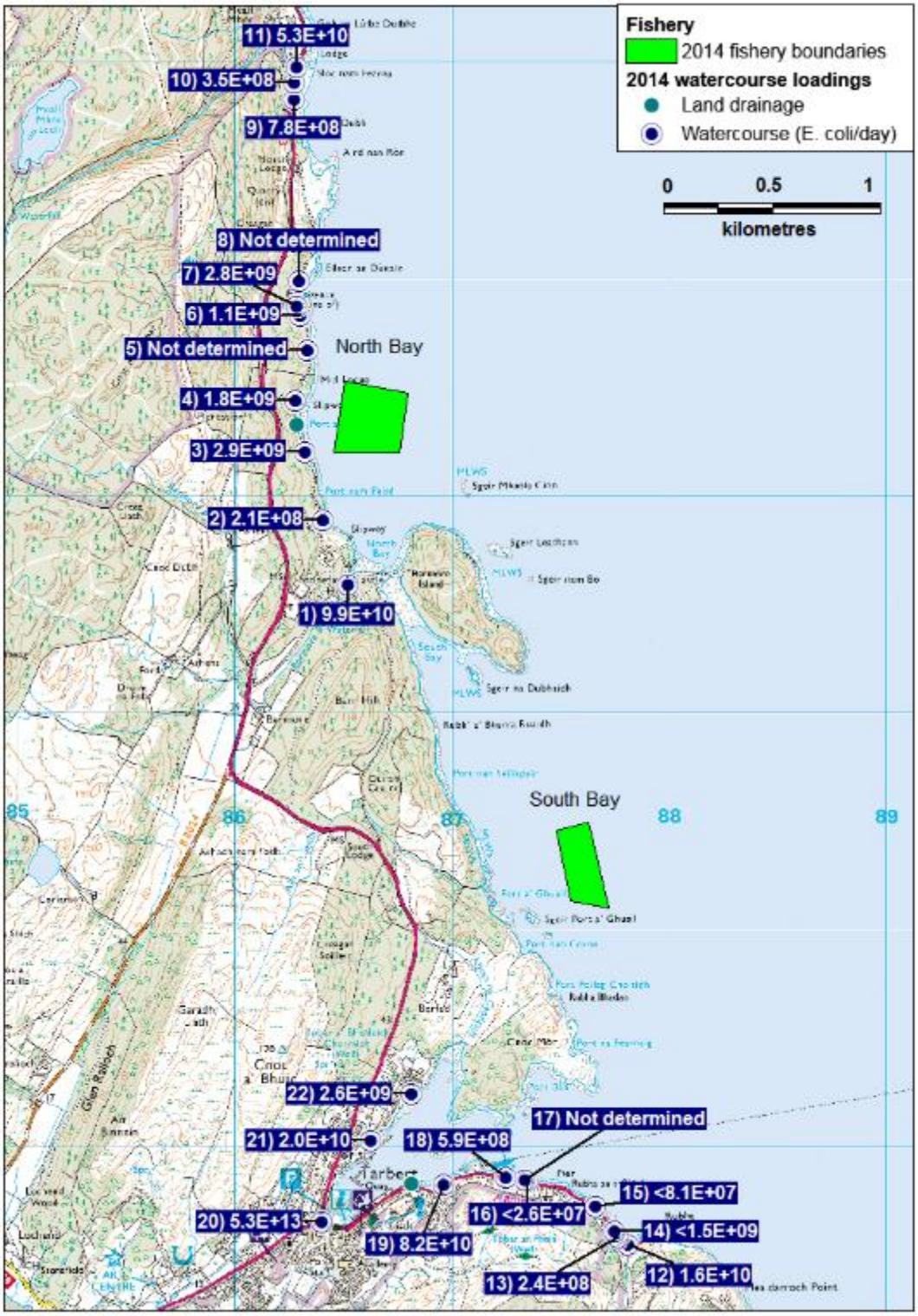

Figure 5.1 Watercourse loadings at Loch Fyne: Stonefield

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

Meteorological data had been purchased from the Meteorological Office for the survey period 01/01/2003 - 31/12/2007 for the analyses undertaken for the 2009 Loch Fyne: Stonefield Sanitary Survey Report. Rainfall boxplots and wind roses for the 2003-2006 period are presented in that report and have not been reproduced here. Total daily rainfall (mm) presented in that report was from records taken at the Skipness House weather station, although 2006 rainfall records were omitted from the analysis due to the number of days with missing data. Due to problems with later missing data for that station, rainfall data from Benmore Younger Botanical Gardens has been used in this review. Wind data in the 2009 report was taken from Glasgow: Bishopton, and this station was also used for this review.

Meteorological data for this Review was purchased from the Meteorological Office in March 2014 for the period 01/01/2003 – 31/12/2013. Rainfall data from Benmore: Younger Botanical Gardens was available for all the days within this period.

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 Benmore Younger Botanical Gardens weather station rainfall dataset for 2003-2013 is presented by year in Figure 6.1 and by month in Figure 6.2.

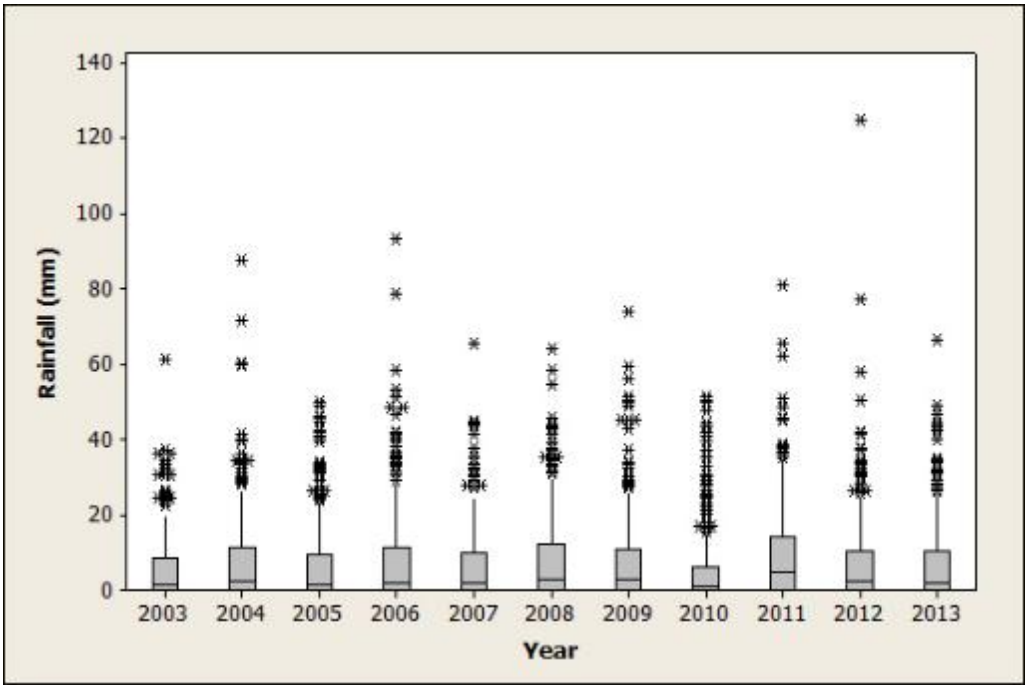

Figure 6.1 Boxplot of daily rainfall at Benmore Younger Botanical Gardens by year (2003-2013)

The majority of observations were below 10 mm per day. Extreme rainfall events of greater than 40 mm per day occurred in all years. The largest single rainfall event exceeded 120 mm and occurred in 2012. The driest year was 2010 (1952 mm) and the wettest year was 2011 (3340 mm). This is despite the missing data from 57 days in 2012, and had the data been complete a greater difference would have been seen.

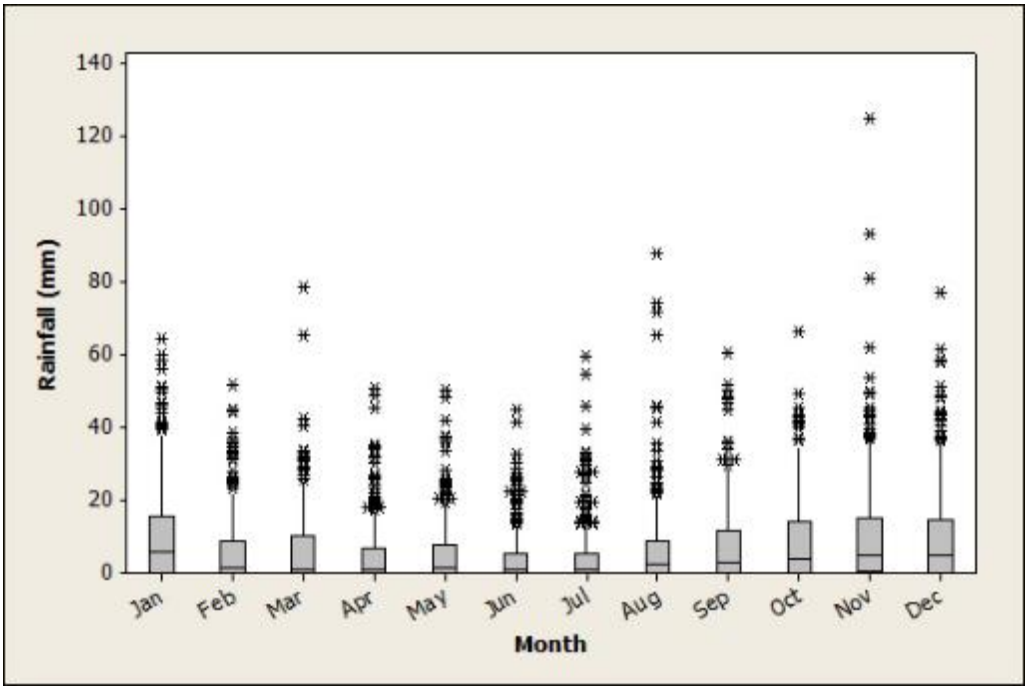

Figure 6.2 Boxplot of daily rainfall at Benmore Younger Botanical Gardens by month (2003-2013)

Overall, daily rainfall values were highest from October to January, and lowest from April to July. Extreme rainfall events exceeding 40 mm per day occurred in all months in the dataset, and therefore runoff associated with high rainfall can occur at any time of year.

Overall patterns in rainfall did not appear to change markedly over time. Comparison with the data presented in the 1009 sanitary survey report is complicated by the missing data from the station used for that analysis and the deliberate change in stations between the sanitary survey and this review.

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 Glasgow: Bishopton for the period 2004-2013 while Figure 6.4 shows the annual wind rose for the same period.

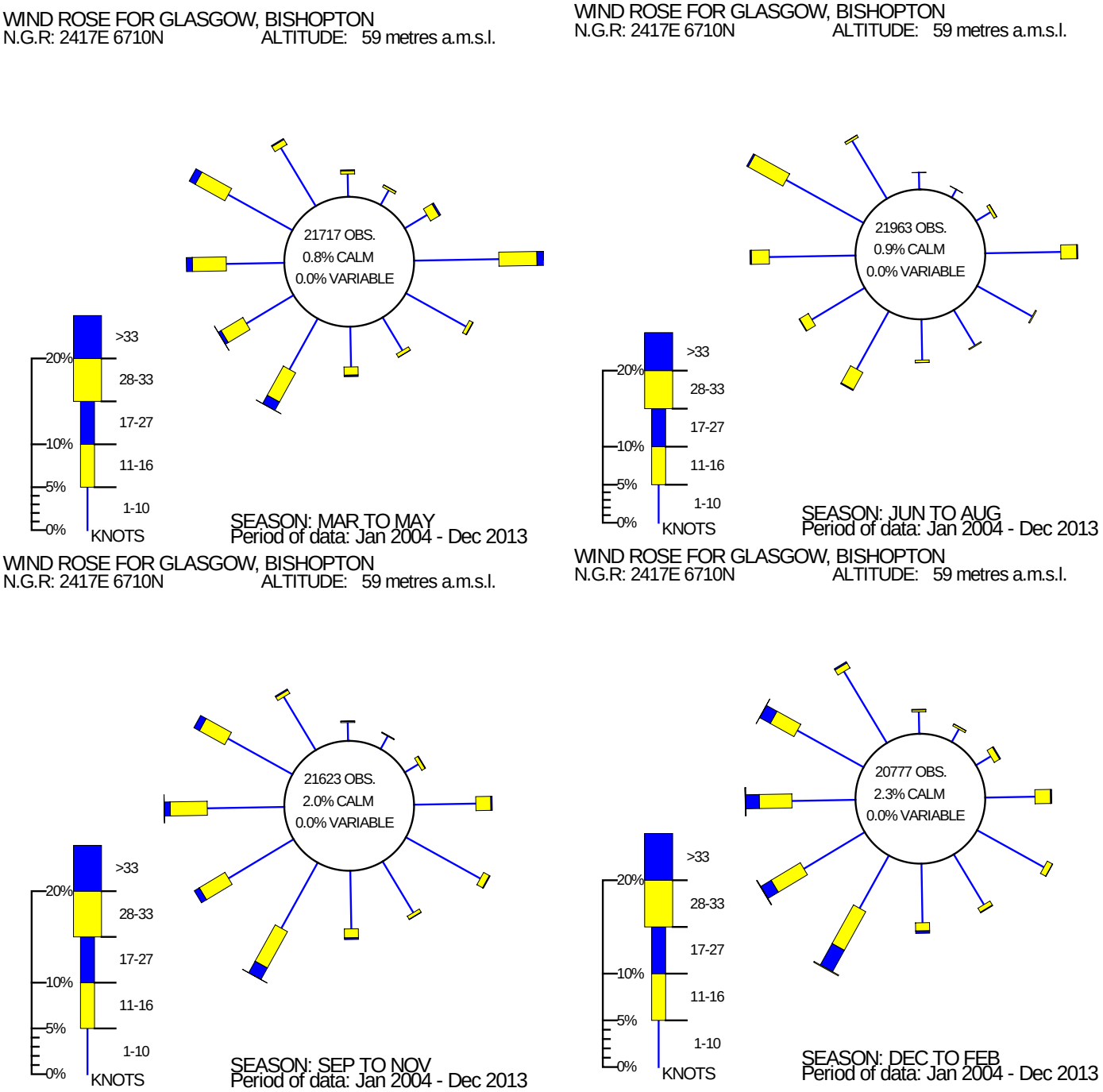

Figure 6.3 Seasonal wind roses for Glasgow: Bishopton (2004-2013)

Prevailing winds are from the west throughout most of the year. However, winds blow from the east a significant proportion of the time, particularly from March to May. Wind strength is weakest from all directions from June to August.

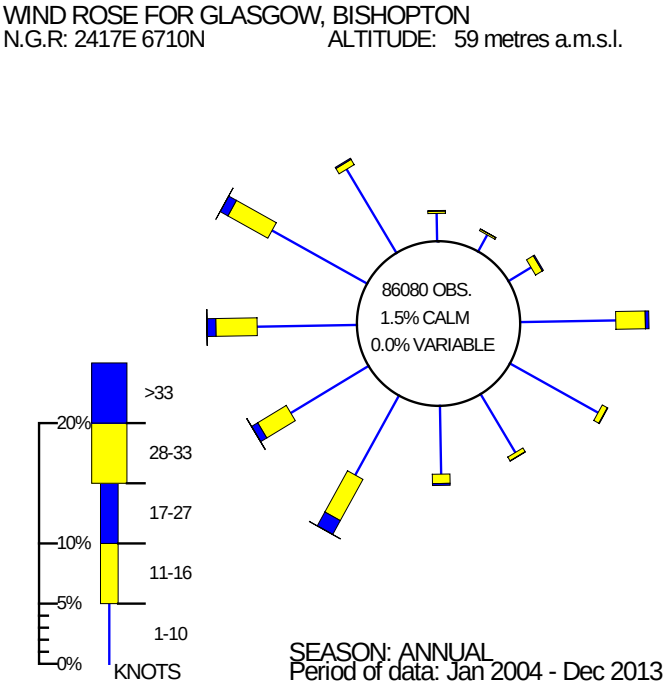

Figure 6.4 Annual wind rose for Glasgow: Bishopton (2004-2013)

Overall, winds tend to blow broadly from a westerly direction at Glasgow Bishopton, with easterly winds occurring a proportion of the time. Whilst Glasgow Bishopton is located on the west coast of mainland Scotland, Loch Fyne: Stonefield is in a part of the loch that runs north-south, with a large stretch of land on the western side (Kintyre headland), which is expected to limit the impact that westerly winds will have on particle transport at the shellfish farm.

7. Historical *E. coli* Data

Results for Loch Fyne: Stonefield and Loch Fyne: Stonefield Oysters production areas between 01/01/2008 and 10/12/2014 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 January 2015. Historical *E. coli* data used in the 2009 report had already been extracted and validated. For the purposes of this report, results from samples pre-dating 2001 were excluded. All *E. coli* results were reported as the Most Probable Number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

Loch Fyne: Stonefield

One sample had yielded an improbable tube combination in the MPN test and was omitted from analysis. All remaining samples were received at the laboratory within 48 hours since collection, had box temperatures of <8^{o}C and plotted within <100 m of the production area.

Loch Fyne: Stonefield Oysters

All samples were identified as valid, were received within 48 hours since collection, had box temperatures of <8^{o}C and plotted within <100 m of the production area.

A total of 37 *E. coli* results reported as <20 or <18 were reassigned a value of 10 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

7.1 Summary of microbiological results

Sampling and results summaries for Loch Fyne: Stonefield and Loch Fyne: Stonefield Oysters between 2002 and 2014 are displayed in Tables 7.1 and 7.2 respectively.

Sampling frequency was relatively even for Queen Scallops over both periods. There was no marked difference between periods in the descriptive statistics for the *E. coli* results.

Pacific oyster sampling started in 2009 and sampling frequency has been relatively even. No results from the Pacific oysters have so far exceeded 1000 *E. coli*/100 g.

Table 7.1 Sampling summary results for Loch Fyne: Stonefield 2002-2014

Sampling Summary				
Production area	Loch Fyne: Stonefield			
Site	North Bay			
Species	Queen Scallops			
SIN	AB-154-43-53			
Location	Various			
Years	2002-2007		2008-2014	
Total no. of samples	63		82	
	2002	11	2008	11
	2003	10	2009	12
	2004	11	2010	12
	2005	12	2011	12
	2006	11	2012	11
	2007	8	2013	12
			2014	12
Minimum	<20		<18	
Maximum	3500		5400	
Median	40		50	
Geometric mean	49		57	
90 Percentile	310		230	
95 Percentile	430		329	
No. Exceeding 230/100g	8 (13%)		6 (7%)	
No. Exceeding 1000/100g	2 (3%)		2 (2%)	
No. Exceeding 4600/100g	0		1 (1%)	
No. Exceeding 18000/100g	0		0	

Table 7.2 Sampling summary results for Loch Fyne: Stonefield Oysters 2009-2014

Sampling Summary		
Production area	Loch Fyne: Stonefield Oysters	
Site	North Bay Oysters	
Species	Pacific oysters	
SIN	AB-435-840-13	
Location	Various	
Years	2009-2014	
Total no. of samples	69	
	2009	10
	2010	12
	2011	12
	2012	11
	2013	12
	2014	12
Minimum	<18	
Maximum	330	
Median	50	
Geometric mean	40	
90 Percentile	230	
95 Percentile	330	
No. Exceeding 230/100g	5 (7%)	
No. Exceeding 1000/100g	0	
No. Exceeding 4600/100g	0	
No. Exceeding 18000/100g	0	

7.2 Geographical patterns of results

The sampling locations of samples taken since 2008 at Loch Fyne: Stonefield and Loch Fyne: Stonefield Oysters are plotted in Figures 7.1 and 7.2 respectively. The symbol sizes are shown proportional to the magnitude of the *E. coli* results. One sample assigned to Loch Fyne: Stonefield had a typographical error in its reported NGR (one digit out in the easting), which was corrected to allow for its inclusion in Figure 7.1.

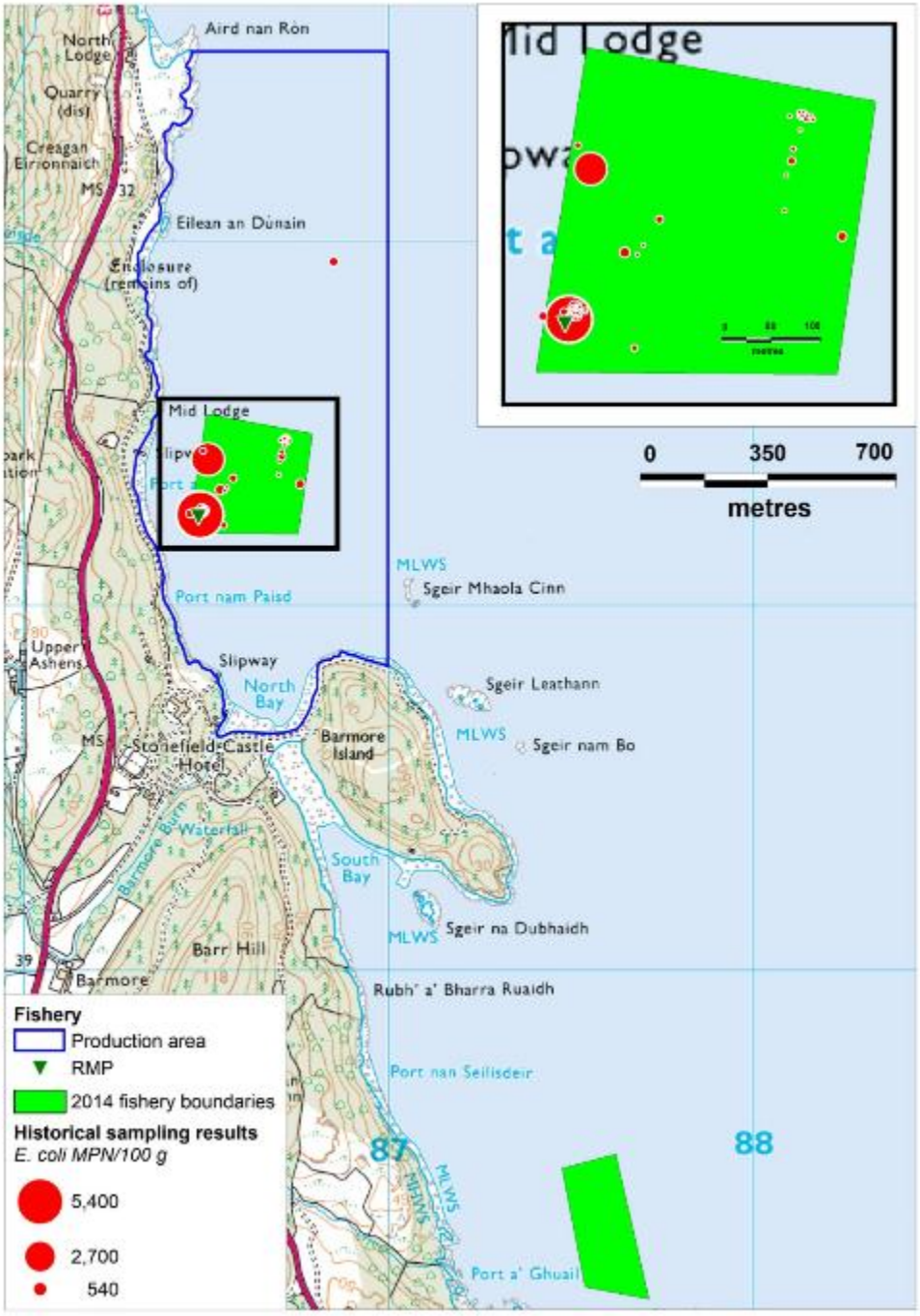

Figure 7.1 Sample results and locations from Loch Fyne: Stonefield

Reported queen scallop sampling locations varied across the North Bay site. The majority of samples (n=57) and the sample with the highest result have been taken

within 25 m of the currently specified RMP at NR 8648 7225. This plots towards the southwesterly extent of the 2014 site boundaries.

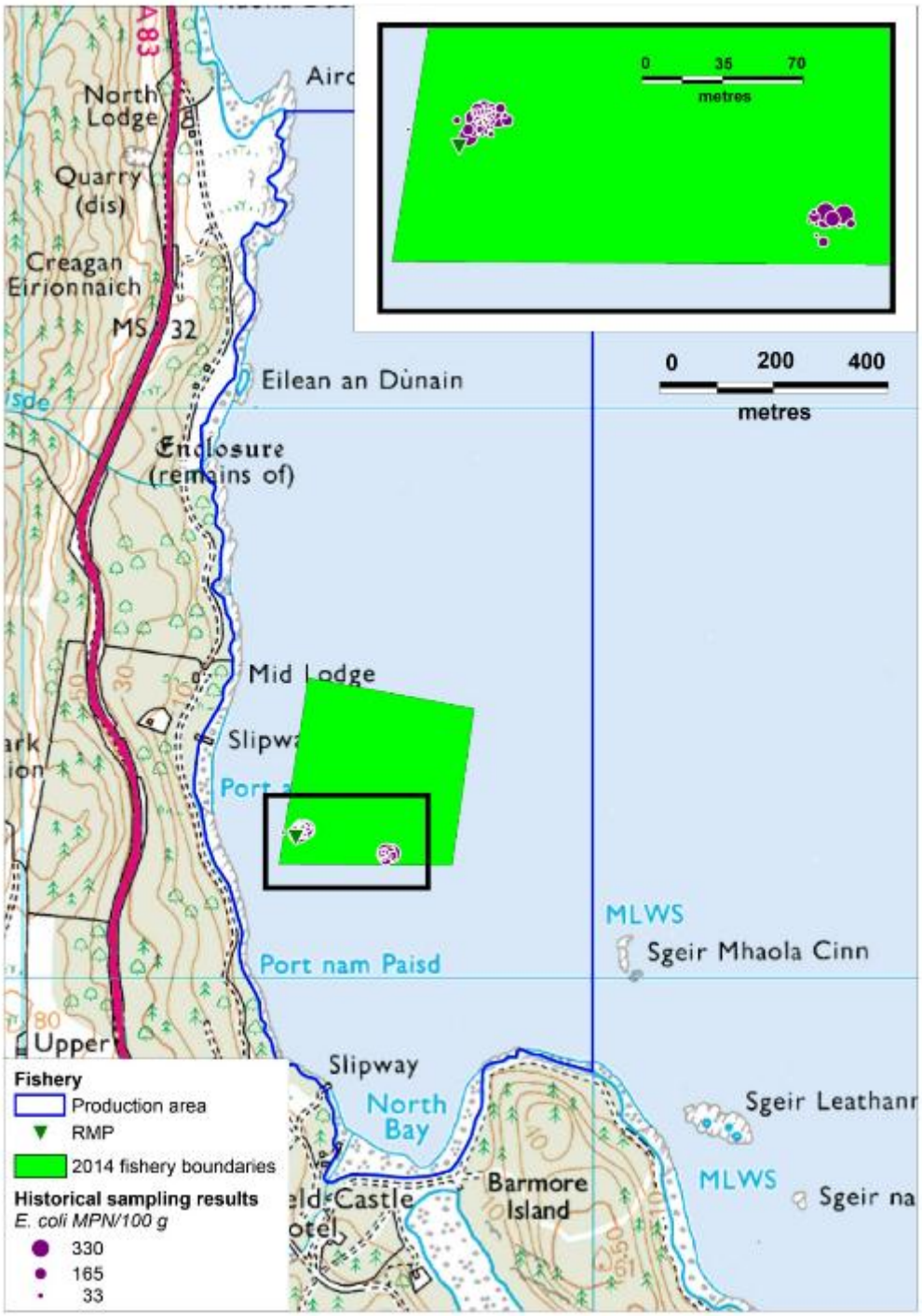

Figure 7.2 Sample results and locations from Loch Fyne: Stonefield Oysters

Pacific oyster samples have been reported to have been taken from two areas at the North Bay (south) site; an area within approximately 30 m of the currently specified RMP at NR 8648 7225 and an area approximately 170 m east of the RMP. Samples reported against the eastern area were taken in 2009 and early 2010 (n=12). The range of results seen at both sites has been the same.

A paired t-test was carried out on 68 pairs of queen scallop and Pacific oyster results that had been taken on the same dates between 2009 and 2014, to determine whether there was a significant difference between the results. A significant difference was found (Paired t-test, $t = 2.31$, $p = 0.024$), with higher results in queen scallops samples than in Pacific oysters.

7.3 Temporal patterns of results

Temporal trends for the E. coli results for queen scallops and Pacific oysters are shown in Figures 7.2 and 7.3 respectively. The figures are fitted with lowess trend lines. These allow for locally weighted regression scatter plot smoothing. At each point in the dataset an estimated value is fitted to a subset of the data, using weighted least squares. The approach gives more weight to points near to the x-value where the estimate is being made and less weight to points further away. In terms of the monitoring data, this means that any point on the lowess line is influenced more by the data close to it (in time) and less by the data further away. A trend line helps to highlight any apparent underlying trends or cycles.

In addition, a statistical comparison was carried out between the results from 2002-2007 and those from 2008-2014. This comparison could not be carried out for Pacific oyster results as sampling only began in 2009.

To test for significant differences between samples taken over the two sampling periods, the following statistical analyses were carried performed:

- 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 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. This test was used instead of a Chi-squared test as two cells had expected counts at less than five in the results from both sampling periods.

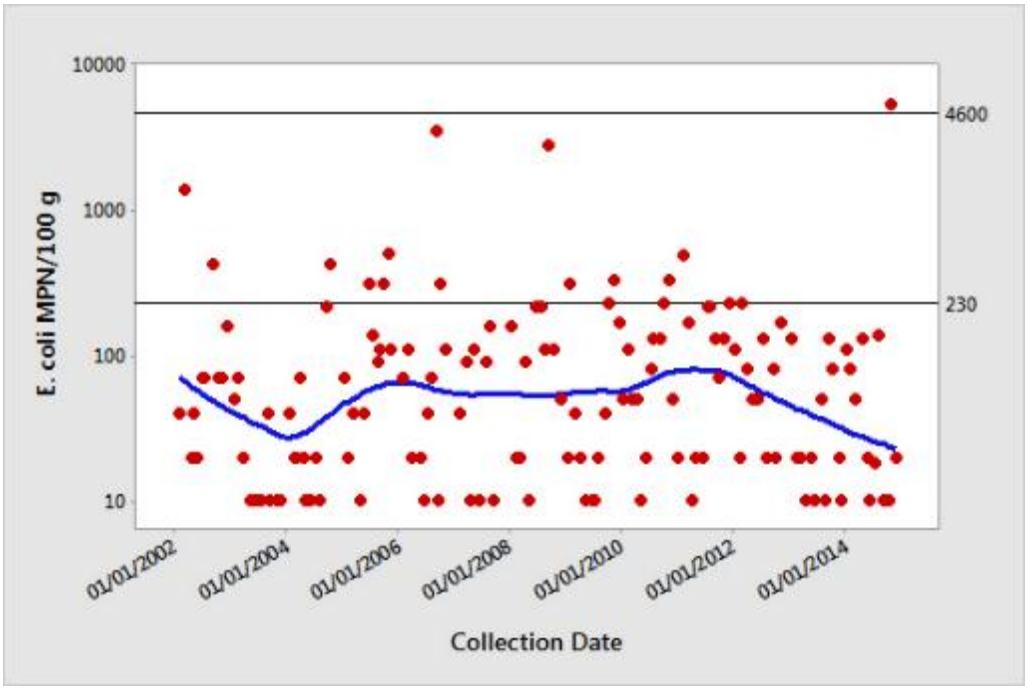

Figure 7.3 Scatterplot of Loch Fyne: Stonefield *E. coli* results by date (2002-2014)

No marked change in the general level of *E. coli* results in the queen scallops was evident over the date range shown.

No significant difference was found between Loch Fyne: Stonefield queen scallop log-transformed *E. coli* results from the two survey periods (Two sample t-test, t= -.70, DF = 131, p = 0.483).

No significant difference was found in the proportion of results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Chi-squared Test, p = 0.277).

No statistically significant difference was found in the proportion of results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 1).

Table 7.3 Results above and below 230 and 1000 *E. coli* MPN/100 g at Loch Fyne: Stonefield

	***E. coli* MPN/100g**			***E. coli* MPN/100g**		
	≤230	>230	**Total**	≤1000	>1000	**Total**
2002-2007	55	8	63	61	2	63
2008-2014	76	6	82	80	2	82
Total	131	14	145	141	4	145

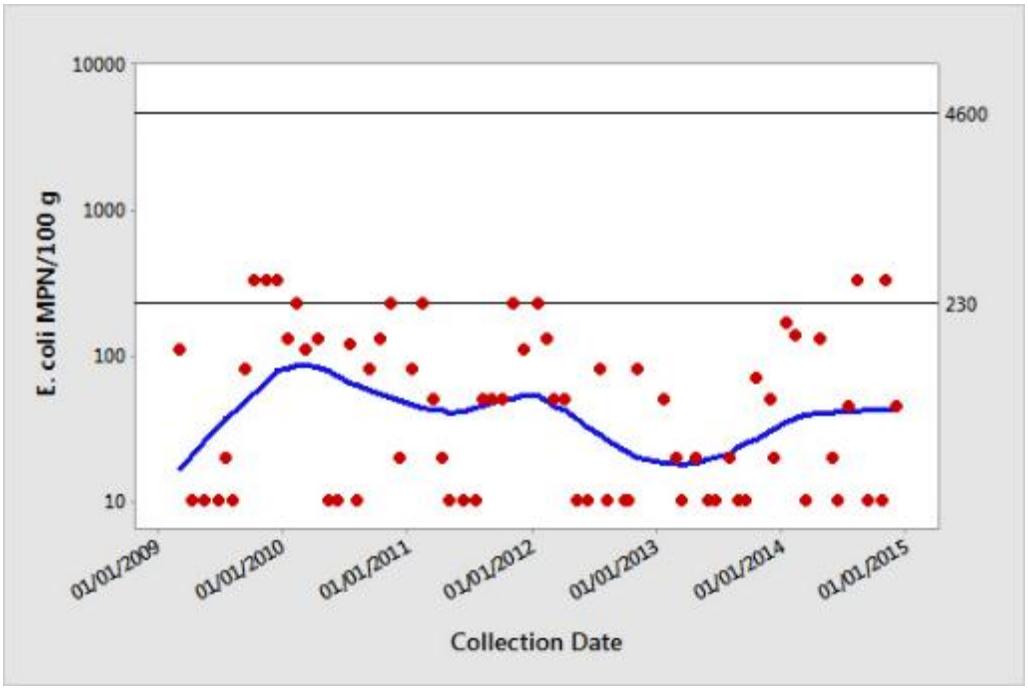

Figure 7.4 Scatterplot of Loch Fyne: Stonefield Oysters *E. coli* results by date (2009-2014)

There is no evidence of a marked change in the level of *E. coli* results in the Pacific oysters since 2009.

Conclusions

Queen scallops

Sampling has been reported at several locations across the site although most of the samples have been taken relatively close to the currently specified RMP. The highest results was reported in that vicinity. There is no evidence of a change in *E. coli* levels in the queen scallops since the beginning of 2002.

Pacific oysters

Pacific oyster sampling began at the North Bay site in 2009 since early 2010 have been taken within approximately 30 m of the currently specified RMP. There is no evidence of a change in *E. coli* levels in the Pacific oysters since the 2009.

Comparison of results between species

A significant difference was found in *E. coli* results between species, with higher results in queen scallops than in Pacific oysters.

8. Movement of contaminants

The conclusions of the bathymetry and hydrodynamics assessment in the 2009 report are as follows:

- Water flows in a northerly direction on flood tides and a southerly direction during ebb tides
- Current speeds are expected to be <1.1 knots owing to the effect of the sill location
- Barmore Island will disrupt near shore flow, creating eddies on the down current side and increasing flow on the up current side of the island
- Contamination impacts from Tarbert STW are unclear, owing to its location further offshore from the fisheries and in a separate and deeper channel
- Contamination inputs at East Loch Tarbert are expected to impact the South Bay site most significantly
- Wind causes flow patterns in the direction of the winds and a return flow along the bottom of the loch sometimes in the opposite direction though this is strongly influenced by bathymetry
- Within basins, wind driven flows will often set up a system of circular current patterns (gyres) at the basin scale
- Northerly and Southerly winds will be funnelled by the topography of the loch, which will impact circulation
- Freshwater inputs are expected to have a lower impact than tidally driven movement
- During high rainfall levels there is anticipated to be a surface low saline area, but no stratification

No estimate of particle transport distance was given in the 2009 sanitary survey report. An approximate particle transport distance of 1.7 km over the single flood or ebb phase of a tide has been estimated for Ardcastle Bay, located further north in Loch Fyne (Cefas/FSAS, 2014).

9. Overall Assessment

The following assessment has taken into account changes in the faecal contamination sources to the fisheries since the 2009 sanitary survey report.

Human sewage Impacts

Human population remains centred in the village of Tarbert, with low population density along the shorelines adjacent to the shellfish sites. Visitors to the area over the summer months will significantly increase the local population of Tarbert. This will increase loading on the public sewage network over the summer.

Several private sewage inputs along the western shoreline may impact the North Bay site. This included a significant source from a raw sewage input to sea noted 1.2 km northwest of the current North Bay site. Several additional inputs associated with new builds identified from planning applications: however, the discharges were intended to go to soakaway. There is some doubt as to whether the Stonefield Castle Hotel septic tank discharges to the marine environment, either directly or indirectly. If so, it may have an impact at the southern end of the present North Bay shellfish site.

Boating activity may have increased in the area following the completion of the new marina at Port a Vadie. Boating activity, particularly from pleasure boats will peak over summer months.

Agricultural impacts

No livestock were observed in the area during the 2014 shoreline survey and agricultural impacts are expected to remain minor.

Wildlife Impacts

Wildlife impacts remain relatively minor and unpredictable with the greatest effect associated with seabirds and eider ducks.

Seasonal Variation

The number of visitors to Tarbert continues to peak in the summer months. Pleasure boat activity will similarly increase from May during the Scottish Series yachting regatta through until the end of the summer.

There was insufficient data on which to assess whether seasonal variation in wildlife impacts might be expected around the North Bay site.

Watercourses

Recorded watercourses were located around East Loch Tarbert and along the shoreline adjacent to the production area. The watercourses entering East Loch Tarbert will impact the water quality there and may potentially impact at the South Bay site. The watercourses along the shoreline adjacent to the production area will be likely to affect water quality on the western side of the North Bay shellfish site.

The loadings estimated from the 2014 shoreline survey observations were markedly higher than those estimated previously. It is not clear as to whether this solely related to the amount of rai9nfall that fell around the time of each shoreline survey or whether it related to other unknown factors.

CTD casts taken at a number of locations across the North Bay shellfish site did not show any marked reduction of salinity with depth (<0.1 psu, which is within the error of the instrument).

Movement of contaminants

There has been no new information to suggest that the movement of contaminants around the North Bay site has changed. However, it is anticipated that the particle transport distance over a single phase of the tidal cycle will be similar to that estimated for Ardcastle Bay (1.7 km). This means that, subject to dilution and dispersion, contamination arising within East Loch Tarbert could reach the South Bay site over a single flood tide but not the North Bay site. Contamination arising from the Tarbert Barfad outfall It could impact at the South Bay site on an ebb tide, with any effects being enhanced by an easterly wind. The contamination could also reach the North Bay site, especially if surface transport were to be enhanced by a southeasterly wind.

Analysis of Results

Historical *E. coli* results

The two highest results seen in the queen scallops were from samples taken on the western side of the North Bay site, with the highest result being seen in the vicinity of the RMP located at the southwestern corner of the site. However, most samples have been recorded as having been taken at, or near, the RMP. Pacific oyster samples have been reported to have been taken from two areas within the site, both at the southern end. There was no apparent difference in results between the two clusters.

There has been no significant change in the *E. coli* levels in the queen scallop over time. There has also not been an apparent change in the *E. coli* levels in the Pacific oysters over time since sampling began in 2009. Average results from queen scallops have been significantly higher than those from Pacific oysters.

Shoreline Survey results

Two queen scallop samples were taken during the 2014 shoreline survey: one on the southeastern side of the North Bay site returned the higher result of 78 *E. coli* MPN/100 g and the other was taken to the mid-west side of the site and which returned a result of 20 *E. coli* MPN/100 g. A Pacific oyster sample taken towards the southeastern side of the North Bay site returned a result of <18 *E. coli* MPN/100 g. All three samples were accompanied by seawater samples and an additional seawater sample was taken at the northwestern corner of the site Three of the samples returned a result of 0 *E. coli* cfu/100 ml while the other returned a result of 2 *E. coli* cfu/100. A seawater sample was also taken at the northeast corner of the South Bay site and this returned a result of 1 *E. coli* cfu/100 ml.

Three other seawater samples were taken: one taken east of Barmore Island returned a result of 0 *E. coli* cfu/100 ml, whilst a sample taken from opposite a watercourse southeast of East Loch Tarbert returned a result of 9 *E. coli* cfu/100 ml. A result of 34 *E. coli* cfu/100 ml was returned from a sample taken from the pier on the southwestern side of East Loch Tarbert (near a PS).

Conclusions

The 2009 report considered the following as the significant sources of faecal contamination to Loch Fyne: Stonefield;

- Significant inputs from CSOs associated with the three pumping stations located in Tarbert, which will impact the South Bay site.
- Boating activity associated with Tarbert Marina and East Loch Tarbert, within the wider Loch Fyne and at anchorages in North Bay are anticipated to impact both sites and will have the greatest level of impact during the busy summer months when yachts will be visiting the area.
- There may be some level of impact from freshwater inputs at the North Bay site, with higher sample results associated with previous seven day rainfall.
- Contaminations inputs at East Loch Tarbert will be carried to the South Bay site upon flood tides.
- Intermittent inputs enter from the north of the production area

This review has found several changes in the contamination sources to Loch Fyne: Stonefield. The most significant contamination sources identified in the 2015 review are as follows;

- Freshwater inputs from watercourses along the shoreline are the most significant identified contamination sources to the North Bay site and will impact the southern and western extents of the site.

- Loadings estimated from the results of the 2014 shoreline survey indicate that contamination from watercourses may, on occasion, be much greater than previously determined.

- The potential impact from the hotel at the southern end of the production area will depend on whether the discharge goes into the marine environment, either directly or indirectly. The available information is conflicting in this regard.

- Several private sewage inputs along land to the north and west of the North Bay site will pose potential sources of contamination to the fishery.

- Additional faecal contamination may arise from boating activities.

- The South Bay site may be more likely to be subject to contamination arising from the East Loch Tarbert area and from the continuous Tarbert Barfad discharge. This is important if there is ever the intention to harvest bivalve shellfish for sale from the South Bay area.

- Queen Scallop sample results were statistically significantly higher than Pacific oyster samples.

- Information from the Loch Fyne: Ardcastle sanitary survey indicates that the particle transport distance over a single phase of the tidal cycle could be of the order of 1.7 km.

Overall, the spatial information relating to the significant faecal contamination sources remains largely unchanged since the 2009 sanitary survey report.

10. Recommendations

It is recommended that the production area boundaries and RMP location for the North Bay site be maintained as previously recommended.

Loch Fyne Stonefield and Loch Fyne: Stonefield Oysters

Production area

This is defined as: the area bounded by lines drawn between NR 8646 7352 and NR 8700 7352 and between NR 8700 7352 and NR 8700 7183 extending to MHWS.

RMP

This is specified as: NR 8648 7225.

Tolerance

A tolerance of 40 m is recommended to allow for the movement of the lines supporting the lantern nets.

Depth

A depth of 10 m is recommended as it is assumed that the nets continue to be located at this depth.

Frequency

Sampling should remain monthly.

South Bay

The outcome of this review has emphasized that the South Bay site may be impacted by different sources to those affecting the North Bay site. Therefore, if the site is ever to be classified for sale of bivalve shellfish, an assessment should be undertaken of the available information (including that in the sanitary survey report and this review) in order to determine a separate RMP and production area boundaries.

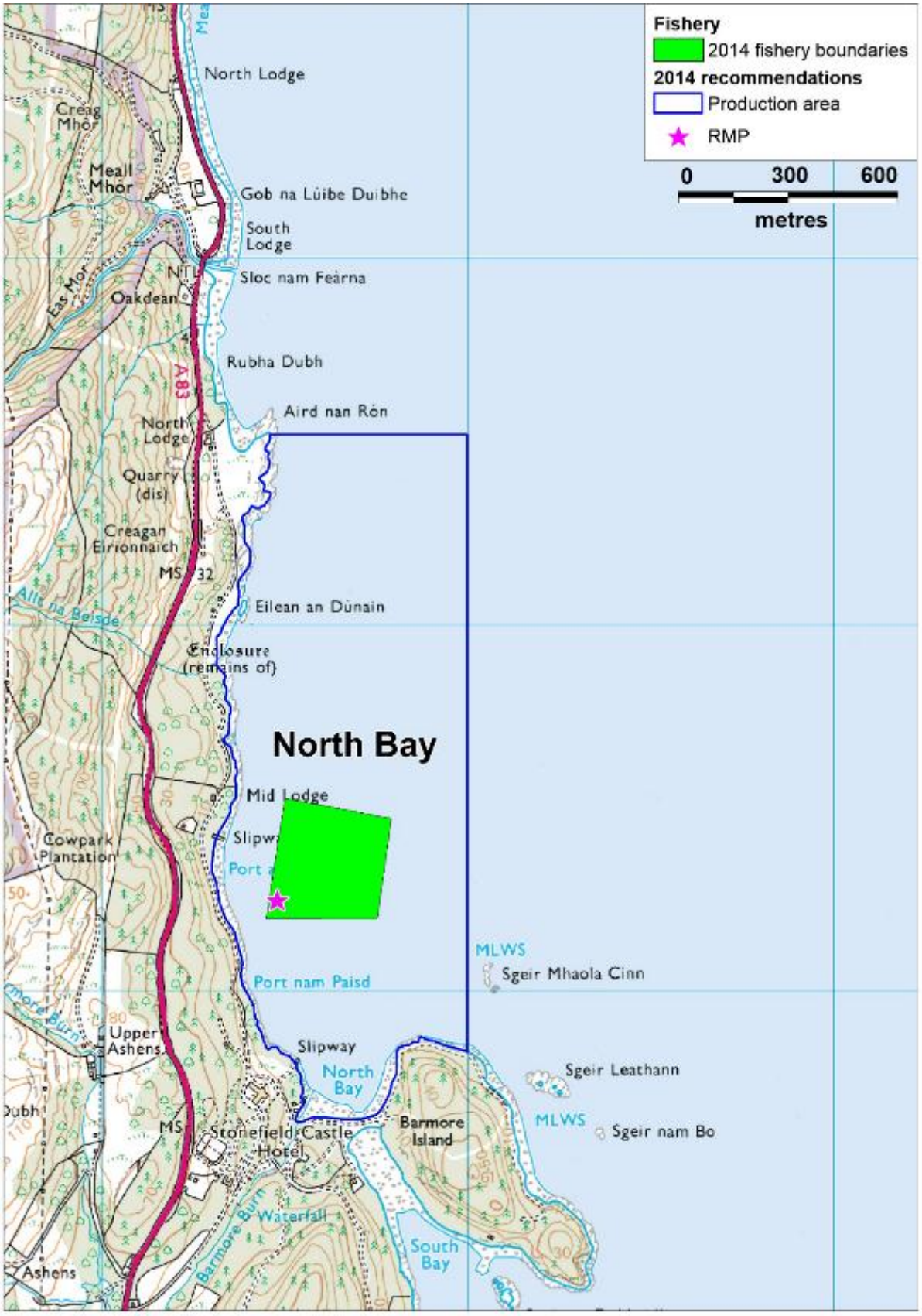

Figure 10.1 Recommended production area boundaries and RMP for Loch Fyne: Stonefield and Loch Fyne: Stonefield Oysters

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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 Loch Fyne: Stonefield are listed in Table 1.

Table 1 Planning applications to areas around Loch Fyne: Stonefield

Location	Date	Ref No	Description	Area
Barfad	28-Sep-11	11/01887/PP	Erection of 5 dwellinghouses, installation of associated sewage treatment plants and formation of new vehicular access	Barfad Tarbert Argyll And Bute
	09-Oct-14	14/02444/PP	Erection of boathouse to store 5 boats and to use natural slipway in coastline at East Barfad	Barfad Tarbert Argyll And Bute
Ashens	03-Mar-11	11/00364/PP	Erection of 2 dwellinghouses, installation of 2 septic tanks and formation of vehicular access	Ashens Stonefield Tarbert Argyll And Bute PA29 6YJ
Stonefield	22-Mar-11	11/00456/PPP	Site for the erection of dwellinghouse and installation of septic tank	Stonefield Tarbert Argyll And Bute
	21-Mar-12	12/00649/PPP	Site for erection of dwellinghouse, installation of septic tank and formation of new vehicular access	Stonefield Tarbert Argyll And Bute
	10-Aug-12	12/01734/PP	Erection of extension to dwelling-house to form garage/utility area, demolition of tea-hut/summer-house and erection of new summer-house (ammended 23.10.12).	Stonefield Tarbert Argyll And Bute PA29 6YJ
	12-Nov-12	12/02552/PP	Renewal of planning permission reference 09/00249/DET (Formation of upgraded access, erection of one dwelling house and its detached garage and installation of septic tank).	Stonefield Tarbert Argyll And Bute PA29 6YJ
	12-Nov-12	12/02528/PP	Renewal of planning permission 09/00248/PP - Formation of upgraded access, erection of four detached dwelling houses and their detached garages and installation of septic tanks	Stonefield Tarbert Argyll And Bute PA29 6YJ
Tarbert	03-Nov-10	10/01855/PP	Erection of 8 affordable housing units comprising of 5 flats, 1 detached dwellinghouse, 2 semi-detached houses, formation of access to classified road and associated works.	Barmore Road Tarbert Argyll And Bute PA29 6TT
	27-Jun-11	11/01103/PP	Erection of a dwellinghouse and alterations to access	Barmore Road Tarbert Argyll And Bute PA29 6TT
	06-Nov-13	13/02579/PP	Change of use of gallery/office to holiday letting accommodation	Harbour Street Tarbert Argyll And Bute PA29 6UD
	26-Sep-14	14/02171/PP	Erection of dwelling house - decision pending	Lady Ileene Road Tarbert Argyll And Bute PA29 6TU

Appendix 2

Shoreline Survey Report

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

Document Number	B0067_Shoreline 0044

Revision History

Revision	Changes	Date
A	Issue for internal review	11/11/2014
B	Issue for internal review	17/11/2014
1	First issue to Cefas	21/11/2014
2	Second issue to Cefas with corrections from issue 01	12/12/2014

	Name & Position	Date
Author	Eilidh Cole & Peter Lamont	11/11/2014
Checked	Andrea Veszelovszki	12/12/2014
Approved	John Hausrath	12/12/2014

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

Production area:	Loch Fyne: Stonefield
Site name:	North Bay
SIN:	AB-154-043-15
Species:	Queen Scallops
Existing RMP:	NR 8648 7225
Site name:	South Bay
SIN:	AB-154-044-15
Species:	Queen Scallops
Existing RMP:	Not currently within production area
Site name:	North Bay Oysters
SIN:	AB-435-840-13
Species:	Pacific Oysters
Existing RMP:	NR 8648 7225
Harvester:	Mr Gordon Goldsworthy
Local Authority:	Argyll and Bute Council
Status:	Existing area
Date Surveyed:	20/10/2014 – 22/10/2014
Surveyed by:	Eilidh Cole & Peter Lamont

Area Surveyed

Approximately 1.5 km of the western shoreline of Loch Fyne starting at Barmore Island heading north until Aird nan Ròn. Approximately a further 1 km was surveyed on the western shoreline from Rubha Dubh heading northwards. Approximately 2.5 km of shoreline was surveyed in the Tarbert area beginning at Rubha Loisgte then heading west until Tarbert then northeast for approximately 1 km.

Weather

Heavy rainfall occurred over the weekend of the 18th and 19th of October, 48 hours prior to the survey.

On the first day of the survey, Monday the 20th of October, there was very little rainfall with only a few light showers later on in the day. Temperature was around 12°C with a light south westerly wind of around 12 mph. It was overcast with around 95% cloud cover and the sea state was calm.

On Tuesday the 21st of October, there had been overnight rain. During the day there was heavier rain with more frequent showers scattered throughout the day. The wind was north westerly up to 35 mph and there was about 70% cloud cover. Temperature was about 9°C and the sea state was choppy.

On Wednesday the 22nd of October it rained continuously for the entire day with the occasional heavier shower throughout. Temperatures were around 9°C and cloud cover was 100%. Wind direction was south westerly and reached approximately 12 mph. Sea state was choppy.

Stakeholder engagement during the survey

Prior to the survey the sampling officer, Mr Willie McQuarrie, was very helpful and provided useful information regarding the survey site and fishery. Unfortunately the survey team were unable to meet with Mr McQuarrie during the course of the survey.

On the first day of the survey (20th October), the survey team met with the Harvester's boat crew, who kindly took the survey team out on the boat to collect seawater and shellfish samples and to collect CTD cast data. All crew members were very helpful and provided further details regarding the site.

Fishery

Queen scallops (*Aequipecten opercularis*) and Pacific oysters (*Crassostrea gigas*) are cultivated within the Loch Fyne Stonefield fishery and harvest takes place all year round but only when the shellfish are large enough.

There are three sites at the shellfishery however, the most northerly site was badly damaged due to bad weather and is no longer there. It is uncertain at present what the future plans might be regarding this site.

There are nine lines in the middle site, located just north of Barmore Island. There were ten lines in total, however, one line was lost due to bad weather damage. The Harvester, Mr. Gordon Goldsworthy, said that spat fall had been poor for the last four years and he had been considering not re-instating the lines destroyed by bad weather. However, spat fall this year has been good and his present plan is to reinstate the lines both north and south of Barmore Island. All shellfish are grown in lantern nets and all samples were taken from the top of the lantern nets.

There were no mature shellfish available to sample at the most southerly site, south of Barmore Island but the location and extent of this site was recorded, as requested (Figures 3 & 4 and waypoints 25-29).

Queen scallop samples were collected at waypoints 6 and 18 and one Pacific oyster sample was collected at waypoint 21. Extra oyster samples could not be taken as there were none available in any other locations. No shellfish

samples could be taken from the most northerly site either, as it was badly damaged during bad weather and there were no longer any lines at that site.

Sewage Sources

The area of shoreline surrounding the shellfishery at Stonefield is largely uninhabited with the town of Tarbert to the south and a scattering of houses along the shoreline north of Tarbert.

Public facilities were observed in Tarbert including public toilets, cafés and restaurants. There were also several hotels and B&Bs in the town. Public toilets, shower facilities and laundry facilities were also observed at the marina in Tarbert at waypoint 104. No obvious sewage discharges were observed coming from any of these facilities although any pipes observed near these areas were noted and sampled where possible. A hotel was also observed along the shoreline north of Tarbert at waypoint 30 and again, no visible discharges were observed coming from the hotel directly.

Seasonal Population

No official campsites or caravan parks were seen in the area surrounding the production area at Stonefield. However, there were several hotels and B&Bs observed in Tarbert and another hotel (Stonefield Castle Hotel) further north opposite Barmore Island.

Boats/Shipping

A large number of boats were observed during the survey at Loch Fyne Stonefield. There was one boat observed at waypoint 12 and another at waypoint 53. Two more boats were seen at waypoint 82. The local sailing club was situated at waypoint 91 and there were nine leisure boats on hard standings, fourteen kayaks and dinghies and one smaller boat, all of them onshore. CalMac ferries were seen throughout the day leaving and arriving from Tarbert. Three boats were at waypoint 93 and with a boatyard and boat builders at waypoint 94. Fishing boats were observed frequently throughout the survey with three at waypoint 97, four at waypoint 98 and four more at waypoint 99. Six smaller leisure boats were also seen at waypoint 99. The marina was situated at waypoint 104 where the harbour master informed the survey team that there were between seventy-three and seventy-five vessels moored there at that time. Three sailing yachts were observed at waypoint 113 along with two smaller boats.

Farming and Livestock

No cattle, sheep or other livestock were observed at any point during the shoreline survey although two peacocks were seen at waypoint 40. There were also no farms or farmland in the area.

Land Use

The land surrounding Loch Fyne Stonefield, outside of Tarbert itself, appears to be mostly used for mixed forestry. Dwellings above Tarbert are scattered. Tarbert appears to be mainly a fishing town and has a large harbour and marina.

Land Cover

The predominant land cover surrounding Loch Fyne Stonefield, is rough heathland with mixed forest. The land is steep in places with rocky sections immediately next to the shore.

Watercourses

Four watercourses were marked on the survey map to be sampled during the survey and all of these were samples successfully. Extra freshwater samples were also taken from pipes as requested in the sampling plan. Piped samples were named SFFW8, SFFW9, SFFW13, SFFW15, SFFW16, SFFW17, SFFW18, SFFW22 and were taken at waypoints 58, 60, 73, 81, 84, 86, 89, and 109 respectively. Extra freshwater samples SFFW2, SFFW3, SFFW4, and SFFW6 were also taken at waypoints 34, 36, 41 and 47 as these watercourses were flowing directly opposite the shellfishery into the sea. Samples SFFW11, SFFW12, SFFW14, SFFW19, SFFW20, SFFW21, and SFFW23 were also taken as extra samples at waypoints 67, 70, 76, 92, 101, 105 and 111 as these were either large, heavily flowing watercourses or because they were deemed to be of high risk due to the proximity of public facilities, houses or other dwelling places.

Of the watercourses sampled, the largest was the Abhainn Strathainn at waypoint 62 which was over 7 m in width. The other watercourses sampled were all 1 m or less in width with the exceptions of the Barmore Burn at waypoint 4 and the unnamed watercourse at waypoint 101, which were both significantly larger.

Wildlife/Birds

Wildlife surrounding Loch Fyne was abundant and a large range of birds and wildlife were observed during the course of the survey.

There was one heron *(Ardea cinerea)* at waypoint 2 and another two herons at waypoint 12. A flock of fifteen eider ducks (*Somateria mollissima*) were observed at waypoint 17 with three more at waypoint 15. Several gulls *(Larus argentatus)* were observed at various points during the survey. One gull was on the water at waypoint 12 and one gull was flying overhead at waypoint 27. Two gulls were observed on the shore at waypoint 68 with a further seagull at waypoint 75. Two more gulls were at 85 and also at 90 and eight gulls were on an artificial island at waypoint 98. Other birds seen during the survey included a buzzard (*Buteo buteo*) at waypoint 50, two great tits (*Parus major*) and two robins (*Erithacus rubecula*) at waypoint 51, one shag (*Phalacrocorax aristotelis*) at waypoint 52, one pipit *(Anthus petrosus)* at waypoint 63 and one oyster *(Haematopus ostralegus)* catcher at waypoint 69 and another at waypoint 74.

One red squirrel *(Sciurus vulgaris)* and one seal were also observed during the survey at waypoints 38 and 103 respectively. Two rabbits (*Oryctolagus cuniculus*) were observed briefly at the start of the Tarbert section (waypoint 65).

Specific observations made during the survey are mapped in Figures 1 and 2 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figures 3 and 4. Bacteriology results are given in Tables 2 and 3. Photographs are presented in Figures 5 – 22.

Figure 1. Loch Fyne: Stonefield waypoints north.

Figure 2. Loch Fyne: Stonefield samples north.

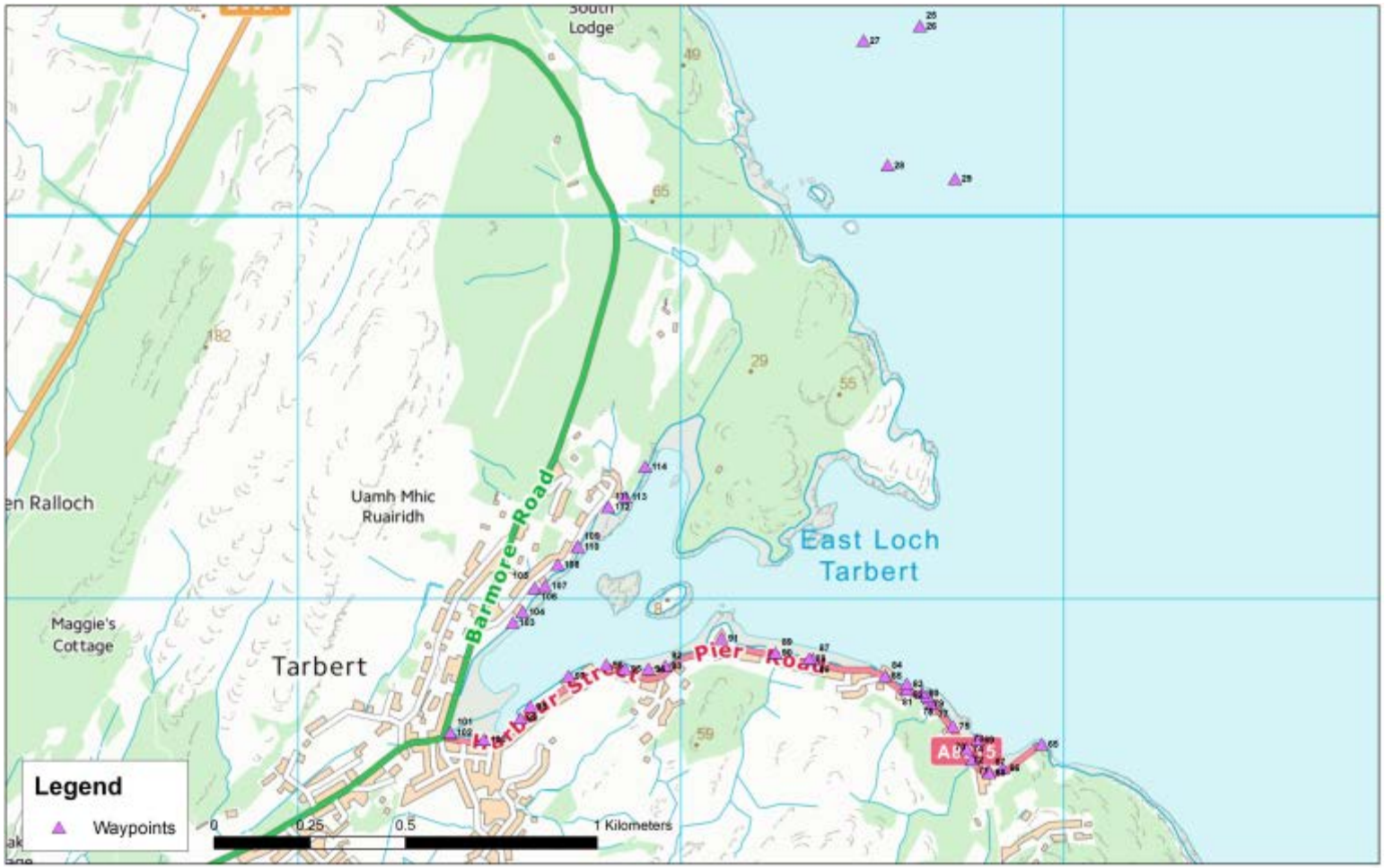

Figure 3. Loch Fyne: Stonefield waypoints south.

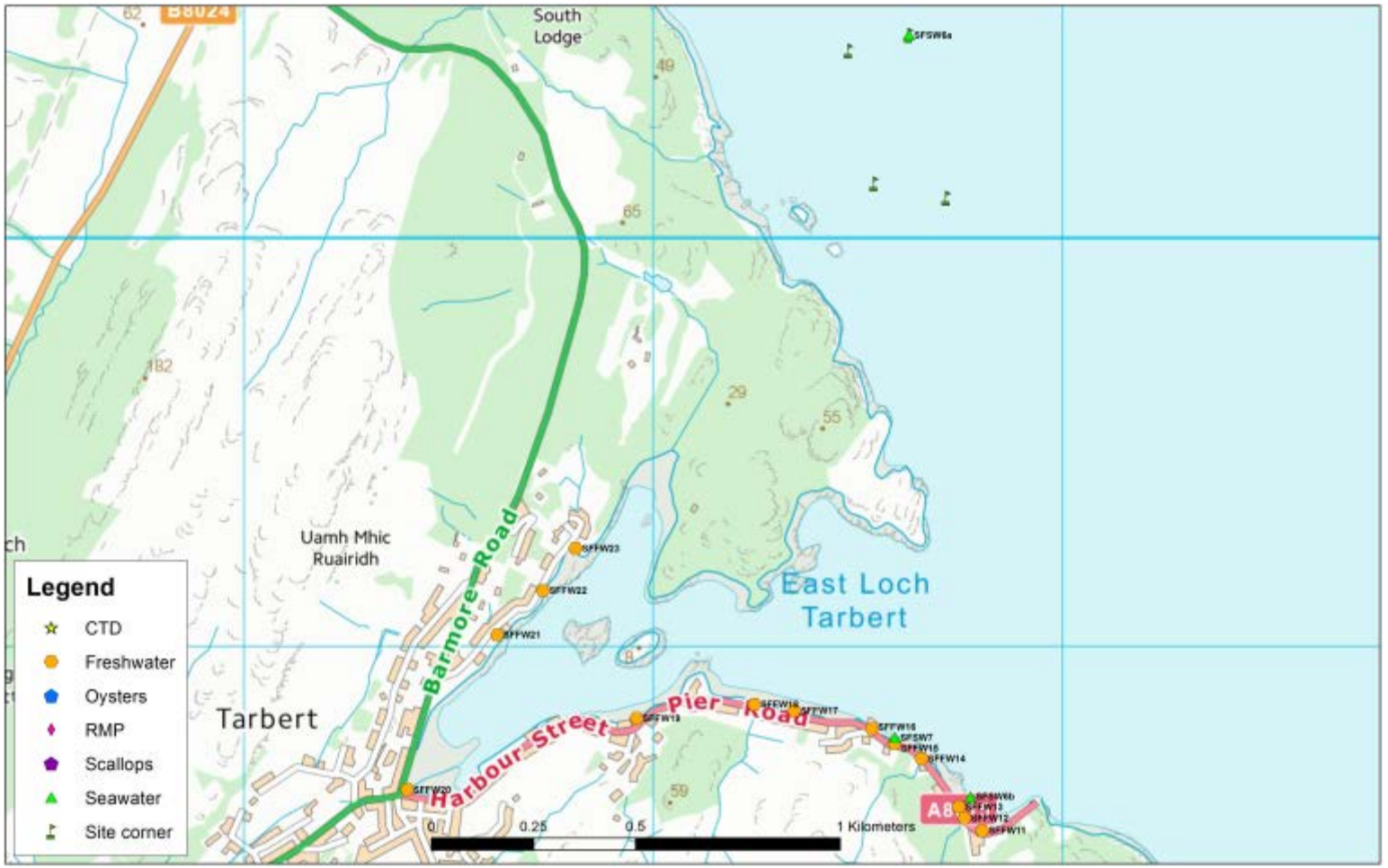

Figure 4. Loch Fyne: Stonefield samples south.

Table 1 Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	20/10/2014	12:24	NR 86822 71833	186823	671834	Fig 5		Start of shore walk at Barmore Island. Stonefield Castle Hotel and two houses on opposite (mainland) shore. One passing working boat close to shore (harvester's boat).
2	20/10/2014	12:32	NR 86668 71625	186668	671625			Shore Cottage on mainland shore south of Barmore Island causeway. One heron in water.
3	20/10/2014	12:35	NR 86555 71624	186556	671625			Harvester shore base consisting of shed with piles of lantern nets stored outside.
4	20/10/2014	12:52	NR 86513 71588	186513	671589	Fig 6	SFFW1	Planned freshwater sample from Barmore Burn.
5	20/10/2014	12:52	NR 86514 71591	186515	671591			Associated with waypoint 4. Stream split into three flows by large rocks: Width 1 = 1.95 m, depth 1a = 16 cm (@ 0.25 m from rock), flow 1a 0.617 m/sec SD 0.017; depth 1b = 19 cm (@ 0.95 m from rock), flow 1b 0.741 m/sec SD0.008. Width 2 = 0.9 m, depth = 25 cm, flow 0.588 m/sec SD 0.020. Width 3 = 1.15 m, depth 15 cm, flow 1.039 m/sec SD 0.019. Shore walk paused for boat work and shellfish sampling.
6	20/10/2014	13:25	NR 86753 72196	186754	672197	Fig 7	SFSF1	Planned shellfish sample of Queen scallops.
7	20/10/2014	13:26	NR 86752 72196	186752	672196		SFSW1	Planned seawater sample.
8	20/10/2014	13:26	NR 86752 72196	186752	672197		CTD	Planned CTD cast sample.
9	20/10/2014	13:32	NR 86752 72195	186753	672195			SE corner of farm array.
10	20/10/2014	13:36	NR 86793 72472	186793	672472			NE corner of farm array of nine lines between 8 and 10 m deep. Harvesting conducted all year and when stock are large enough.
11	20/10/2014	13:39	NR 86501 72526	186502	672526			NW corner of farm array. No shellfish available for sampling at this location.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
12	20/10/2014	13:41	NR 86452 72478	186452	672478			No shellfish present and planned sample not possible from this location. One gull on water and two herons. One other boat visible.
13	20/10/2014	13:42	NR 86451 72477	186451	672477		SFSW2	Planned seawater sample.
14	20/10/2014	13:42	NR 86450 72477	186451	672478		CTD	Planned CTD cast sample.
15	20/10/2014	13:50	NR 86451 72198	186451	672199	Fig 8		SW corner of array. Two eider drakes and one eider duck.
16	20/10/2014	13:50	NR 86451 72198	186451	672199			RMP
17	20/10/2014	13:53	NR 86522 72340	186522	672341			Wildlife; flock of about 15 eiders on water.
18	20/10/2014	13:53	NR 86522 72341	186523	672341		SFSF2	Shellfish sample of Queen scallops.
19	20/10/2014	13:53	NR 86522 72340	186523	672340		SFSW3	Planned seawater sample.
20	20/10/2014	13:57	NR 86523 72340	186523	672341		CTD	Planned CTD cast sample.
21	20/10/2014	14:04	NR 86672 72289	186673	672290		SFSF3	Planned shellfish sample Pacific oysters.
22	20/10/2014	14:05	NR 86674 72289	186675	672289		SFSW4	Planned seawater sample.
23	20/10/2014	14:05	NR 86675 72288	186676	672289		CTD	Planned CTD cast sample. One boat out at sea.
24	20/10/2014	14:21	NR 87473 71591	187473	671591	Fig 9	SFSW5	Planned seawater sample taken opposite Barmore Island.
25	20/10/2014	14:29	NR 87624 70496	187624	670496			NE corner of farm array south of Barmore.
26	20/10/2014	14:29	NR 87624 70496	187624	670496		SFSW6a	Planned seawater sample from NE corner of farm array south of Barmore Island.
27	20/10/2014	14:31	NR 87477 70458	187477	670458			NW corner of farm array. One gull overhead.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
28	20/10/2014	14:34	NR 87540 70132	187540	670132			SW corner.
29	20/10/2014	14:35	NR 87716 70097	187716	670098			SE corner.
30	21/10/2014	09:56	NR 86519 71595	186519	671596			Resumption of Stonefield Castle Hotel shore walk at bridge over stream by harvester's shore based shed. Rain overnight and river water raised above the level of the day before.
31	21/10/2014	10:04	NR 86524 71789	186525	671790			Slipway. The team were informed by harvester boat crew that there is a pipe running into the sea by this slipway but did not observe the pipe possibly because the tide was high at the time.
32	21/10/2014	10:08	NR 86424 71765	186424	671766			Large concrete septic tank about 30 m from the hotel. Approximate size 2.4 x 4.8 m and with three manhole covers.
33	21/10/2014	10:08	NR 86424 71766	186424	671766			Extra waypoint taken in error.
34	21/10/2014	10:15	NR 86401 71890	186401	671890		SFFW2	Unplanned freshwater sample. Small unnamed watercourse.
35	21/10/2014	10:15	NR 86401 71889	186401	671890			Associated with waypoint 34. Width 0.2 m, depth 3 cm, flow 48 L/min (measured by jug 2 L in 2.5 sec).
36	21/10/2014	10:31	NR 86319 72204	186320	672205		SFFW3	Unplanned freshwater sample. Unnamed watercourse.
37	21/10/2014	10:31	NR 86320 72204	186320	672205			Associated with waypoint 36. Width - 0.7 m, depth - 4 cm, flow - 0.803 m/sec, SD -0.014.
38	21/10/2014	10:40	NR 86303 72287	186303	672287			One red squirrel on tree next to shore.
39	21/10/2014	10:41	NR 86279 72331	186280	672332			Overnight rain runoff.
40	21/10/2014	10:43	NR 86271 72398	186271	672398			Dwelling appearing to be new. Sign on entrance gate claims peacocks are kept. Two peacocks were observed.
41	21/10/2014	10:47	NR 86272 72440	186273	672440	Fig 10	SFFW4	Unplanned freshwater sample. Unnamed watercourse running in open, rectangular masonry culvert into sea alongside new dwelling referred to in waypoint 40.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
42	21/10/2014	10:47	NR 86273 72440	186274	672441	Fig 10		Associated with waypoint 41. Width - 0.55 m, depth - 4 cm, flow - 0.849, SD - 0.191.
43	21/10/2014	10:54	NR 86306 72494	186306	672495			House landward of roadway with nearby building under construction to the seaward of the roadway on a rocky promontory. No septic tank observed for first house but three metal drain covers of about 30 cm diameter were observed spaced out down the lawn towards the sea.
44	21/10/2014	10:58	NR 86330 72671	186331	672672			Small unnamed watercourse. Not sampled as less than 1 m in width.
45	21/10/2014	11:02	NR 86298 72831	186299	672832		SFFW5	Planned freshwater sample from Allt na Béisde.
46	21/10/2014	11:02	NR 86298 72831	186298	672832			Associated with waypoint 45. Width -0.65 m, depth - 16 cm, flow - 0.205, SD - 0.023.
47	21/10/2014	11:13	NR 86280 72875	186281	672876		SFFW6	Unplanned freshwater sample from unnamed watercourse.
48	21/10/2014	11:13	NR 86281 72874	186282	672875			Associated with waypoint 47. Width - 1.0 m, depth - 18 cm, flow - 0.887 m/sec, SD - 0.056.
49	21/10/2014	11:22	NR 86288 72988	186289	672989			Unnamed small watercourse. Not sampled as less than 1 m in width.
50	21/10/2014	11:24	NR 86331 73066	186332	673066			One buzzard perched in tree. Slipway nearby.
51	21/10/2014	11:29	NR 86359 73131	186360	673132			Two great tits *(Parus major)* and two robins *(Erithacus rubecula)*.
52	21/10/2014	11:33	NR 86327 73347	186328	673348	Fig 11		One shag *(Phalacrocorax aristotelis)* perched on rocks by sea.
53	21/10/2014	11:35	NR 86314 73427	186314	673428			Boat, Dell Quat dory on shore seen from waypoint 51.
54	21/10/2014	11:37	NR 86307 73545	186308	673545			North Lodge dwelling house mainland side of the roadway with septic tank on lawn seaward of the roadway. End of Stonefield Castle Hotel shore walk section.
55	21/10/2014	12:33	NR 86267 73706	186267	673706			Start of north section of Loch Fyne Stonefield shore walk. Roadside A83.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
56	21/10/2014	12:37	NR 86268 73827	186268	673827	Fig 12	SFFW7	Planned freshwater sample from unnamed watercourse.
57	21/10/2014	12:37	NR 86268 73827	186268	673827	Fig 12		Associated with waypoint 56. Width - 0.39 m (internal diameter of piped watercourse), flow width - 31 cm, depth - 8 cm, flow - 1.816 m/sec, SD - 0.064.
58	21/10/2014	12:45	NR 86273 73872	186273	673873	Fig 13	SFFW8	Unplanned freshwater sample from soil pipe.
59	21/10/2014	12:45	NR 86272 73873	186273	673873	Fig 13		Associated with waypoint 58. Brown plastic 100 mm diameter soil pipe with outlet under water. Leak at joint sampled.
60	21/10/2014	12:53	NR 86268 73906	186268	673907		SFFW9	Unplanned freshwater sample from pipe.
61	21/10/2014	12:53	NR 86268 73906	186268	673907			Associated with waypoint 60. Possible field drain with dwelling house nearby on the mainland side (west) of the A83. Diameter - 0.45 m, flow width - 37 cm, depth - 10 cm, flow - 0.273 m/sec, SD - 0.063.
62	21/10/2014	12:59	NR 86282 73975	186282	673976		SFFW10	Planned freshwater sample from Abhainn Strathainn.
63	21/10/2014	12:59	NR 86281 73975	186282	673976			Associated with waypoint 62. Width - 7.3 m, depth - 15 cm, flow - 1.868 m/sec, SD - 0.051 @ 1 m from north bank. Fairly level stream bed with uniform depth across river. Septic tank and outfall on the north bank about five metres upstream of the bridge. One pipit on the shore downstream of the bridge.
64	21/10/2014	13:14	NR 86327 74185	186327	674186			End of Loch Fyne Stonefield northern shore walk section at Gob na Luibe Duibhe. Fishfarm.
65	22/10/2014	09:50	NR 87942 68620	187942	668620			Start of Loch Fyne Stonefield, Tarbert shore walk section beginning at the south end. Two mooring buoys off the shore and passing ferry. Two rabbits.
66	22/10/2014	10:03	NR 87841 68557	187841	668558			Two metal manhole covers on road above iron pipe below. Pipe leads underground with another manhole cover in the ground. Pipe diameter 18 cm, house behind on mainland side of road.
67	22/10/2014	10:05	NR 87804 68549	187804	668550	Fig 14	SFFW11	Unplanned freshwater sample from culvert.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
68	22/10/2014	10:06	NR 87805 68546	187805	668546	Fig 14		Associated with waypoint 67. Stone-built under-road culvert. Width - 0.95 m, depth - 2 cm at each side becoming 6 cm in the middle, flow - 1.150 m/sec, SD - 0.034. Flow was measured from the centre of the culvert at 6 cm depth. Ceramic soil pipe 12 cm diameter in culvert but with no flow. Two seagulls and one oyster catcher on shore.
69	22/10/2014	10:16	NR 87775 68631	187775	668632		SFSW6b	Unplanned seawater sample.
70	22/10/2014	10:22	NR 87760 68580	187761	668580		SFFW12	Unplanned freshwater sample from unnamed watercourse.
71	22/10/2014	10:23	NR 87760 68579	187761	668579			Associated with waypoint 70. Watercourse running under road onto the shore. Width - 0.9 m, depth - 4 cm, flow 0.761 m/sec, SD - 0.090. Roadside underground pipe (about 10 cm diameter) exposed above watercourse.
72	22/10/2014	10:31	NR 87746 68607	187747	668608	Fig 15		Field drain pipe, black corrugated plastic.
73	22/10/2014	10:32	NR 87747 68607	187747	668607	Fig 15	SFFW13	Unplanned freshwater sample from pipe mentioned in waypoint 72.
74	22/10/2014	10:32	NR 87746 68607	187747	668607	Fig 15		Associated with waypoint 73. Pipe internal diameter 150 mm. Water flow width - 8 cm, depth - 2 cm, flow - 1.079 m/sec, SD - 0.036. One oystercatcher on shore.
75	22/10/2014	10:37	NR 87710 68667	187710	668667			Double manhole cover on road shore side, houses mainland side. Possibly part of Scottish Water communal system. One mooring buoy in sea. One sea gull.
76	22/10/2014	10:43	NR 87655 68725	187656	668725		SFFW14	Unplanned freshwater sample from culvert.
77	22/10/2014	10:43	NR 87655 68725	187655	668725			Associated with waypoint 76. Culvert running past Dunivaig B&B under road to shore. Width - 9 cm, depth - 8 cm, flow - 1.298 m/sec, SD - 0.087.
78	22/10/2014	10:47	NR 87648 68738	187649	668739			Two metal manhole covers on road. Possibly part of Scottish Water communal system.
79	22/10/2014	10:47	NR 87643 68745	187644	668746			Concrete manhole cover.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
80	22/10/2014	10:48	NR 87630 68753	187631	668754			Metal manhole cover.
81	22/10/2014	10:58	NR 87589 68762	187590	668763	Fig 16	SFFW15	Unplanned freshwater sample from pipe.
82	22/10/2014	10:58	NR 87589 68762	187590	668763	Fig 16		Associated with waypoint 81. Broken pipe emerging from old brickwork block on shore about 3 m east of Scottish Water pumping station close to pier. Pipe internal diameter 48 cm. Water flow width - 14 cm, depth - 2, flow - 1.096 m/sec, SD - 0.167. One boat out at sea and one boat on shore.
83	22/10/2014	10:59	NR 87589 68777	187590	668777		SFSW7	Planned seawater sample taken from beside pier. Scottish water pumping station nearby (referred to in waypoint 80).
84	22/10/2014	11:06	NR 87534 68798	187534	668799	Fig 17	SFFW16	Unplanned freshwater sample from pipe.
85	22/10/2014	11:06	NR 87533 68798	187534	668799	Fig 17		Associated with waypoint 84. Ceramic pipe next to possible shellfish depuration site on pier beside road. Pipe diameter - 150 mm, water width - 8 cm, depth - 1 cm, flow - 0.098 m/sec, SD - 0.400. Loose pipe and leaking water underneath pier but inaccessible to sample. Houses on mainland roadside. Two gulls on sea.
86	22/10/2014	11:16	NR 87344 68842	187345	668843		SFFW17	Unplanned freshwater sample from pipe.
87	22/10/2014	11:18	NR 87345 68842	187346	668842			Associated with waypoint 86. Plastic pipe 150 mm diameter. Water width - 8 cm, depth - 1 cm, flow approximately - 1.8 L/min (measured by sample bottle 30 ml in 1 sec). House on mainland roadside.
88	22/10/2014	11:23	NR 87335 68843	187335	668844			Very small watercourse running onto shore under road. Not sampled as less than 1m width.
89	22/10/2014	11:29	NR 87247 68858	187247	668858	Fig 18	SFFW18	Unplanned freshwater sample from pipe.
90	22/10/2014	11:29	NR 87247 68859	187247	668859	Fig 18		Associated with waypoint 89. Under road pipe. Diameter - 0.9 m, water width - 35 cm, depth - 7 cm, flow - 2.766 m/sec, SD - 0.361. One mooring buoy off the shore. Two gulls on shore.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
91	22/10/2014	11:39	NR 87106 68896	187107	668897	Fig 19		Sailing club premises with 9 leisure craft on hard standing, 14 kayaks plus dinghies. One small boat moored. CalMac ferry terminal slipway immediately eastward.
92	22/10/2014	11:46	NR 86959 68823	186959	668824		SFFW19	Unplanned freshwater sample.
93	22/10/2014	11:46	NR 86959 68824	186959	668824			Associated with waypoint 92. Unnamed watercourse hidden by vegetation. Width - 0.2 m, depth - 6 cm, flow - 0.794 m/sec, SD - 0.161. One yacht moored, two boats on shore.
94	22/10/2014	11:56	NR 86915 68817	186915	668817			Tarbert boatyard. A & R Way, Boat builders (Cairnbaan).
95	22/10/2014	12:00	NR 86853 68816	186854	668817			Metal manhole cover on road.
96	22/10/2014	12:03	NR 86805 68827	186806	668827			Ceramic pipe with flow. Emerging on inaccessible vertical walling above shore about 0.5 m below road level. Appears to be road drainage from road verge grating on mainland roadside opposite. Not sampled.
97	22/10/2014	12:07	NR 86706 68798	186707	668798			Tarbert harbour. Three commercial fishing boats berthed alongside.
98	22/10/2014	13:04	NR 86606 68719	186606	668719	Fig 20		Four commercial fishing boats berthed alongside plus one CalMac ferry vessel. Toilet block mainland roadside. Eight seagulls on artificial island.
99	22/10/2014	13:05	NR 86581 68688	186581	668688			Small pontoon. Four fishing boats and six smaller vessels berthed. Two seagulls.
100	22/10/2014	13:09	NR 86485 68632	186486	668632			Barge converted to floating café. Closed for the winter.
101	22/10/2014	13:11	NR 86398 68649	186399	668649		SFFW20	Unplanned freshwater sample.
102	22/10/2014	13:11	NR 86397 68650	186398	668651			Associated with waypoint 101. Large unnamed watercourse emerging from two arches by road junction with harbour and A83. Arch 1; water width - 1.60 m, depth - 90 cm, flow - 0.238 m/sec, SD - 0.011. Arch 2; water width - 2.60 m, depth - 100 cm, flow - 0.325 m/sec, SD - 0.005.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
103	22/10/2014	13:29	NR 86561 68938	186561	668938	Fig 21		Pier and Pontoon by Tarbert Yacht Chandlery. One seal in water.
104	22/10/2014	13:31	NR 86586 68965	186586	668966			Toilet and shower block with laundry facilities next to harbour office. 73-75 boats in harbour according to harbour office.
105	22/10/2014	13:36	NR 86618 69028	186618	669028	Fig 22	SFFW21	Unplanned freshwater sample.
106	22/10/2014	13:36	NR 86618 69028	186619	669028	Fig 22		Associated with waypoint 105. Large unnamed watercourse directed under road through black plastic pipe. Houses behind. Water width - 30 cm; Pipe diameter - 59 cm; Depth = 5 cm; Flow - 3.192 m/s; SD - 0.189.
107	22/10/2014	13:41	NR 86645 69034	186645	669034			Slipway.
108	22/10/2014	13:45	NR 86678 69089	186678	669090			Metal manhole cover on road.
109	22/10/2014	13:49	NR 86730 69136	186731	669137		SFFW22	Unplanned freshwater sample from pipe.
110	22/10/2014	13:49	NR 86731 69135	186731	669136			Associated with waypoint 109. Septic tank and outflow pipe (iron). Pipe diameter - 10 cm; Flow - 30 ml / 1 sec (using measuring jug and timer).
111	22/10/2014	13:59	NR 86810 69240	186811	669240		SFFW23	Unplanned freshwater sample.
112	22/10/2014	13:59	NR 86810 69240	186811	669241			Associated with waypoint 111. Large unnamed watercourse heavily flowing with pipe next to it. Houses behind and Scottish Water structures above. Width - 0.78 m; Depth - 14 cm; Flow - 0.109 m/s; SD - 0.203.
113	22/10/2014	14:12	NR 86855 69266	186855	669267			Five boats out at sea (three sailing yachts and two small boats). Ten other mooring buoys.
114	22/10/2014	14:17	NR 86906 69345	186907	669346			End of shoreline walk.

Photographs referenced in the table can be found attached as Figures 5 – 22.

Sampling

Seawater and freshwater samples were collected at the sites marked in Figure 2 and 4. All planned freshwater samples and seawater samples were obtained. Several extra freshwater samples were taken from pipes as requested in the sampling plan. Piped samples were named SFFW8, SFFW9, SFFW13, SFFW15, SFFW16, SFFW17, SFFW18, SFFW22 and were taken at waypoints 58, 60, 73, 81, 84, 86, 89, and 109 respectively. Extra freshwater samples SFFW2, SFFW3, SFFW4, and SFFW6 were also taken at waypoints 34, 36, 41 and 47 as these watercourses were flowing directly opposite the shellfishery. Samples SFFW11, SFFW12, SFFW14, SFFW19, SFFW20, SFFW21, and SFFW23 were also taken as extra samples at waypoints 67, 70, 76, 92, 101, 105 and 111 as these were either large, heavily flowing watercourses or because they were deemed to be of high risk due to the proximity of public facilities, houses or other dwelling places.

Extra seawater samples were taken at waypoints 19 and 22.

Queen scallop samples were obtained at waypoints 6 and 18 and one pacific oyster sample was taken at waypoint 21. It was not possible to take two oyster samples as requested due to the limited adult stock on the site.

All the samples were transferred to a Biotherm 30 box with ice packs and posted to Glasgow Scientific Services (GSS) for *E. coli* analysis. All freshwater samples, seawater samples and shellfish samples were received by GSS within 24 hours of collection. The sample temperature on arrival at GSS ranged between 2.0°C and 5.8°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:

Salinity (ppt) = 0.0018066 X Cl^- (mg/L)

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100ml)	Salinity (ppt)
1	20/10/2014	SFFW1	NR 86513 71588	Freshwater	210	
2	20/10/2014	SFSW1	NR 86752 72196	Seawater	0	33.6
3	20/10/2014	SFSW2	NR 86451 72477	Seawater	2	34.51
4	20/10/2014	SFSW3	NR 86522 72340	Seawater	0	33.6
5	20/10/2014	SFSW4	NR 86674 72289	Seawater	0	33.06
6	20/10/2014	SFSW5	NR 87473 71591	Seawater	0	33.6
7	20/10/2014	SFSW6a	NR 87624 70496	Seawater	1	33.96

8	21/10/2014	SFFW2	NR 86401 71890	Freshwater	310	
9	21/10/2014	SFFW3	NR 86319 72204	Freshwater	150	
10	21/10/2014	SFFW4	NR 86272 72440	Freshwater	110	
11	21/10/2014	SFFW5	NR 86298 72831	Freshwater	60	
12	21/10/2014	SFFW6	NR 86280 72875	Freshwater	20	
13	21/10/2014	SFFW7	NR 86268 73827	Freshwater	20	
14	21/10/2014	SFFW8	NR 86273 73872	Freshwater	900000	
15	21/10/2014	SFFW9	NR 86268 73906	Freshwater	40	
16	21/10/2014	SFFW10	NR 86282 73975	Freshwater	30	
17	22/10/2014	SFFW11	NR 87804 68549	Freshwater	290	
18	22/10/2014	SFSW6b	NR 87775 68631	Seawater	9	33.42
19	22/10/2014	SFFW12	NR 87760 68580	Freshwater	10	
20	22/10/2014	SFFW13	NR 87747 68607	Freshwater	<1000	
21	22/10/2014	SFFW14	NR 87655 68725	Freshwater	<10	
22	22/10/2014	SFFW15	NR 87589 68762	Freshwater	20	
23	22/10/2014	SFSW7	NR 87589 68777	Seawater	34	32.7
24	22/10/2014	SFFW16	NR 87534 68798	Freshwater	80	
25	22/10/2014	SFFW17	NR 87344 68842	Freshwater	<1000	
26	22/10/2014	SFFW18	NR 87247 68858	Freshwater	10	
27	22/10/2014	SFFW19	NR 86959 68823	Freshwater	10000	
28	22/10/2014	SFFW20	NR 86398 68649	Freshwater	70000	
29	22/10/2014	SFFW21	NR 86618 69028	Freshwater	480	
30	22/10/2014	SFFW22	NR 86730 69136	Freshwater	<1000	
31	22/10/2014	SFFW23	NR 86810 69240	Freshwater	250	

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (MPN/100g)
1	20/10/2014	SFSF1	NR 86753 72196	Queen Scallops	78
2	20/10/2014	SFSF2	NR 86522 72341	Queen Scallops	20
3	20/10/2014	SFSF3	NR 86672 72289	Pacific oysters	<18

Salinity Profiles

Four CTD profiles were taken at locations detailed in Figures 2 and 4. The gathered data will be sent to Cefas as agreed previously on a separate Excel sheet.

Photographs – Loch Fyne: Stonefield

Figure 5. Associated with waypoint 1. Harvester's boat passing close to shore.

Figure 6. Associated with waypoint 4. Site of freshwater sample SFFW1 from Barmore Burn.

Figure 7. Associated with waypoint 6. Location of Queen scallop sample SFSF1.

Figure 8. Associated with waypoint 15. Two eider drakes and one eider duck.

Figure 9. Associated with waypoint 24. Location of planned seawater SFSW5.

Figure 10. Associated with waypoints 41 and 42. Location of unplanned freshwater sample SFFW4 from an unnamed watercourse running in open, rectangular masonry culvert.

Figure 11. Associated with waypoint 52. One shag perched on rocks by sea.

Figure 12. Associated with waypoints 56 and 57. Location of planned freshwater sample SFFW7 from an unnamed watercourse.

Figure 13. Associated with waypoints 58 and 59. Location of unplanned freshwater sample SFFW8 from leak in pipe.

Figure 14. Associated with waypoints 67 and 68. Location of unplanned freshwater sample SFFW11 from culvert.

Figure 15. Associated with waypoints 72, 73 and 74. Location of unplanned freshwater sample SFFW13 from pipe.

Figure 16. Associated with waypoints 81 and 82. Location of unplanned freshwater sample SFFW15 from pipe.

Figure 17. Associated with waypoints 84 and 85. Location of unplanned freshwater sample SFFW16 from broken pipe.

Figure 18. Associated with waypoints 89 and 90. Location of unplanned freshwater sample SFFW18 from under road pipe.

Figure 19. Associated with waypoint 91. Sailing club premises with 9 leisure craft on hard standing and 14 kayaks plus dinghies.

Figure 20. Associated with waypoint 98. Eight seagulls on artificial island.

Figure 21. Associated with waypoint 103. Pier and Pontoon by Tarbert Yacht Chandlery.

Figure 22. Associated with waypoints 105 and 106. Location of unplanned freshwater sample SFFW21 from large unnamed watercourse directed under road through black plastic pipe.

Appendix 3

Loch Fyne: Stonefield CTD data

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

Figure A Location of CTD cast

CAST 1

Data Header

% Device	10G100653
% File name	10G100653_20141020_123019
% Cast time (local)	20/10/2014 13:30
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	55.895508
% Start longitude	-5.4121574
% Start GPS horizontal error(Meter)	2.75
% Start GPS vertical error(Meter)	5.289999962
% Start GPS number of satellites	8
% Cast duration (Seconds)	61.6
% 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)
0.149118748	12.29277232	32.7973515
0.447342635	12.2828261	32.79014214
0.74557006	12.28327467	32.80172408
1.043792963	12.27679234	32.82575911
1.342009441	12.2766144	32.85406585
1.640219107	12.26362315	32.87993239
1.938426488	12.26205942	32.86777152

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
2.236634104	12.26097127	32.87422969
2.534840745	12.26143384	32.87327604
2.833046794	12.25648627	32.87540786
3.131252678	12.25566853	32.87034493
3.429458432	12.25722566	32.87376435
3.727662944	12.26158155	32.87982778
4.025865811	12.26162083	32.88643942
4.324067923	12.25939051	32.8830035
4.6222696	12.26445002	32.88801561
4.920469925	12.25799018	32.89167447
5.218668453	12.25198246	32.8979029
5.516865525	12.25314411	32.90041994
5.81506097	12.25240753	32.90944653
6.113255073	12.24804494	32.90809816
6.411448421	12.24346357	32.91096864
6.709646027	12.24610415	32.86690257
7.007848896	12.24178769	32.86093725
7.306050531	12.23943928	32.87322538
7.604251512	12.24163603	32.86372664
7.90245377	12.2423388	32.8596397
8.200655149	12.24280958	32.86882452
8.498855536	12.24395026	32.8658482
8.797056886	12.24753908	32.85847131
9.0952589	12.24316936	32.85679999
9.44167726	12.24295268	32.86187036

CAST 2

Data Header

% Device	10G100653
% File name	10G100653_20141020_124247
% Cast time (local)	20/10/2014 13:42
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	55.8979016
% Start longitude	-5.4172311
% Start GPS horizontal error(Meter)	2.210000038
% Start GPS vertical error(Meter)	4.349999905
% Start GPS number of satellites	8
% Cast duration (Seconds)	74.8
% 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)
0.149103333	12.31279654	32.93957013
0.447295569	12.3143304	32.93674386
0.745493216	12.31127167	32.93120036
1.04368989	12.31094103	32.94155992
1.341884426	12.30688005	32.94610031
1.640077099	12.30343265	32.95325102
1.93826959	12.31523324	32.94678987
2.236462582	12.30677492	32.9466542

2.534653659	12.30440994	32.95812463
2.832842821	12.31194962	32.96193411
3.131033668	12.31052726	32.94170699
3.429225567	12.3029077	32.94742237
3.727414279	12.29413838	32.96294464
4.025599701	12.29199189	32.97093753
4.32378279	12.28993148	32.97962143
4.621966067	12.28871248	32.96548183
4.920150175	12.29023203	32.96935315
5.218333636	12.29049125	32.96868527
5.516516135	12.28730112	32.97418224
5.81469908	12.28307723	32.9599295
6.112881984	12.28077947	32.96997361
6.41106301	12.27915471	32.972635
6.709243618	12.27728506	32.96984711
7.007424254	12.27657489	32.96878692
7.305604839	12.27585071	32.96695763
7.603784846	12.27562612	32.97071044
7.901963963	12.27403032	32.9714266
8.200142569	12.2725211	32.97149726
8.498320981	12.27426949	32.9702253
8.796499341	12.27308176	32.969125
9.094677523	12.27146447	32.96813896
9.392854591	12.26592035	32.97426833
9.554038448	12.27210426	32.97797523

CAST 3

Data Header

% Device	10G100653
% File name	10G100653_20141020_124435
% Cast time (local)	20/10/2014 13:44
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	55.8978764
% Start longitude	-5.4171952
% Start GPS horizontal error(Meter)	1.710000038
% Start GPS vertical error(Meter)	3.319999933
% Start GPS number of satellites	8
% Cast duration (Seconds)	53.8
% 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)
0.149111078	12.30169273	32.87539408
0.447312287	12.29983876	32.88743661
0.745515673	12.29800187	32.90917165
1.043714218	12.29527018	32.92625764
1.341910075	12.29428598	32.92910869
1.640104117	12.29171602	32.93849334
1.938297008	12.29261475	32.93593015
2.236489512	12.28968419	32.93844502

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
2.534679149	12.28255689	32.95589611
2.832864532	12.2763494	32.96991503
3.131046742	12.27326601	32.97875986
3.429227434	12.27072053	32.97902295
3.727406765	12.27008165	32.98706121
4.025586062	12.26922601	32.97597764
4.323765278	12.26738025	32.98414718
4.621943732	12.2668716	32.97918314
4.92012265	12.26686598	32.97692256
5.218300911	12.26913252	32.98259249
5.516479176	12.26653243	32.97382536
5.814656995	12.26375881	32.98225421
6.112833979	12.26415468	32.97766151
6.411010272	12.26329915	32.98529523
6.709185949	12.26339761	32.97996457
7.00736164	12.26179681	32.98181928
7.305535904	12.2599262	32.98879271
7.603709484	12.259179	32.98426419
7.901883484	12.25812485	32.9816525
8.200057209	12.25813754	32.98346711
8.498230435	12.25835536	32.98315789
8.796402881	12.25678753	32.98707743
9.094574697	12.25764566	32.98559298
9.392746252	12.2548111	32.98591985
9.566317224	12.25759492	32.99233943

CAST 4

Data Header

% Device	10G100653
% File name	10G100653_20141020_125808
% Cast time (local)	20/10/2014 13:58
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	55.8966864
% Start longitude	-5.4159644
% Start GPS horizontal error(Meter)	2.339999914
% Start GPS vertical error(Meter)	4.570000172
% Start GPS number of satellites	8
% Cast duration (Seconds)	54.8
% 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)
0.149105119	12.29886549	32.92044131
0.447298524	12.29962846	32.93883594
0.745493585	12.29681001	32.94517992
1.04368759	12.29387542	32.94381939
1.341881916	12.29620802	32.9392074
1.640076825	12.29531025	32.93602537
1.93827204	12.29475941	32.9331622
2.236465353	12.29307653	32.94936735

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
2.534655785	12.29040498	32.95464486
2.832843602	12.28727094	32.96814965
3.131029798	12.28364644	32.96438681
3.429214975	12.28106515	32.97267914
3.727398556	12.27655946	32.97381313
4.025581242	12.27569861	32.97632828
4.323763129	12.27505209	32.97755022
4.621945042	12.27560288	32.97309875
4.920126864	12.27365626	32.97502966
5.218307886	12.27371198	32.9767556
5.516488325	12.27386124	32.97727275
5.814668066	12.27465331	32.98020215
6.11284743	12.27246266	32.97728467
6.411026288	12.27308144	32.98133434
6.709204737	12.27448283	32.97843016
7.007383115	12.27284661	32.97893161
7.305561184	12.27249443	32.97769923
7.603738763	12.27152936	32.9799763
7.901915914	12.2706649	32.97807217
8.200092629	12.26920108	32.98029491
8.498268907	12.26801236	32.978315
8.796444862	12.2646461	32.97906824
9.094619823	12.26596079	32.98365154
9.392795084	12.26689414	32.97397118
9.612269659	12.26535399	32.98445032

CAST 5

Data Header

% Device	10G100653
% File name	10G100653_20141020_130856
% Cast time (local)	20/10/2014 14:08
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	55.8962688
% Start longitude	-5.4134258
% Start GPS horizontal error(Meter)	7.699999809
% Start GPS vertical error(Meter)	16.37000084
% Start GPS number of satellites	7
% Cast duration (Seconds)	83.6
% 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)
0.149111078	12.30169273	32.87539408
0.447312287	12.29983876	32.88743661
0.745515673	12.29800187	32.90917165
1.043714218	12.29527018	32.92625764
1.341910075	12.29428598	32.92910869
1.640104117	12.29171602	32.93849334
1.938297008	12.29261475	32.93593015

Depth (Meter)	Temperature (Celsius)	Salinity (Practical Salinity Scale)
2.236489512	12.28968419	32.93844502
2.534679149	12.28255689	32.95589611
2.832864532	12.2763494	32.96991503
3.131046742	12.27326601	32.97875986
3.429227434	12.27072053	32.97902295
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