Scottish Sanitary Survey Review

Gruting Voe Browland Voe and Gruting Voe Quilse

SI-081-425-08 and SI-083-427-08

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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 Gruting Voe: Browland Voe and Gruting Voe: Quilse. The survey was conducted to identify the location, extent and nature of the shellfishery and the potential sources of faecal contamination to the shellfishery, and to recommend boundaries and sampling plans for the production areas. The associated shoreline survey was undertaken in June 2008.

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

The present report constitutes a review of publicly available information in order to assess changes that have occurred since the 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 – Gruting Voe: Browland Voe

	2009 report	2015 review	Changes from 2009
PRODUCTION AREA	Gruting Voe: Browland Voe		No change
SITE NAMES	Browland Voe		
SIN	SI-081-425-08		
SPECIES	Common mussels		
TYPE OF FISHERY	Long-line		
NGR OF RMP	HU 2633 5033	HU 2632 5030	Moved back to the previously recommended location but with a slight amendment to reflect current location of mussel lines
EAST	426330	426320	
NORTH	1150330	115030	
TOLERANCE (M)	20	40	Increased to allow for movement of mussel lines
DEPTH (M)	1		No change
METHOD OF SAMPLING	Hand		
FREQUENCY OF SAMPLING	Monthly		
LOCAL AUTHORITY	Shetland Island Council		
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathryn Winter, Marion Slater	Sean Williamson, Marion Anderson, Gwen Williamson, Vicki Smith	Change in personnel
RECOMMENDED PRODUCTION AREA	The area bounded by lines drawn between HU 2619 5070 and HU 2682 5070 and between HU 2764 4986 and HU 2764 4950 and between HU 2690 4940 and HU 2750 4940 extending to MHWS		Slight amendment to ensure that the southern boundary aligns with the northern boundary of Gruting Voe: Quilse.

Sampling Plan – Gruting Voe: Quilse

	2009 report	2015 review	Changes from 2009
PRODUCTION AREA	Gruting Voe: Quilse		No change
SITE NAME	Quilse		
SIN	SI-083-427-08		
SPECIES	Common mussels		
TYPE OF FISHERY	Long-line		
NGR OF RMP	HU 2690 4874	HU 2692 4875	Changed to reflect current location of mussel lines
EAST	426900	426920	
NORTH	1148740	1148750	
TOLERANCE (M)	20	40	Increased to allow for movement of mussel lines
DEPTH (M)	1		No change
METHOD OF SAMPLING	Hand		
FREQUENCY OF SAMPLING	Monthly		
LOCAL AUTHORITY	Shetland Island Council		
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathryn Winter, Marion Slater	Sean Williamson, Marion Anderson, Gwen Williamson, Vicki Smith	Change in personnel
RECOMMENDED PRODUCTION AREA	The area bounded by lines drawn between HU 2645 4820 to HU 2747 4820 and HU 2750 4940 to HU 2690 4940 and extending to MHWS		Slight change to ensure that the area extends to MHWS

1. Area Description and Fishery

The location of Gruting Voe is shown in Figure 1.1.

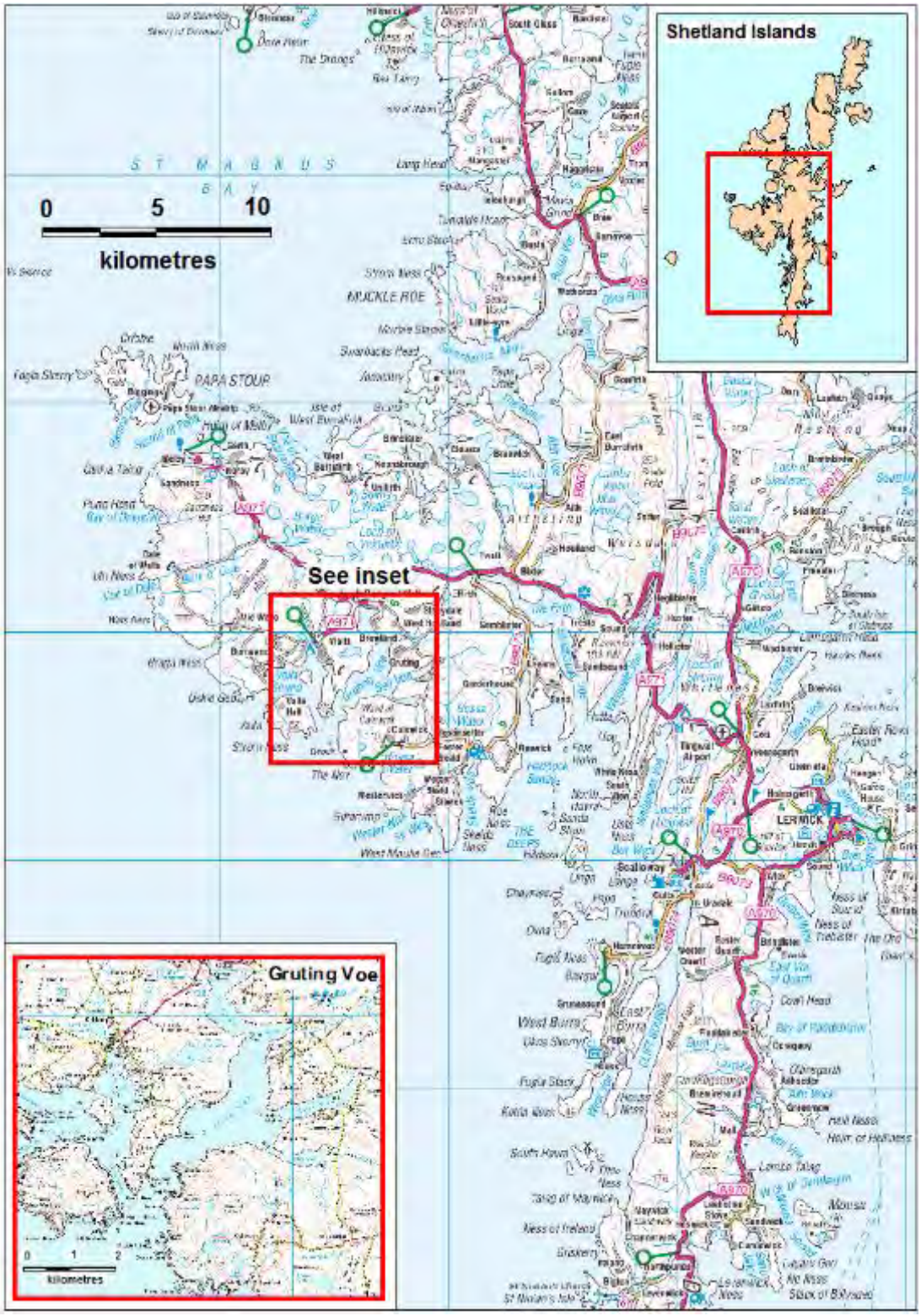

Figure 1.1 Location of Gruting Voe

The two production areas in Gruting Voe; Browland Voe and Quilse remain classified in 2015 and details given in the 2014/15 classification listing are listed in Table 1.1.

Table 1.1 Currently monitored fisheries operating in Gruting Voe

Production area	Site	SIN	Species	RMP
Gruting Voe: Browland Voe	Browland Voe	SI-081-425-08	Common mussels	HU 2667 4969
Gruting Voe: Quilse	Quilse	SI-083-427-08		HU 2690 4874

The currently specified production area boundaries are as follows:

Gruting Voe: Browland Voe Area bounded by lines drawn between HU 2619 5070 and HU 2682 5070 and between HU 2764 4986 and HU 2764 4950 and between HU 2690 4939 and HU 2748 4940 extending to MHWS.

Gruting Voe: Quilse Area bounded by lines drawn between HU 2645 4820 to HU 2747 4820 and HU 2750 4940 to HU 2690 4940.

These boundaries are as recommended in the 2009 sanitary survey report.

The location of the current RMPs and production area boundaries are displayed in Figure 1.2. The Gruting Voe Quilse RMP location remains unchanged from that recommended in the 2009 sanitary survey report. However, the current RMP for Browland Voe has been relocated from the northeastern extent of the Browland Voe North site (HU 2633 5033), to the southwestern extent of the Browland Voe South site (HU 2667 4969). The latter location was first given in the 2013/14 FSAS classification document although the geographical analysis of historical *E. coli* results displayed in Section 7.2 of this review shows the sampling location was changed in early 2012. The reason behind this change is not clear. The location of the 2009 recommended Browland Voe RMP is displayed in Figure 2.1.

Mussel farm locations and boundaries reported in the 2008 and 2014 shoreline surveys are also displayed in Figure 1.2. Changes at the mussel farms between the surveys are as follows:

Browland Voe North: remains as 5x220 metre (m) double headed longlines with 5 m droppers. The site is licenced for 5x160 m quad-headline longlines.

Browland Voe South: has decreased between surveys, from 7x440 m double headed longlines with 7 m droppers to 5x400 m with 8 m droppers. The site is licenced for 5x410 m quad-headline longlines.

The 2008 shoreline survey noted that both Browland Voe sites were harvested year round, dependent on demand, biotoxin status, and the status of other sites under the same ownership. The 2014 shoreline survey recorded that stock was harvested when mussels reached the required size, but in general both sites were reportedly farmed for spat. Despite this information, both sites contained mature sized stock.

Quilse: remains as 5x220 m double headed longlines, but dropper length has decreased from 12 to 8-9 m. The site is licenced for 6x220 m quad-headline longlines. In 2014 the site was stocked with mature mussels and harvesting was planned for early 2015.

Two additional sites used solely for spat collection were noted during the 2014 survey and their details are as follows;

Scutta Voe: consisted of 2x100 m double headed longlines with 4 m droppers and was located in Scutta Voe. The site is licenced for 4x100 m double-headed longlines. The site contained spat, which are reportedly moved to a grower site after 18 months.

Maraness: consisted of 2x280 m double headed longlines with 8-9 m droppers and was located adjacent to the Hill of Maraness. The site is licenced for 3x220 m double-headed longlines.

Sites used solely for spat collection do not require to be located within a classified production area. The contamination impacts to the Scutta Voe and Maraness sites will therefore not be assessed in this review. Although the 2014 survey reported the two Browland Voe sites were now predominantly spat farms, evidence suggested that both sites continue to rear mussels to harvestable size. This review will therefore consider the main impacts to the Browland Voe sites and the Quilse site.

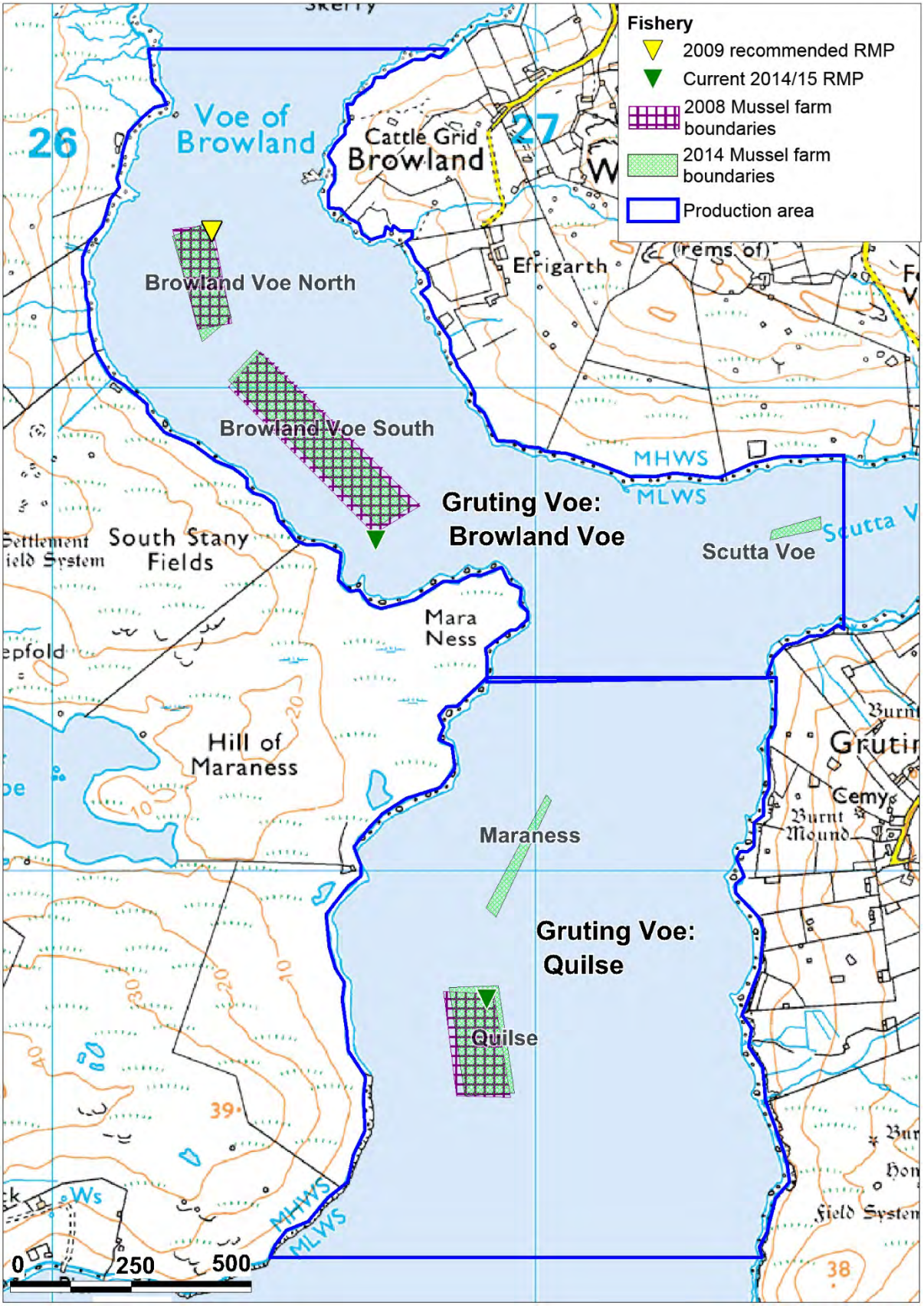

Figure 1.2 Gruting Voe: Browland Voe and Gruting Voe: Quilse fisheries

2. Population and Human Sewage Impacts

2.1 Population

Population data from the General Register Office for Scotland from both the 2001 and 2011 censuses are shown in Table 2.1. Direct comparisons between census areas is made difficult owing to changes in areas between census years. Figure 2.1 shows the census output areas in the vicinity with the colour intensity of the areas graduated according to the 2011 population density.

Table 2.1 Scottish Government Census data for years 2001 and 2011

2001 Census data		2011 Census data	
60RD000029	190	S00059412	81
		S00059578	108
		S00059580	96
60RD000030	86	S00059518	82
60RD000031	151	S00059468	161
TOTAL	**427**	**TOTAL**	**528**

Overall there has been a slight increase in human population within census areas between 2001 and 2011. However, increases are not expected to have been significant in the areas immediately adjacent to Gruting Voe, where the population density remains predominantly low. The 2014 shoreline survey noted that houses remained concentrated along the shorelines at Bridge of Walls, West Houlland and Gruting.

Numbers of visitors to the area remain low, with one guest house (Shoreside Holiday Cottage) situated in Bridge of Walls recorded during the 2014 shoreline survey. No further information on guest house accommodation in the area was found during internet searches for this review.

Two planning applications pertaining to areas around Gruting Voe have been approved since the 2009 sanitary survey report. These applications were downloaded from the Shetland Island Council Planning Portal in February 2015 (Shetland Islands Council, 2014), with full details listed in Appendix 1. The locations of the properties associated relating to these planning applications are displayed in Figure 2.1 and have been inferred from maps associated with the applications. The two applications related to new dwelling houses set inland, northeast of West Houlland. Both applications identified an intention to install new septic tanks (ST) with land soakaways.

Boat traffic within the voe remains low and largely associated with boats servicing local aquaculture sites. Small amounts of activity is also associated with local creel boats and leisure activities. The 2014 shoreline survey noted a pontoon at the head of Scutta Voe where plans for a small marina were identified in the 2009 report. Two

empty noosts (onshore furrow where boats are drawn up) adjacent to two houses and a small open boat ashore were also noted at Gruting.

Figure 2.1 Current distribution of human population around Gruting Voe

2.2 Sewage Discharges

The 2009 sanitary survey report provided information provided by SEPA on the one consented private septic tank discharge in the area, which was associated with the village hall located on the northern shoreline of Scutta Voe. Information on a second private tank discharge, located more than 1 km inland to the west of the Gruting Voe: Quilse production area, was provided by SEPA in support of a data request connected to the 2010 Lower Gruting Voe sanitary survey report. Details of both discharges are listed in Table 2.2, with their locations mapped in Figure 2.2.

Table 2.2 SEPA sewage discharges to Gruting Voe

Ref No.	NGR	Level of Treatment	Flow (m^3/d)	PE	Discharges to
CAR/R/1025329	HU 2792 4989	ST	-	5	Land via soakaway
CAR/R/1037372	HU 2512 4877	ST	-	5	Land via soakaway

-No information given

The 2008 Gruting Voe shoreline survey noted four private sewage sources. They included a ST discharging to sea at the location of the village hall (consented to discharge to soakaway) and three discharges located in Bridge of Walls. Overall it was concluded that human sewage would not have a significant impact on the fisheries, as inputs served low population equivalents and were located >700 m from the fisheries.

The 2009 Lower Gruting Voe shoreline survey reported five private STs, discharging to sea or to land via soakaway. Four of the STs were located around Seli Voe and one was located in Quilse. These discharges have been listed in Table 2.3 and their locations are displayed in Figure 2.2.

Table 2.3 Sewage discharge-related observations around Lower Gruting Voe from the 2009 shoreline survey

No.	NGR	Observation
1	HU 2856 4824	House with septic tank and soakaway
2	HU 2532 4742	Pipe from septic tank
3	HU 2866 4788	Large house and shore base for salmon farm, area inaccessible, no septic pipes directly observed, septic tank presumed nearby
4	HU 2843 4786	Septic tank for house, faint odour, line of rocks running from shore but no apparent pipe
5	HU 2913 4809	White plastic discharge pipe, not flowing but active. Whitish-grey area on substrate below pipe
6	HU 2914 4810	Clay pipe underwater, no apparent discharge

As the inputs in Seli Voe and Quilse similarly serve low population equivalents and are located >1.5 km to the closest Gruting Voe fishery (Quilse), they are not expected to pose as significant contamination sources to the Gruting Voe fisheries.

Sewage related observations made during the 2014 shoreline survey are listed in Table 2.4 and are also displayed in Figure 2.2.

Table 2.4 Sewage discharge-related observations around Gruting Voe from the 2014 shoreline survey

No	NGR	Description
1	HU 2642 5106	One dwelling house in close proximity to beach with piped outlet to sea. End of pipe not visible underwater
2	HU 2648 5107	Septic tank near shoreline associated with 1 chalet above
3	HU 2653 5107	Sewer pipe into sea below one dwelling house, end of pipe not visible underwater
4	HU 2666 5103	One dwelling house (Shoreside holiday cottage) in close proximity to shoreline. Piped outlet in surrounding wall with no flow
5	HU 2791 4987	Septic tank flowing to soakaway associated with old Gruting school buildings above which lie in close proximity to shoreline. The buildings have been converted into one dwelling house and a small community centre
6	HU 2802 4984	Modern dwelling house above shoreline. No septic tank identified. Possible associated outlet pipe to the right of the property ending above beach. No obvious smell

The four sewage inputs noted during the 2008 Gruting Voe shoreline survey were also observed during the 2014 survey. A seawater sample taken adjacent to the ST discharge pipe to sea adjacent to the village hall returned a result of 80 *E. coli* cfu/100 ml, with a salinity of 5.9 ppt. The results indicate a significant freshwater input but a relatively low level of faecal contamination.

Two additional discharge sources were also identified; a dry piped outlet below the holiday cottage at Bridge of Walls and a piped outlet that ended in a stagnant pool at the top of the beach along the northern shoreline of Scutta Voe.

Conclusion

Human population around Gruting Voe remains low and limited to the small settlements of Bridge of Walls, West Houlland, Gruting, as well as around Seli Voe and Quilse. Visitor numbers and boat activity in the area remains low, with the latter potentially having increased very slightly following the installation of a new marina at Scutta Voe.

With respect to the mussel farms, the identified numbers of septic tank discharges will pose a small contamination risk to the fisheries and, ignoring the sites used solely for spat production, this will mainly be at the northern end of Gurting Voe: Browland Voe and the southern end of Gruting Voe: Quilse.

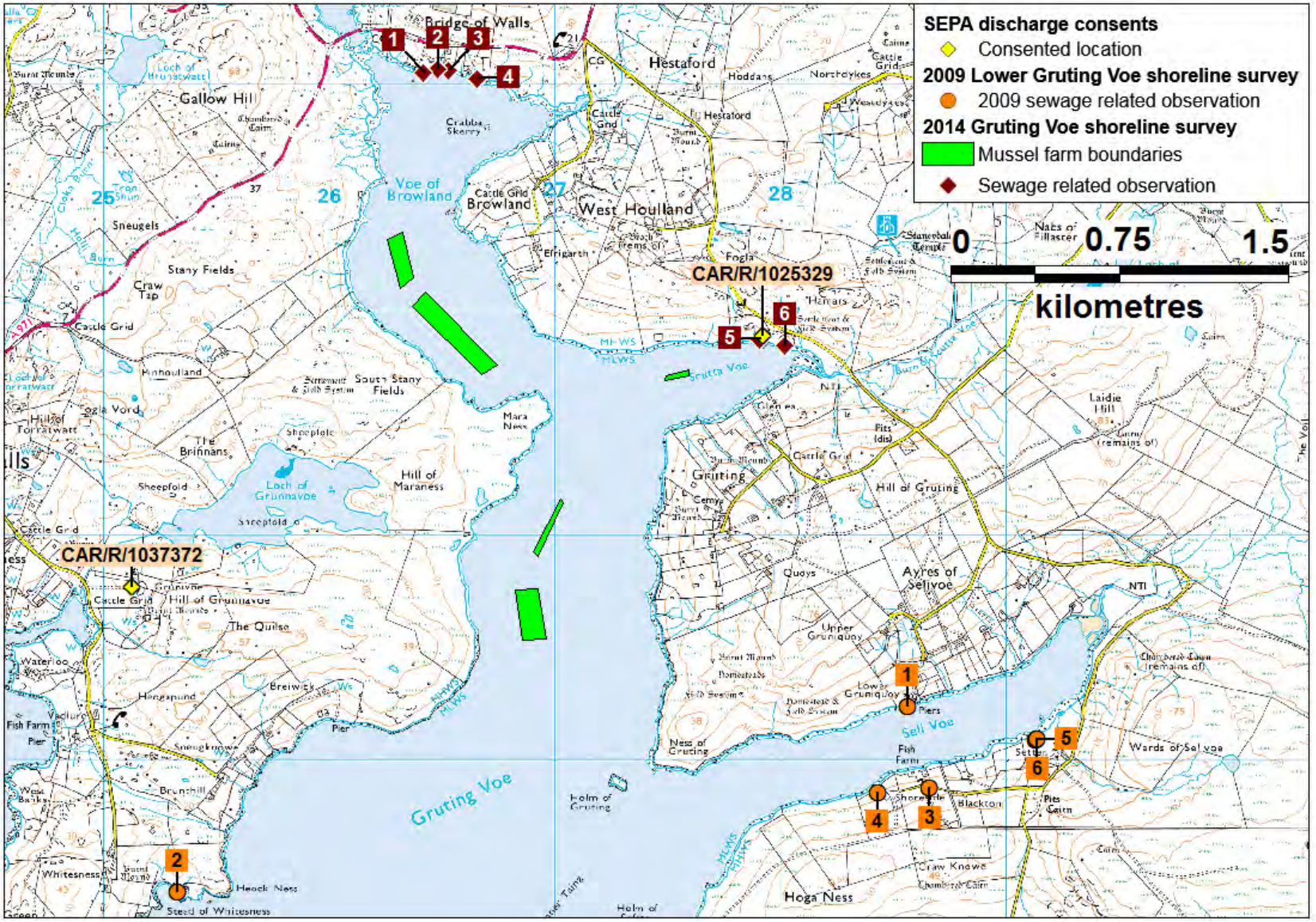

Figure 2.2 Map of sewage discharge locations in the vicinity of Gruting Voe

3. Farm Animal Population and Agricultural Impacts

Farm census data was provided by Scottish Government in support of the 2009 sanitary survey report. The data indicated that sheep were the dominant species kept on the surrounding land. This was supported by the shoreline survey undertaken on the 17th June 2008, with sheep grazing particularly prevalent along the eastern shoreline. Overall, agricultural contamination sources were considered to be a significant source of contamination to Gruting Voe and would mostly enter from the eastern shoreline. Impacts would be highest during the lambing season (May-September), when sheep numbers would approximately double.

The Lower Gruting Voe shoreline survey conducted on 25-28th August 2009 similarly found that sheep grazing was prevalent on both eastern and western shores in the area. Contamination arising from animals in that area may therefore impact the southern extent of the Quilse site.

More recent information on agricultural based contamination sources was been obtained through a shoreline survey conducted in November 2014 and by means of an internet search. This information is shown on the map in Figure 3.1. Sheep grazing continues to dominate the land on the eastern side of Gruting Voe, where the majority of sheep had shore access and significant amounts of sheep faeces were noted.

Two recently cut silage fields and four agricultural sheds set inland along the eastern shoreline were also observed in 2014. Five applications for agricultural sheds were identified during planning application searches undertaken for this review. All five sheds were planned for areas on the eastern coastline and their locations are mapped in Figure 3.1. Four out of the five applications were for general purpose agricultural sheds. The fifth shed was to be used as an enclosed sheep handling building located at Murrister (northeast) and the application stated that faecal material would be added to an existing slurry tank.

Conclusion

Sheep remain a significant potential contamination source primarily along the eastern side of Gruting Voe fisheries. Silage will also contribute to contamination levels entering from the eastern shoreline. Smaller levels of inputs are also expected from the small flock of sheep reared on croftland to the northwest of the voe, which will impact the western extent of both Browland Voe sites. The southern extent of the Quilse site may also be impacted by sheep grazing on land in the southern part of Gruting Voe.

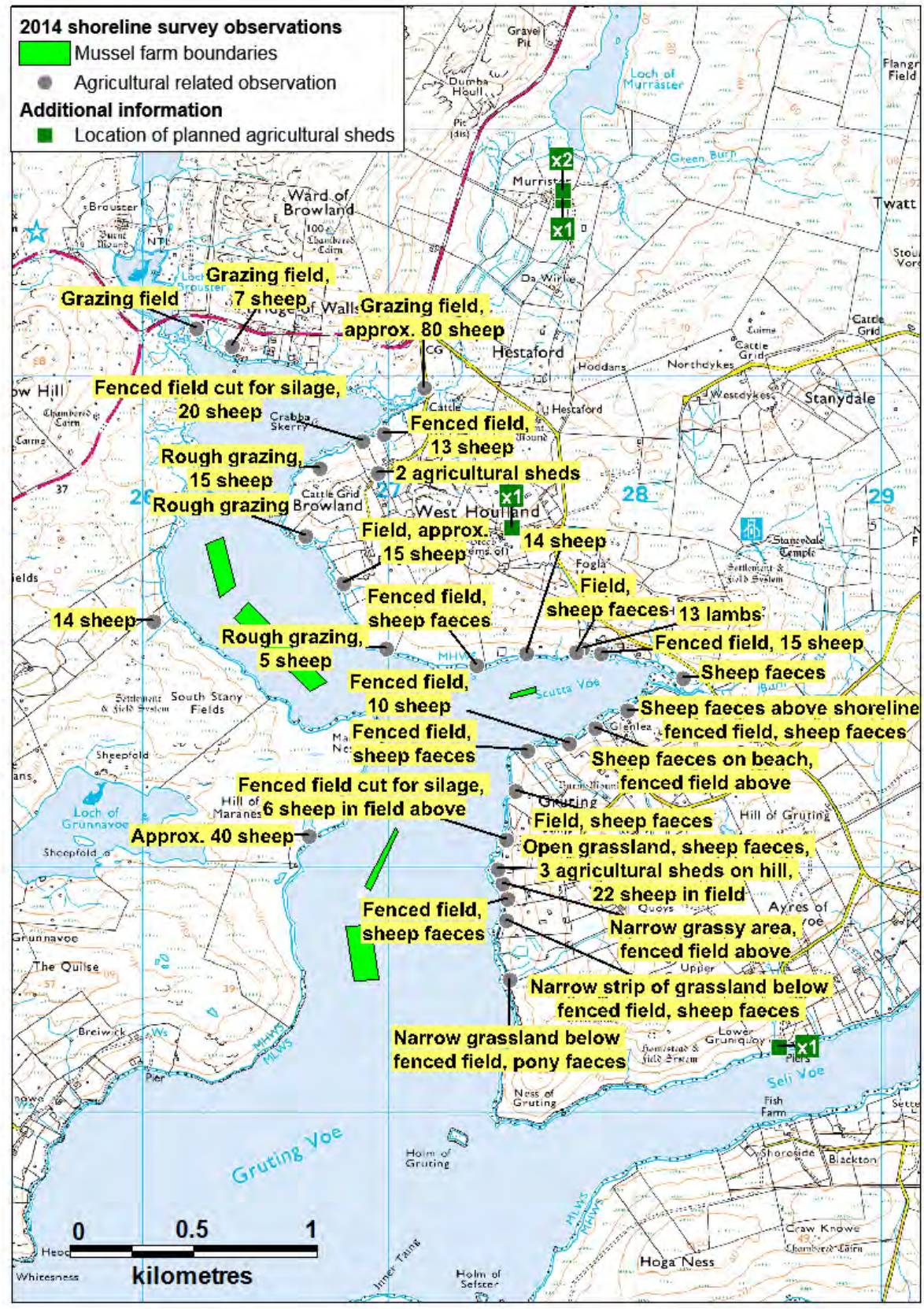

Figure 3.1 Map of farm animals and associated observations made during the 2014 shoreline survey

4. Wildlife

The 2009 sanitary survey report concluded that seals and seabirds would be the most significant wildlife contributors of faecal contamination at the sites but that wildlife impacts would be unpredictable and would affect both sites evenly. For this review, information on pollution sources from wildlife was obtained from the JNCC collated dataset (http://jncc.defra.gov.uk/page-4460), through the 2014 shoreline survey, and via an internet search. The shoreline survey observation information only relates to the time of the survey on the 26th November 2014. Wildlife information from the JNCC dataset and observations from the 2014 shoreline survey and are displayed in Figure 4.1.

Pinnipeds

The most recent Special Committee on Seals report (SCOS, 2013) indicated that approximately 10 common seals were observed within 10 km of the mouth of Gruting Voe during August surveys conducted between 2007 and 2011. Comparatively only five grey seals were noted in the same area during surveys conducted over the same period. Common seal populations in Shetland have experienced a 30% decrease between 2000 and 2010. Although population estimates are not available for Shetland grey seals, pup production remains stable at 3,299 pups in 2010.

The Marine and Spatial Plan for Shetland 2012 report indicates an absence of grey seal habitat in and around Gruting Voe. The report did however find extensive common seal habitat to the north around the Voe of Browland and to the southwest near Quilse.

Seals were observed on four occasions during the 2014 survey; twice at the head of Scutta Voe and twice at Crabba Skerry near the head of Browland Voe.

Cetaceans

There are anecdotal accounts of a pod of 18+ (*sic*) white-sided dolphins in Gruting Voe in August 2014 (Nature in Shetland, 2015). However, there no other reports/accounts of any other cetaceans within Gruting Voe were found. No cetaceans were observed during the 2014 shoreline survey.

Seabirds

Seabird data was downloaded from the JNCC website (http://jncc.defra.gov.uk/page-4460) in April 2014. Data from a 5 km radius around Gruting Voe is listed in Table 4.1. In order to aid visualisation, only the records relating to locations within 4 km of Gruting Voe are displayed in Figure 4.1.

Table 4.1 JNCC seabird data for Gruting Voe

Common name	Species name	Qualifier	Count*	Accuracy
Kittiwake	*Rissa tridactyla*	Occupied nests	72	Accurate
Fulmar	*Fulmarus glacialis*	Occupied sites	1884	Accurate
Shag	*Phalacrocorax aristotelis*	Occupied nests	375	Accurate
Black Guillemot	*Cepphus grylle*	Individuals on land	32	Accurate
Common Guillemot	*Uria aalge*	Individuals on land	32	Accurate
Great Cormorant	*Phalacrocorax carbo*	Occupied nests	4	Unknown
Great Skua	*Stercorarius skua*	Occupied territory	40	Accurate
Arctic Skua	*Stercorarius parasiticus*	Occupied territory and individuals on land	146	Accurate
Arctic Tern	*Sterna paradisaea*	Individuals on land and occupied nests	551	One count estimate, 21 counts accurate
Herring Gull	*Larus argentatus*	Occupied territory and individuals on land	48	Accurate
Black-Headed Gull	*Larus ridibundus*	Occupied territory and individuals on land	222	Accurate
Great Black-Backed Gull	*Larus marinus*	Occupied territory, nests and individuals on land	271	Accurate
Lesser Black-Backed Gull	*Larus fuscus*	Occupied territory	2	Accurate
Common Gull	*Larus canus*	Occupied territory, nests and individuals on land	433	Accurate

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

The JNCC seabird dataset indicates that the land around Gruting Voe is important for breeding colonies of fulmars, Arctic terns, common gulls and shags. Fulmars had the largest breeding colonies, located southwest on the island of Gluibuil (west of Vaila Island) at the entrance to Vaila Sound and south of Culswick. Smaller seabird colonies are also noted within the immediate area around Gruting Voe, which are anticipated to have a higher level of impact on the fisheries owing to their proximity to the fisheries. Contamination impacts will be highest during the breeding season, which largely falls between May and October.

Data from the Marine and Spatial Plan for Shetland indicates that there is a large amount of duck and diver habitat in Browland Voe but also towards the southern end of Gruting Voe as well as in Vaila Sound. Eider habitat was only noted at the southwestern end of Gruting Voe and in the adjoining part of Vaila Sound. Black guillemot habitat was most widespread: however, the JNCC dataset recorded low numbers of these birds. Suitable habitat for herring gulls and Arctic terns was noted north of Gruting Voe, whilst Arctic tern habitat was present within in Seli Voe (southeast).

Birds were the most common wildlife observed during the 2014 survey. Species included common gulls, black backed gulls, snipe, herons, cormorants, greylag

geese, mallard ducks and a wren. Greylag geese were most numerous, with a flock of approximately 24 noted along the western coastline of Gruting. Two lots of goose droppings were noted in fields within the vicinity of the geese. Bird faeces were noted on buoys at all mussel sites, with at least one seabird present at each site at the time of the shoreline survey. Shell debris which possibly represented a bird feeding area was noted on the northern shoreline of Scutta Voe.

Otters

The Marine and Spatial Plan for Shetland did not identify any suitable otter habitat around Gruting Voe or the immediate vicinity. The National Biodiversity Network (https://data.nbn.org.uk/) did not provide any updated information on otters within Gruting Voe. No otters were observed during the 2014 survey.

Conclusions

The most significant potential wildlife impacts continue to stem from seabirds and seals (specifically common seals). The largest seabird colonies were noted to the south and southwest of the production areas being considered in this review: the actual impact from these will depending on their feeding range and the colonies located in the vicinity of the mussel farms will pose a greater risk. There is expected to be a higher contamination impact at the top of the dropper lines, from seabirds defaecating on the fishery buoys. However, there is not expected to be any consistent spatial pattern in the extent of contamination arising from these sources.

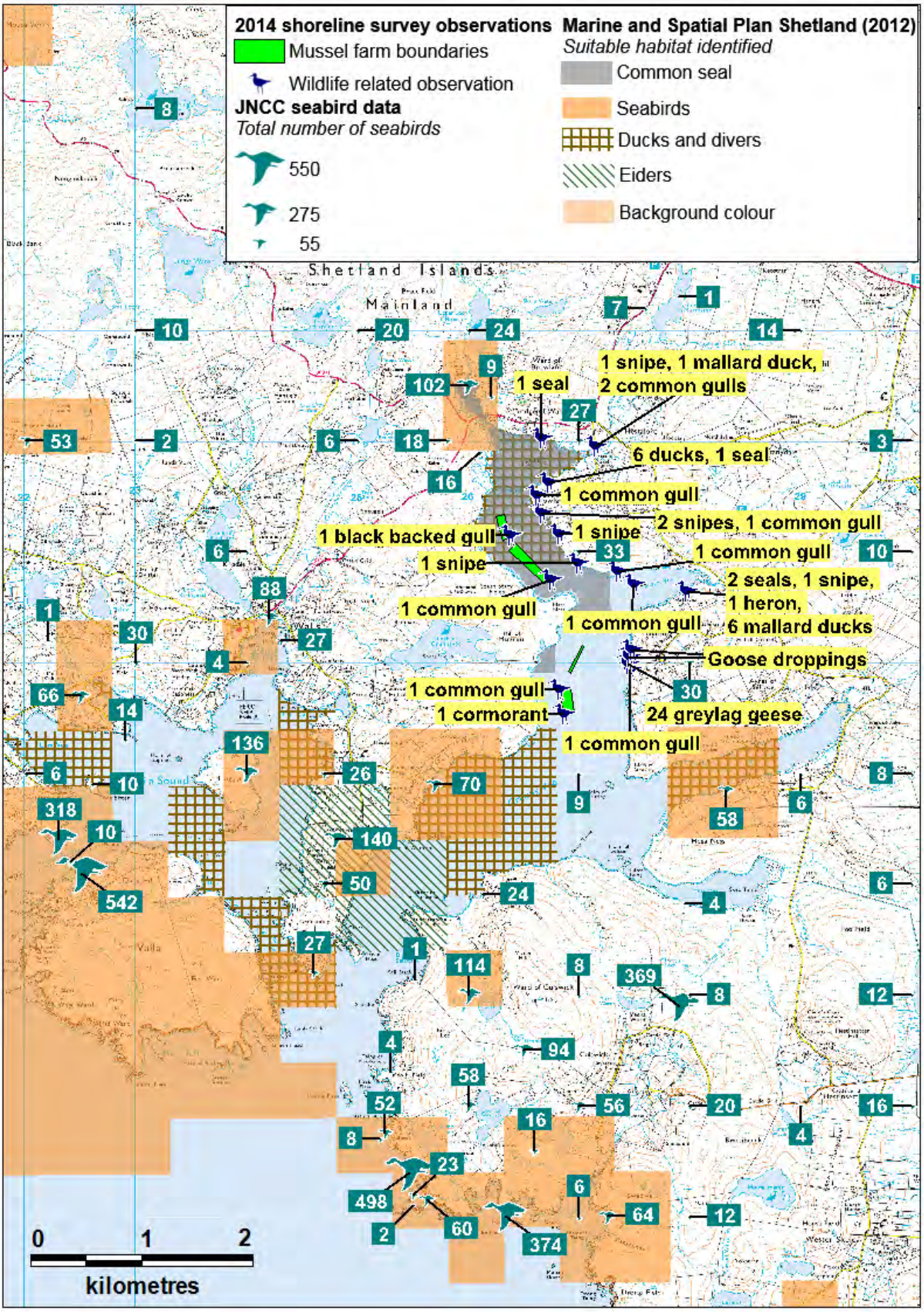

Figure 4.1 Map of wildlife around Gruting Voe, including observations made during the 2014 shoreline survey

5. Watercourses

Information on watercourses for the 2009 sanitary survey came from the shoreline survey conducted in June 2008. The sanitary survey report concluded that watercourses were important pathways by which diffuse contamination from livestock will be carried into the production areas. It identified that the majority of the observed watercourses discharged to the northern and eastern shores of the voe and therefore that both sites would be evenly affected. No gauging stations on watercourses entering into Gruting Voe were identified for this review. The weather at the time of both surveys was as follows:

2008: light rain fell in the 48 hours prior to the survey and the first survey day, though the second day was dry.

2014: Light showers were recorded in the 48 hrs prior to the survey, but the survey itself was dry with sunny spells.

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, six watercourses were measured and sampled in the 2008 survey, three of which were re-sampled in 2014. Watercourse loadings estimated from the 2014 shoreline survey measurements and sample results are displayed on the map in Figure 5.1. A full list of recorded flow measurements and sample results from the 2014 shoreline survey can be found in Appendix 2.

Table 5.1 Watercourse loadings to Gruting Voe estimated from measurements made during the 2008 and 2014 shoreline surveys

No.[1]	Description	NGR	2008 Loading (*E. coli*/day)	2014 Loading (*E. coli*/day)
1	Unnamed watercourse	HU 2749 4854	-	$7.0x10^6$
2	Small field drain	HU 2746 4866	$1.8x10^7$	Not determined
3	Field drain	HU 2748 4885	-	Not determined
4	Unnamed watercourse	HU 2757 4948	-	$1.4x10^7$
5	Small watercourse	HU 2766 4949	-	Not determined
6	Field drain	HU 2787 4960	-	Not determined
7	Burn of Scutta Voe	HU 2827 4971	$7.8x10^9$	$4.1x10^9$
8	Unnamed watercourse	HU 2778 4989	-	$4.5x10^7$
9	Small unnamed watercourse	HU 2676 5033	-	$2.3x10^7$
10	Small burn	HU 2714 5090	-	Not determined
11	Tributary of Loch of Murraster	HU 2716 5095	$5.9x10^8$	$2.4x10^9$

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

Loadings associated with watercourses remain low to moderate, with the majority of recorded inputs entering from the east side of the voe. A large number of watercourses noted during the 2014 shoreline survey had too little flow to measure. Several areas of land drainage and boggy areas were noted. The high state of the tide prevented accurate flow measurements to be taken from the Loch of Brouster, at the head of the voe, during the 2014 shoreline survey: a freshwater sample taken at that location yielded a low result of 8 *E. coli* cfu/100 ml.

It should be noted that there are several short watercourses shown on the western side of Browland Voe of the OS map. This side of the voe was not surveyed on foot due to access difficulties and therefore the loadings associated with these watercourses, near the Browland Voe north mussel farm, could not be estimated.

Conclusions

Loadings from watercourses continue to be low to moderate, with the majority of measured and sampled watercourses entering on the eastern side of the voe. However, there are a number of small watercourses a relatively short distance to the west and northwest of the Browland Voe North mussel site and, given that these are much closer than the measured and sampled watercourses, they may have a more direct impact on the water quality at that site. Loadings are expected to be higher following rainfall.

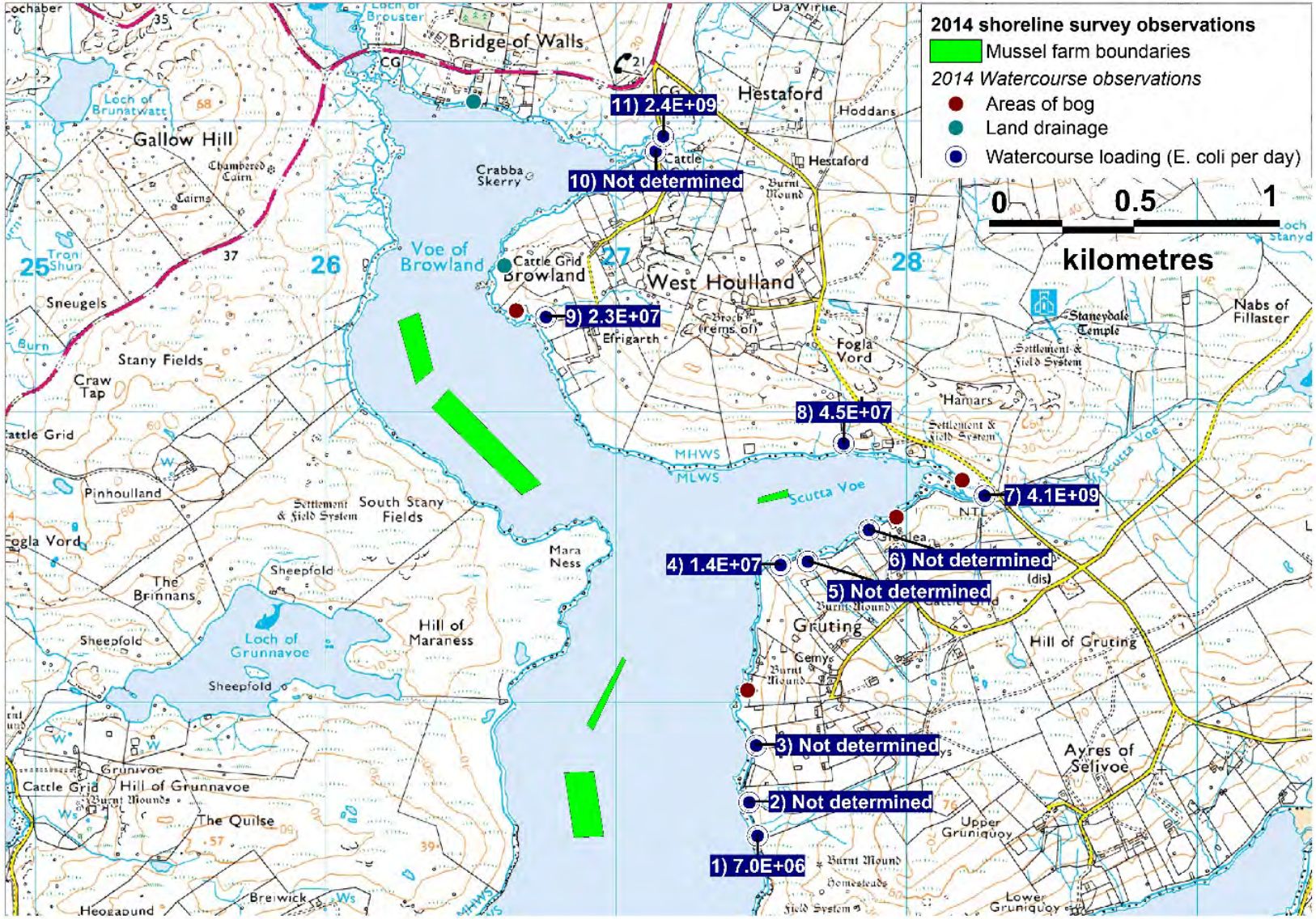

Figure 5.1 Watercourse loadings at Gruting Voe from the 2014 shoreline survey

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

6. Meteorological data

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 Gruting Voe sanitary survey report: rainfall box-plots and wind roses for 2003-2007 period are presented in that report and have not been reproduced here. Rainfall was recorded in total daily rainfall (mm) were taken from the Lerwick weather station, which lies 20 km southeast of the Gruting Voe. Wind roses were also taken from the Lerwick weather station.

Meteorological data for this Review was purchased from the Meteorological Office in March 2014 for the period 01/01/2008 - 31/12/2013. Rainfall data from Lerwick was available for all of the survey days.

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 Lerwick weather station rainfall dataset for 2007-2012 is presented by year in Figure 6.1 and by month in Figure 6.2.

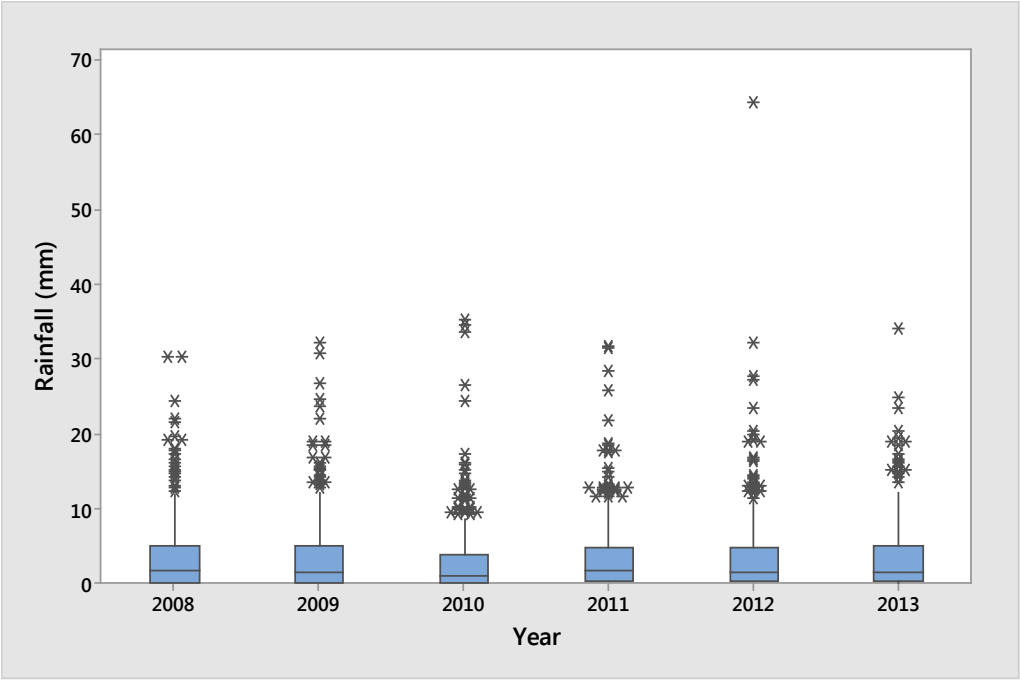

Figure 6.1 Boxplot of daily rainfall at Lerwick by year (2008-2013)

In both data sets, the bulk of the observations were below 10 mm rainfall/day, with the majority of years yielding at least one rainfall event >30 mm. Incidence of a rainfall event >60 mm occurred in both datasets: in 2004 and again in 2012.

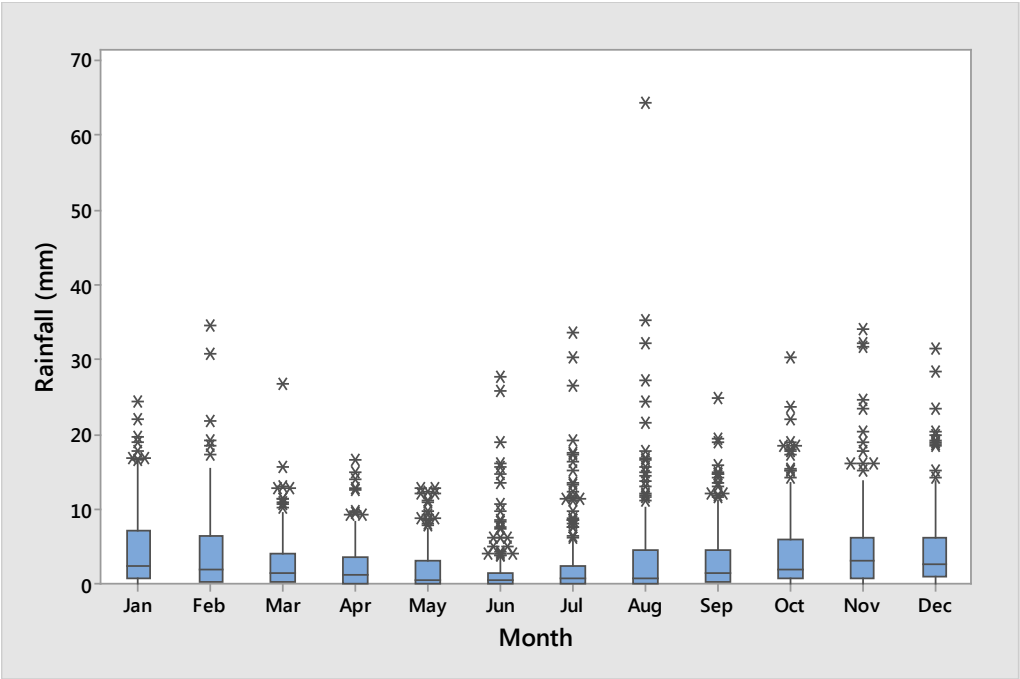

Figure 6.2 Boxplot of daily rainfall at Lerwick by month (2008-2013)

The 2009 sanitary survey report identified the wettest months as October to January and July the driest. A similar trend is noted in Figure 6.2, although the wettest months also include February, with June the driest. The extreme rainfall event of >60 mm rainfall/day was seen in August.

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 Lerwick for the period 2004-2013 while Figure 6.4 shows the annual wind rose for the same period. The local topography of Gruting Voe and its direction is likely to cause a variation in wind patterns to those shown in the wind roses (Lerwick is located on the east coast of mainland Shetland, whilst Gruting Voe is on the west coast and is south facing).

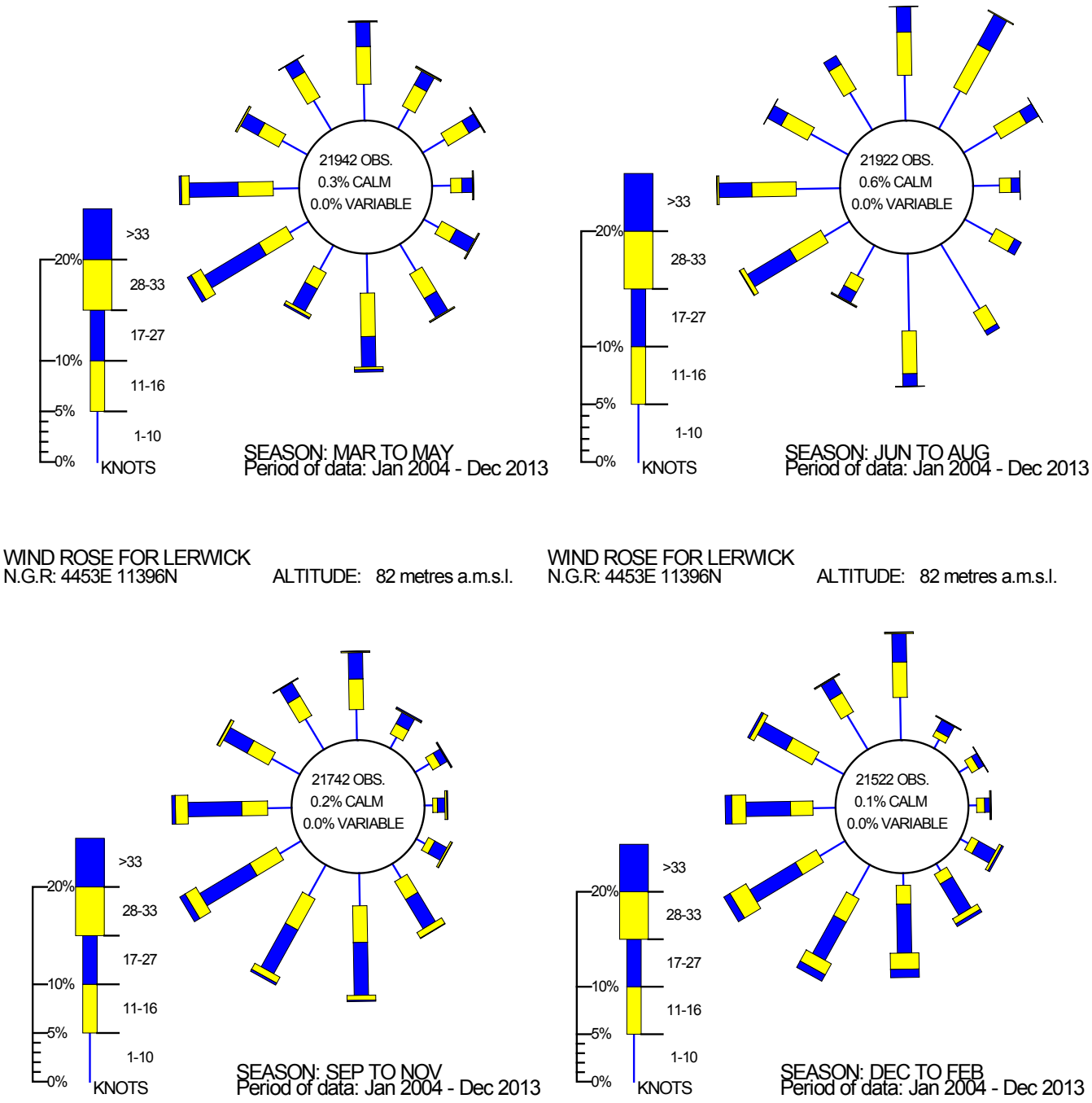

Figure 6.3 Seasonal wind roses for Lerwick (2004-2013)

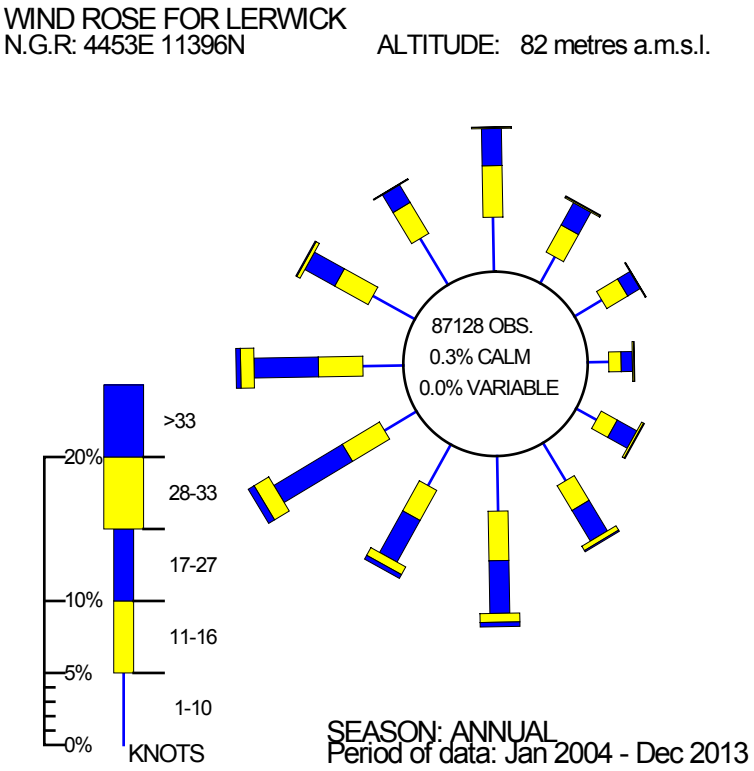

Figure 6.4 Annual wind rose for Lerwick (2004-2013)

The wind rose in Figure 6.4 shows that the overall prevailing annual wind direction is from the west-southwest, as well as from the south and west. Although winds are strongest in the autumn and winter, significant west south-westerlies are also present in the spring. Gruting Voe is relatively sheltered by the surrounding land. Southerly winds are expected to be funnelled up the voe whilst northerly winds will tend to be constrained down the voe.

7. Historical *E. coli* Data

Results for Gurting Voe: Browland Voe and Gruting Voe: Quilse production areas, taken between 01/01/2008 and 11/02/2015, 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 February 2015. Historical *E. coli* data used in the 2009 report had already been extracted and validated. All *E. coli* results were reported as most probable number per 100 g of shellfish flesh and intravalvular fluid.

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

Two samples from Browland Voe and one sample from Quilse were reported as rejected and were omitted from further analysis in this review. The remaining samples from both sites were all received within 48 hrs since collection, had box temperatures of <8^{o}C and plotted within the production area.

7.1 Summary of microbiological results

Summary results for Browland Voe and Quilse are displayed in Tables 7.1 and 7.2 respectively.

The general level of contamination at both sites appears to have been less since 2007, with maximum, 95%ile and geometric mean values for 2008-2015 being lower than those for 2002-2007.

Statistical analyses undertaken for the 2009 sanitary survey report found no significant difference in average *E. coli* values between the sites. Since the data set used for that report, samples has been taken at the two sites on the same day on 73 occasions. No significant difference was found in sample results between sites (Paired t-test: t = -0.24, p = 0.808).

Table 7.1 Sampling summary results for Browland Voe 2002-2015

Sampling Summary				
Production area	Gruting Voe: Browland Voe			
Site	Browland Voe			
Species	Common mussels			
SIN	SI-081-425-08			
Location	HU 268 508 and HU 263 501		Various	
Years	2002-2007		2008-2015	
Total no. of samples	70		78	
	2002	11	2008	9
	2003	12	2009	10
	2004	13	2010	11
	2005	12	2011	11
	2006	12	2012	12
	2007	10	2013	12
			2014	12
			2015	1
Minimum	<20		<18	
Maximum	9100		1300	
Median	20		15	
Geometric mean	41		27	
90 Percentile	750		176	
95 Percentile	1700		243	
No. Exceeding 230/100g	12 (17%)		3 (4%)	
No. Exceeding 1000/100g	6 (9%)		1 (1%)	
No. Exceeding 4600/100g	2 (3%)		0	
No. Exceeding 18000/100g	0		0	

Table 7.2 Sampling summary results for Quilse 2002-2015

Sampling Summary				
Production area	Gruting Voe: Quilse			
Site	Quilse			
Species	Common mussels			
SIN	SI-083-427-08			
Location	Various			
Years	2002-2007		2008-2014	
Total no. of samples	67		77	
	2002	11	2008	9
	2003	13	2009	9
	2004	14	2010	11
	2005	10	2011	11
	2006	12	2012	12
	2007	7	2013	12
			2014	12
			2015	1
Minimum	<20		<18	
Maximum	2400		1700	
Median	50		20	
Geometric mean	65		27	
90 Percentile	710		130	
95 Percentile	2020		677	
No. Exceeding 230/100g	14 (21%)		5 (7%)	
No. Exceeding 1000/100g	5 (8%)		3 (4%)	
No. Exceeding 4600/100g	0		0	
No. Exceeding 18000/100g	0		0	

7.2 Geographical patterns of results

Reported sampling locations for Browland Voe and Quilse for the period 2008-2015 are shown in Figure 7.1 with the symbol sizes shown proportional to the magnitude of the *E. coli* result.

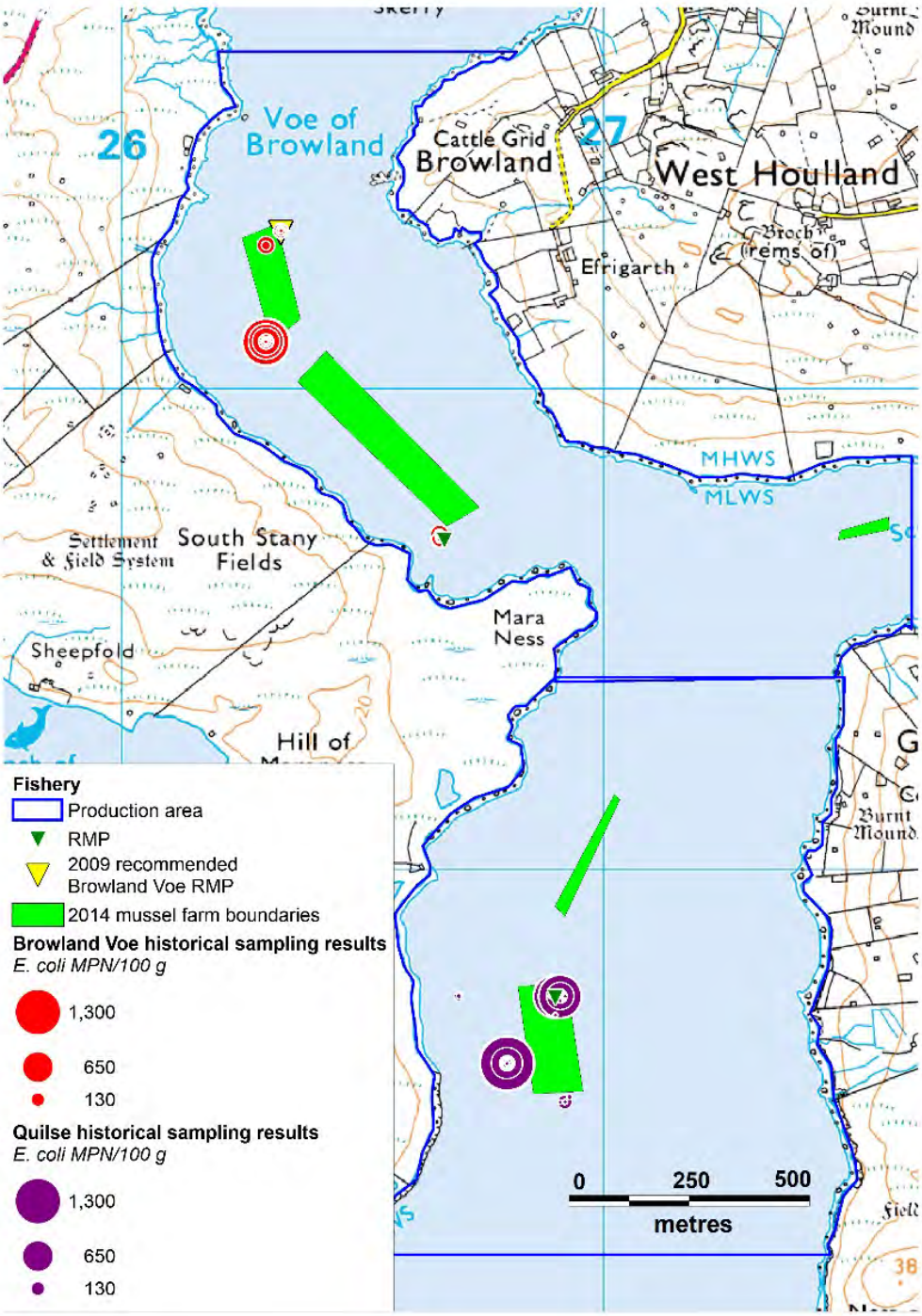

Figure 7.1 Reported sampling locations for the Browland Voe and Quilse common mussel fisheries

Browland Voe

Reported sampling locations for Browland Voe have been in three main areas;

- The southwest extent of the Browland Voe north site, from the latter half of 2007 until July 2010.

- An area within approximately 40 m of the 2009 recommended RMP (HU 2633 5033), from August 2010 to April 2012.An area within 14 m of the current RMP (HU 2667 4969), situated approximately 23 m southwest of location of the Browland Voe south site as recorded during the 2014 shoreline survey. Sampling began here in May 2012.

A summary of sampling results at these three areas is listed in Table 7.3.

Table 7.3 Sampling summary results for the three areas of sampling at Browland Voe

Site	Location	No. of samples	Minimum	Maximum	GM	95%
Browland Voe North	Northeastern	19	<18	230	28	230
Browland Voe North	Southwestern	26	<20	1300	36	1122
Browland Voe South	Southwestern	33	<18	230	20	230

The highest result was from a sample reported to have been taken southwest of the northern site, which was the area that also had the highest geometric mean and 95 percentile, compared to the other two sites.

A one-way ANOVA was conducted to determine whether there was a significant difference in sample results between the three sites. No significant difference was found (One-way ANOVA: f = 1.53, p = 0.224).

Quilse

Reported sampling locations at Quilse have predominantly been in two areas:

- An area approximately 170 m to the southwest of the current RMP, where sampling remained from the latter half of 2007 until May 2012.

- An area within 40 m of the current RMP (HU 2690 4874), where samples date from March 2013.

In addition to these areas, two 2012 samples with results of 20 and 50 *E. coli* MPN/100 g were taken approximately 200 m west of the current RMP and nine samples taken between June 2012 to February 2013 plotted approximately 220 m south of the current RMP. Sample results in the latter area varied between <20 and 130 *E. coli* MPN/100 g.

A summary of sampling results at the two main areas is listed in Table 7.4.

Table 7.4 Sampling summary results for the two main areas of sampling at Quilse

Site	No. of samples	Minimum	Maximum	GM	95%
North	41	<18	1100	27	1039
Mid-west	25	<20	1700	34	1379

A two-sample t-test was carried out to determine whether there was a statistically significant difference in sample results between the two main areas of sampling. No significant difference was found between the means of the $\log_{10}$-transformed *E. coli* results between the areas (Two sample t-test: t = -0.60, DF: 47, p = 0.552).

7.3 Temporal patterns of results

The trends of *E. coli* sampling results for both Browland Voe and Quilse have been analysed for the years between the previous sampling period (2002-2007) and the current sampling period (2008-2015). The following statistical analyses were carried out:

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

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

Temporal trends for Browland Voe and Quilse are displayed in Figures 7.3 and 7.4, followed by results from the t-test and the Chi-squared Test or Fisher's Exact Test.

Browland Voe

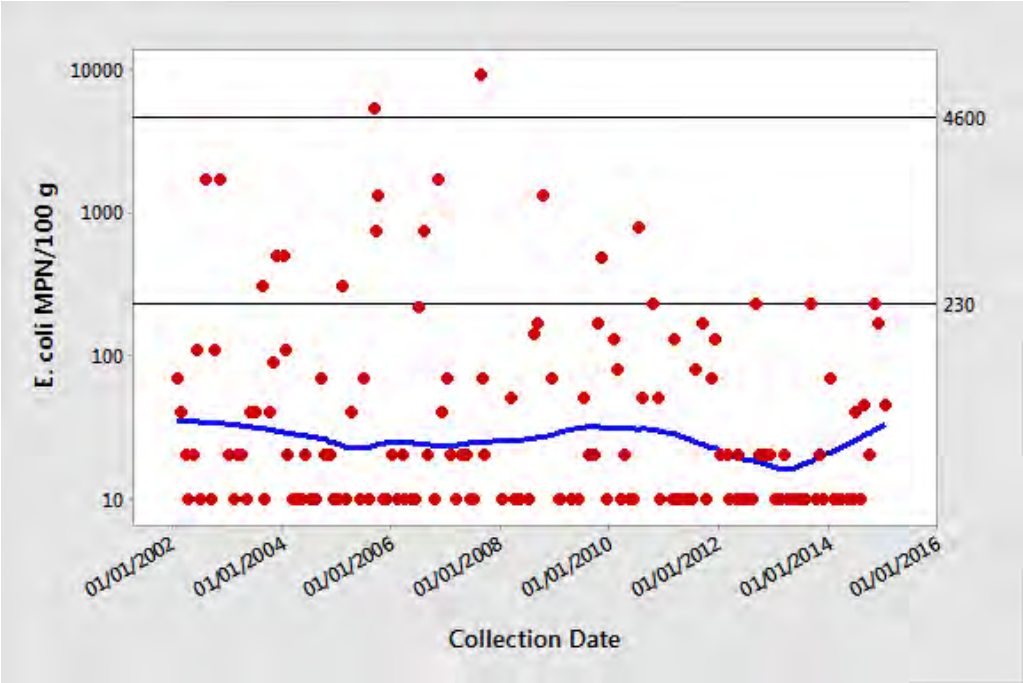

Figure 7.2 Scatterplot of Browland Voe *E. coli* results by date (2002-2015)

The trend line shows that no marked change over the period. However, no results exceeding 230 *E. coli* MPN/100 g have been seen since 2010.

No significant difference was found between the mean values of log transformed *E. coli* results from the two survey periods (Two sample t-test, t = 1.67, DF = 124, p = 0.097).

Table 7.5 Results above and below 230 and 1000 *E. coli* MPN/100 g at Browland Voe

	***E. coli* MPN/100g**		**Total**	***E. coli* MPN/100g**		**Total**
	≤230	>230		≤1000	>1000	
2002-2007	58	12	70	64	6	70
2008-2015	75	3	78	77	1	78
Total	133	15	148	141	7	148

A significant difference was found between the proportion of results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.012).

No significant difference was found between the proportion of results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.052).

Quilse

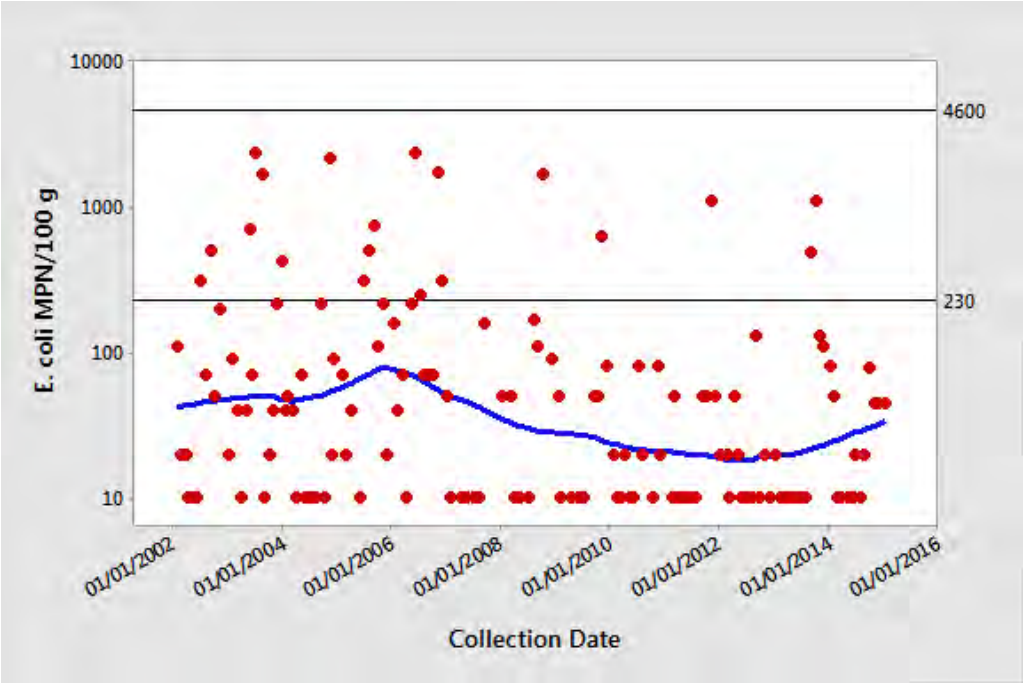

Figure 7.3 Scatterplot of Quilse *E. coli* results by date (2002-2015)

The trend line shows some sign of a possible reduction in E. coli levels over the period and the accompanying proportion of results >230 E. coli MPN/100g appears to be lower from 2007 on. ,. Contamination levels at Quilse are shown to have decreased since 2006, as highlighted by the trend-line, which also shows a slight increase again from 2013 onwards. This decrease is thought to relate to an increase in samples with results of <20 *E. coli* MPN/100 g.

A statistically significant difference was found between Quilse common mussel log transformed *E. coli* results from the two survey periods (Two sample t-test, t = 3.51, DF = 124, p = 0.001).

Table 7.6 Results above and below 230 and 1000 *E. coli* MPN/100 g at Quilse

	***E. coli* MPN/100g**		**Total**	***E. coli* MPN/100g**		**Total**
	≤230	>230		≤1000	>1000	
2002-2007	53	14	67	62	5	67
2008-2015	72	5	77	74	3	77
Total	125	19	144	136	8	144

A statistically significant difference was found between sampling results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Chi-squared Test, p = 0.011).

No statistically significant difference was found between sampling results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.472).

Conclusions

No significant difference was found in the average level of *E. coli* results between the two production areas. Sampling locations have varied over time within both production areas. No significant difference was seen in the average level of *E. coli* results between the sampling locations for each production area but any effect would have been potentially confounded by the different locations being sampled at different periods of time.

No significant difference was found in average *E. coli* values between sampling periods at Browland Voe. However, a lower proportion of results of >230 *E. coli* MPN/100 g was seen in the 2008-2015 period than in the 2002-2007 period. However, no significant difference was found in the proportion of results above and below 1000 *E. coli* MPN/100 g. The reported sampling location varied between three areas but no significant difference was found in sample results between areas.

A significant difference was found in average *E. coli* values between sampling periods at the Quilse. A lower proportion of results of >230 *E. coli* MPN/100 g was recorded in the 2008-2015 sampling period compared to the 2002-2007 period. However, no significant difference was found in the proportion of results above and below 1000 *E. coli* MPN/100 g. No significant difference was found in average *E. coli* values between the two main reported areas of sampling.

8. Movement of contaminants

The 2009 sanitary survey report identified the following in its hydrographic assessment;

- Tidal currents are weak, and vaguely bidirectional.
- Wind driven currents are likely to significantly alter circulation within the voe, depending of course on wind strength and direction.
- Density driven surface currents of fresher water following heavy rainfall will flow slowly in a seaward direction.
- Northerly or north easterly winds and freshwater driven currents may be expected to transport contamination from the north and eastern side of the voe towards the shellfisheries

No estimate of particle transport distance was given in the report. On the basis of the current meter data presented there, it would be expected that the maximum particle transport distance under normal conditions would be 1.5 km although in parts of the voe it would be more likely to be of the order of 0.5 km.

During the 2014 shoreline survey, salinity profiles were taken at two locations in the Gruting Voe: Browland Voe production area. At the northeastern corner of the Browland Voe North site the salinity at the surface was 1.49 ppt less than at depth. At the southeastern corner of the Scutta Voe site the salinity at the surface was 2.89 ppt less than at depth. Both differences exceeded the variability of the instrument (± 0.35 ppt). In addition, a difference in temperature with depth was seen at both sites, which emphasizes the presence of slight stratification.

9. Overall Assessment

The following assessment analyses the changes in contamination sources and their spatial impacts on the fisheries within Gruting Voe.

Human sewage Impacts

The human population in the immediate vicinity of Gruting Voe remains low and concentrated along the shorelines at Bridge of Walls, West Houlland and Gruting. Numbers of visitors to the area remains insignificant with one guest house identified at Bridge of Walls. Boat activity also remains low: although a new marina was noted in Scutta Voe, any increase in pleasure boat activity is expected to have been small.

Dwellings in the area remain on private ST facilities and those that have been identified are located >700 m from the mussel farms. Sewage impacts are therefore expected to be minor and any that does occur will mainly be at the northern end of Gruting Voe: Browland Voe and the southern end of Gruting Voe: Quilse.

Agricultural impacts

Sheep grazing predominantly along the eastern side of Gruting Voe remain a significant identified source of potential contamination to the mussel farms. Some contamination may also arise from the small numbers of sheep located to the northwest of the voe. The southern extent of the Quilse site may also be affected by sheep kept on land in the southern part of Gruting Voe.

Wildlife Impacts

The most significant impacts from wildlife sources will be associated with seabirds and seals. There is expected to be a higher impact near to the surface of the lines. No evidence was found on which to base an assessment of a consistent spatial pattern in the extent of contamination arising from these sources.

Seasonal Variation

No significant seasonal variation is expected in loadings from human sources. Agricultural impacts from sheep are expected to remain highest during the lambing season, broadly between May and September. Seabird impacts are expected to be higher during the breeding season, generally between May and October. Higher rainfall levels are between October and February although high rainfall events in the summer may wash accumulated animal and/or bird droppings off the land. Analyses presented in the 2009 sanitary survey report showed that higher mussel *E. coli* results tended to be seen in summer and autumn.

Watercourses

Watercourses recorded during the shoreline survey were principally located on the eastern side of the voe. Estimated E. coli loadings associated with the watercourses were low to moderate. However, due to access problems, watercourse located to the west and northwest of the Browland Voe North site were not measured or sampled during the shoreline survey. These are much closer to a mussel site than the recorded watercourses on the eastern side of the voe and therefore pose a potentially greater, but unquantifiable risk of contamination to the Browland Voe North site.

Movement of contaminants

Particle transport distance, based on current data presented in the 2009 sanitary survey report, is likely to be in the order of 0.5 to 1.5 km over a single phase (ebb or flood) of a tidal cycle although this distance, as well as any current direction, will be markedly affected by wind.

Salinity profiles showed that there was a relatively small, but measurable decrease of salinity at the surface compared to depth, indicating some freshwater influence at the surface.

Analysis of Results

Historical *E. coli* results

There remains no statistically significant difference in sample results between the sites Browland Voe and Quilse. Although sampling location at both sites has varied between 2008 and 2015, no significant differences were found in sample results between locations at either site.

There are indications that *E. coli* levels within both production areas have declined over time.

Shoreline Survey results

Three mussel samples were taken from the top (1-3 m) of the droppers. The highest result (330 *E. coli* MPN/100 g) was from a sample taken at the northeast extent of the Quilse site, with the lowest result (45 *E. coli* MPN/100 g) from a sample taken at the southwestern extent of the Browland Voe South site. A sample taken at the northwestern extent of the Browland Voe North site returned a result of 230 *E. coli* MPN/100 g.

Accompanying seawater samples returned results ranging from 1 to 4 *E. coli* cfu/100 ml, with the highest result from a sample taken at the northeastern extent of the northern Browland Voe site. Three other seawater samples were taken. Ones taken at the northeastern extent of the Maraness site and at the southeastern extent of the Scutta Voe site both returned results of 3 *E. coli* cfu/100 ml. The third sample was

taken opposite a discharge pipe noted below a suspected ST at the village hall in Scutta Voe and returned a result of 80 *E. coli* cfu/100 ml.

Conclusions

The 2009 report found the following were the most significant sources of contamination to the fisheries in Gruting Voe:

- Dense sheep grazing along the north and eastern coastline will impact the northern and eastern extents of the sites evenly and is expected to be highest during the lambing season, when sheep numbers approximately double.
- Seals and seabirds posed as significant sources of localised contamination.
- Freshwater inputs following heavy rainfall is expected to cause first flush effects along the north and eastern shorelines, impacting the sites evenly.
- Historical sampling results from both sites were higher in the autumn and summer than winter and spring. Higher results at Browland Voe correlated with recent rainfall and westerly winds.
- Wetter and windier conditions occur in autumn and winter, when winds prevail in a south-westerly direction.

In general, this review has found no significant change in the main faecal sources of contamination to the Gruting Voe fisheries, or their spatial impacts. Both sites continue to receive even amounts of contamination, predominantly from sheep and watercourses, which was in part verified by no statistically significant difference between historical sample results between sites. However, sufficient evidence does remain to recommend that both production areas should remain separate.

10. Recommendations

This review has not found sufficient evidence to suggest that there has been a significant change in the spatial input of faecal contamination to Gruting Voe that would necessitate a change in the sampling plan. This review therefore concludes that only slight changes are needed to the RMP locations to factor in the current location of the fisheries, and to relocate the Browland Voe RMP back to the northeast extent of the current location of the northern site. It is suggested that light amendments be made to the production area definitions to make sure that the adjacent boundaries coincide, and to identify that the Gruting Voe: Quilse production area includes the area up to MHWS.

Gruting Voe: Browland Voe

Production area: the area bounded by lines drawn between HU 2619 5070 and HU 2682 5070 and between HU 2764 4986 and HU 2764 4950 and between HU 2690 4940 and HU 2750 4940 extending to MHWS.

RMP: to be relocated back to the northeast of the northern site at HU 2632 5033.

Tolerance: has increased to 40 m to allow for movement of mussel lines

Depth: to remain at 1 m in order to reflect freshwater-borne contamination and direct inputs from seabirds.

Frequency: to remain at monthly.

Gruting Voe: Quilse

Production area: the area bounded by lines drawn between HU 2645 4820 to HU 2747 4820 and HU 2750 4940 to HU 2690 4940 and extending to MHWS.

RMP: at the northeast extent of the current fishery location at HU 2692 4875.

Tolerance: increased to 40 m to allow for movement of mussel lines

Depth: to remain at 1 m in order to reflect freshwater-borne contamination and direct inputs from seabirds.

Frequency: to remain at monthly.

Use of bagged mussels

If usage of either site is such that mature mussels will not be reliably available within the defined tolerance from the RMP, it is recommended that bagged mussels should be placed at the RMP location, at a depth of 1 m. The mussels should be in situ for at least two weeks prior to sampling in order that they reliably take on the microbiological quality of the RMP location.

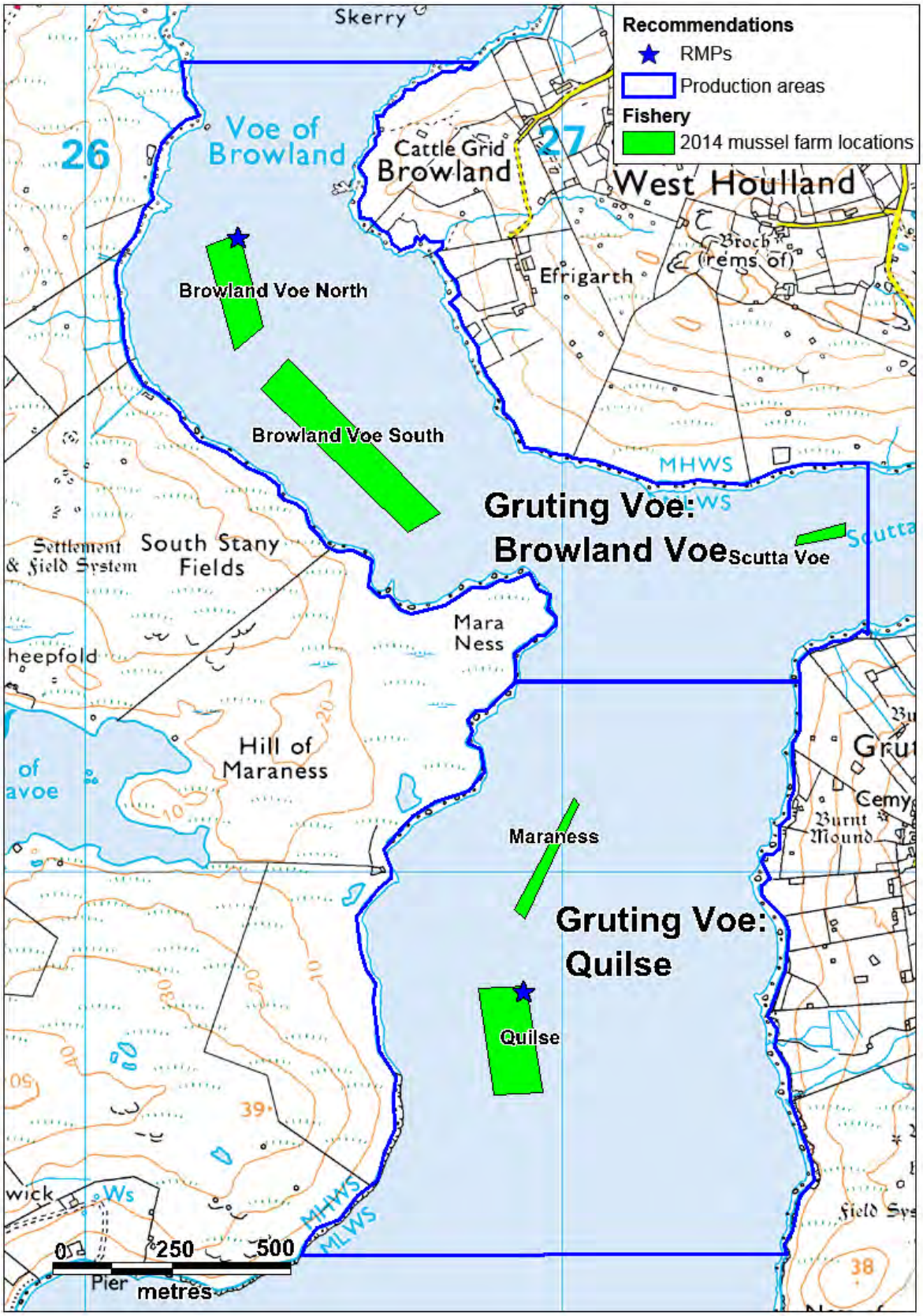

Figure 10.1 Recommended production area boundaries and RMPs for Gruting Voe: Browland Voe and Gruting Voe: Quilse

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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 Gruting Voe: Browland Voe and Quilse are listed in Table 1.

Table 1 Planning applications to areas around Gruting Voe: Browland Voe and Quilse

Location	Date	Ref No	Description	Area
Bridge of Walls	Jan 2010	2010/9/PCD	Erect new dwellinghouse and associated septic tank	Staneydale Bridge of Walls ZE2 9NS
	Sep 2011	2011/290/PPF	To demolish derelict crofthouse and outbuildings and erect new dwellinghouse and detached garage	Hestaford Gruting Bridge Of Walls Shetland ZE2 9NR

Appendix 2

Shoreline Survey Report

Production Areas:	Gruting Voe: Browland Voe	
	Gruting Voe: Quilse	
Site Names:	Browland Voe North	
	Browland Voe South	
	Scutta Voe	
Maraness		
	Quilse	
SIN:	Browland Voe:	SI-081-425-08
	Quilse:	SI-083-427-08
Harvesters:	**Shetland Mussels**:	Michael Tait
	Selivoe Shellfish:	Lyndon Mouat
	Peter Tait:	Peter Tait
Local Authority:	Shetland Islands Council	
Status:	Existing area	
Date surveyed:	26 November 2014	
Surveyed by:	Sean Williamson (Hall Mark Meat Hygiene Ltd.), Helena Mackay (SSQC Ltd)	
	We are grateful to Shetland Mussels for providing assistance during the marine survey work.	
Existing RMPs	HU 2667 4969 *(E.coli)*	
	HU 2690 4874 *(E.coli)*	
Area Surveyed:	See Figure 1	

Specific observations made on site are mapped in Figure 1 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figures 2 and 3. Bacteriology results are given in Tables 2 and 3. Salinity profiles are presented in Table 4 with profile locations marked on Figure 2. Photographs are presented in Figures 4-17.

Weather

Wednesday 26 November 2014

Overcast conditions in the morning brightened to scattered cloud with sunny spells during the afternoon. F4 southerly breeze persisted throughout the day. It remained dry for the duration of the boat work and shoreline walk.

Tuesday 25 November 2014

Partly cloudy, remained dry throughout the day. Initial F2-3 westerly winds veered SE by evening, increasing to F4.

Preceding the shoreline survey, Monday 24 November was partly cloudy and dry during the day with light showers occurring later during the night. A light, predominately NW breeze shifted westerly during the morning, moved SW throughout the day before returning to

westerly by evening. Sunday 23 November was mainly dry with some light showers recorded during the early evening and overnight. SW winds, with speeds between F2-F4, shifted northerly overnight from Sunday to Monday.

Fishery

The location of the mussel lines for all five fisheries are mapped in Figure 1. Three of the sites - Quilse, Browland North and Browland South - were stocked with mature mussels, whilst the Maraness and Scutta Voe sites were populated with spat only. Harvesting from the Quilse site will begin in early 2015. Both Browland Voe sites are harvested as mussels reach the required size, though in general these sites are farmed for spat. The Maraness site is dedicated as a spat site. Mussel spat grown on the Scutta Voe lines are moved to a grower site at around 18 months.

The **Browland Voe North** fishery consisted of 5 x 200m mussel lines running north-south, parallel to the western shoreline of Browland Voe (Figure 4). All lines were double-headed longlines with 5 metre droppers. The site is licenced for five 160 metre quad-headline longlines. One mussel sample was collected from the first line, fourth buoy down at the north east corner of this site.

The **Browland Voe South** fishery consisted of 5 x 400m long mussel lines adjacent to the western shoreline of Browland Voe (Figure 5). All lines were double-headed longlines with 8 metre droppers. The site is licenced for five 410m metre quad-headline longlines. One mussel sample was collected at the south west corner of the site.

The **Scutta Voe** fishery consisted of 2 x 100m long mussel lines running west-east adjacent to the northern coastline of Scutta Voe (Figure 6). All lines were double-headed longlines with 4 metre droppers. The site is licenced for four 100m double-headed longlines. This site was populated with mussel spat; no mussel samples were collected from this fishery.

The **Maraness** fishery consisted of 2 x 280m long mussel lines aligned north-south adjacent to the western coast of Quilse Voe below Hill of Maraness (Figure 7). All lines were double-headed longlines with 8 to 9 metre droppers. The site is licenced for three 220 metre twin-headrope longlines. No mussel samples were collected from this site.

The **Quilse** fishery consisted of 5 x 220m mussel lines running parallel to the western coastline of Quilse Voe (Figure 8). All lines were double-headed longlines with 8-9 metre droppers. The site is licenced for six 220 metre quad-headline longlines. One mussel sample was collected near the north east corner of the site.

Sewage/Faecal Sources

Gruting, on the eastern coastline of Gruting Voe is a sparsely populated area with approximately 10 dwelling houses situated around the coastline between Quoys and the Burn of Scutta Voe. None of the houses were positioned near the shoreline and no sanitary outlets were recorded on this section of the shoreline walk.

Moving north from the head of Scutta Voe to Green Burn, one modern and one traditional dwelling house, which is attached to a small community centre, were situated on the lower side of the road near the head of Scutta Voe. No septic tank was identified associated with the modern dwelling house, however a possible outlet pipe exiting above the beach was recorded to the right of the property (Figures 9 & 10). There was no discernible smell in the vicinity of the pipe.

A septic tank flowing to a soakaway associated with the traditional dwelling house and community centre, was recorded in close proximity to the shoreline (Figure 11). No further houses were recorded around the coastline until reaching Browland where 2 dwelling houses were noted on the hill a good way up from the shoreline.

The Bridge of Walls at the head of Browland Voe is sparsely populated with 4 dwelling houses on the lower side of the road in close proximity to the shore (Figure 12). Approaching from the east, no septic tank was identified associated with the first dwelling house reached. A piped outlet via the surrounding wall onto the beach below was recorded with no discharge observed (Figure 13). Moving west a sewer pipe was observed entering the sea below a dwelling house near the head of Browland Voe, however the end of the pipe was not visible underwater (Figure 14). A septic tank associated with a chalet above was recorded close to the shoreline (Figure 15). A second sewer pipe was recorded entering the sea in front of the final house near the shoreline before reaching the bridge and the end of the survey route (Figure 16). A further 4 dwelling houses were situated above the road, a good distance from the shoreline.

Sample analysis

Seven freshwater samples were obtained from watercourses around Gruting Voe, all of which were collected from the eastern coastline. Seven sampling points were outlined in the survey plan and all of these were collected. All of the watercourses sampled were found to have *E.coli* levels between 2-60 cfu/100 ml. No additional freshwater samples were collected.

Seawater samples were obtained from all five fisheries. Samples were collected from the north ends of Quilse, Maraness and Browland Voe North sites and from the south ends of Scutta Voe and Browland Voe South sites. *E.coli* levels were between 1 to 4 cfu/100ml. Away from the fishery, a planned seawater sample was collected below a septic tank associated with the old Gruting school buildings, which currently accommodate a dwelling house and small community centre. This sample contained *E.coli* levels of 80cfu/100ml. No additional seawater samples were collected.

Mussel samples were obtained from as close as possible to the NE corners at the Quilse and Browland Voe North sites. In both cases, there were no mussels located at the NE corner points. A third mussel sample was collected from the SW corner of the Browland Voe South site. All samples collected were obtained from within the top 3m of the droppers. No mussel samples were collected from the Maraness and Scutta Voe fisheries as these were

populated with mussel spat only with no mature mussels available. No shore mussels were collected. The Quilse, Browland Voe North and Browland Voe South samples returned results of 330 *E.coli* MPN/100g, 230 *E.coli* MPN/100g and 45 *E.coli* MPN/100g respectively.

Salinity profiles were obtained from two of the fisheries as detailed on the survey plan; from the NE corner of Browland Voe North site and the SE corner of Scutta Voe site. At both sites observed variation in salinity measurements with depth exceeded the accuracy value of the probe used (± 0.35 ppt) with a difference of between 1.49 ppt and 2.89 ppt present between the surface reading and the deepest measurement recorded.

Surface salinity ranged from 30.49 ppt at the north east corner of the Browland Voe North fishery to 31.99 ppt at the south east corner of the Scutta Voe fishery. The water was too shallow to collect a salinity measurement at a 10 metre depth at both sites.

Temperature profiles were also obtained from these locations. The profiles at both fisheries showed a decrease in temperature from 5m to the surface, in particular at the Browland Voe North fishery (2°C difference). Surface temperature ranged from 7.2°C to 7.8°C. The water was too shallow to collect a temperature measurement at a 10 metre depth at both sites.

Salinities of the seawater samples analysed at the laboratory showed salinities ranging from 5.908 PSU present at the sampling point below the old Gruting school buildings on the northern periphery of Scutta Voe to 33.67 PSU present at the NE corner of the Maraness fishery.

Seasonal population

Shoreside holiday cottage (sleeps 4-5) is situated in close proximity to the shoreline near the Bridge of Walls. There are no other registered holiday accommodation providers in the vicinity of the Gruting Voe coastline.

Boats/Shipping

Boat traffic within the Gruting Voe area is largely associated with the fishery, salmon farming, creel fishing and leisure activities. All five fisheries are serviced from shorebases out with the production areas. One floating pontoon was recorded below a dwelling house and small community centre towards the head of Scutta Voe (Figure 17). A small open boat was noted pulled up onto the beach near the start of the shoreline walk below Gruting.

Farming and Livestock

The majority of the land observed during the survey around the production areas was rough grazing. Approximately 290 sheep were observed whilst undertaking the survey; 54 were recorded on the western shoreline from the boat, the remainder sighted during the shoreline walk along the eastern coastline. Thirty eight sheep were recorded between the start of the walk at Gruting and the head of Scutta Voe, a further 110 were noted below West Houlland with the remainder being sighted between the Loch of Murraster tributary and the Bridge of

Walls. Sheep faeces were noted on 9 occasions where animals were not present, of which 3 occurrences were at the shoreline. All of the livestock recorded on the western coast of Gruting Voe had access to the shore. Approximately 170 sheep had access to the shoreline on the eastern coastline from Gruting to the Bridge of Walls.

Pony faeces were observed in an enclosed field below Gruting. No animals were present at the time of the survey.

Agricultural buildings were noted on five occasions during the shoreline survey, all of which were situated on the eastern coastline, a good distance away from the shore.

Land Use and Land Cover

Rough grassland dominates the coastline around Gruting Voe. High embankments at the start of the shoreline walk at Gruting quickly gave way to lower level rocky outcrops interspersed with pebble beaches. Low grassland areas typically characterise the stretches of coastline flanking Scutta Voe and onwards to the Bridge of Walls. Rough grazing fields in general terminate to pebble or shingle beaches towards sea level. A small number of sparsely populated settlements stretch across the rural landscape. Two fields cut for silage were recorded; the first at Gruting and the second near Browland.

A number of wet boggy areas were noted throughout the shoreline walk, particularly on the southern bank of Scutta Voe

Watercourses

Seven watercourses were sampled during the shoreline survey, all of which were outlined on the sample plan. No additional freshwater samples were collected. Flow rates were recorded at six of the seven watercourses sampled and from an additional five small watercourses. No flow rates were recorded alongside the sample obtained from the tributary of Loch of Brouster due to difficulties in accessibility.

Wildlife/Birds

Birds were observed in all areas surveyed with 6 common gulls, 24 grey lag geese, 6 snipes, 7 mallard ducks, a wren and a heron being recorded during the shoreline walk. An area adjacent to the north east corner of the Scutta Voe fishery was observed to contain shell debris indicating a possible bird feeding site.

Seabirds were present at three of the five fisheries, with none being recorded at the Maraness or Scutta Voe sites. Bird faeces were observed on buoys at all five fisheries.

Four seals were noted in the water, 2 in Scutta Voe and 2 approaching the head of Browland Voe. One rabbit was observed in a field at the Bridge of Walls.

General observations

Recorded observations apply to the dates of survey only. Animal numbers were recorded on the day from the observer's point of view. This does not necessarily equate to total numbers present as natural features may obscure individuals and small groups of animals from view.

Dimensions and flows of watercourses are estimated at the most convenient point of access and not necessarily at the point at which the watercourse enters the voe.

Figure 1 Map of shoreline observations Gruting Voe.

Table 1 Shoreline Observations

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
1	26/11/2014 09:29	HU 26958 48540	426958	1148540			Gruting Voe Sanitary Survey 26 November 2014. F4 southerly winds, partly cloudy, dry. Start of boatwork. SE corner of Peter Tait's Quilse site, the southernmost site in Quilse Voe within the Gruting Voe: Quilse production area. The site consists of 5 x 220m lines with 8-9m droppers situated adjacent to the western coastline of Gruting Voe.
2	26/11/2014 09:30	HU 26855 48534	426855	1148534			SW corner of Quilse site. 1 cormorant noted on buoy.
3	26/11/2014 09:32	HU 26822 48758	426822	1148758			NW corner of Quilse site. 1 common gull in flight.
4	26/11/2014 09:33	HU 26924 48762	426924	1148762			NE corner of Quilse site. Planned sample point, however no mussels located at the end of this line. Some bird faeces on buoys at fishery
5	26/11/2014 09:34	HU 26926 48753	426926	1148753		GRU-MUSS-01 & GRU-SW-01	NE of Quilse site. Mussel and sea water sample collected, as near as possible to planned sample point on the same line. Mussel sample collected from within the top 3m of dropper.
6	26/11/2014 09:41	HU 26920 48904	426920	1148904			SE corner of Peter Tait's Maraness site, the northernmost site in Quilse Voe, which consists of 2 x 280m lines with 8-9m droppers. The mussel lines are situated adjacent to the western coastline of Gruting Voe. There were no mature mussels at this site. It is understood that this site is used for spat only.
7	26/11/2014 09:42	HU 26899 48924	426899	1148924			SW corner of Maraness site.
8	26/11/2014 09:43	HU 27023 49157	427023	1149157	Figure 7		NW corner of Maraness site. Photo looking south across fishery.
9	26/11/2014 09:44	HU 27034 49145	427034	1149145		GRU-SW-02	NE corner of Maraness site. No birds were noted at or in the vicinity of mussel ropes. Some bird faeces on buoys. Sea water sample collected. Approximately 40 sheep with access to shore recorded from boat, above western shoreline of Gruting Voe.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
10	26/11/2014 09:56	HU 26743 49753	426743	1149753			SE corner of Shetland Mussels' Browland Voe South fishery within the Gruting Voe: Browland Voe production area. The site consists of 5 x 400m lines with 8m droppers situated adjacent to the western coastline in Browland Voe. 1 common gull on buoy.
11	26/11/2014 09:57	HU 26675 49714	426675	1149714	Figure 5	GRU-MUSS-02 & GRU-SW-03	SW corner of Browland Voe South site. Photo taken looking north east across fishery. 1 mussel sample and 1 seawater sample collected. Mussel sample collected from within the top 3m of dropper.
12	26/11/2014 10:04	HU 26365 50015	426365	1150015			NW corner of Browland Voe South site. 14 sheep recorded from boat above western shoreline.
13	26/11/2014 10:05	HU 26424 50078	426424	1150078			NE corner of Browland Voe South site. Some bird faeces noted on buoys.
14	26/11/2014 10:06	HU 26371 50145	426371	1150145			SE corner of Shetland Mussels' Browland Voe North fishery consisting of 5 x 200m lines with 5m droppers. The mussel lines are positioned running N-S adjacent to the western shoreline of Browland Voe. 1 black backed gull on buoys. Some bird faeces noted on buoys.
15	26/11/2014 10:07	HU 26311 50095	426311	1150095			SW corner of Browland Voe North fishery.
16	26/11/2014 10:08	HU 26250 50313	426250	1150313			NW corner of Browland Voe North fishery.
17	26/11/2014 10:10	HU 26322 50342	426322	1150342	Figure 4		NE corner of Browland Voe North fishery. Photo taken looking south west across fishery. Salinity Profile 1 collected (ppt/°C): 10m N/A, 5m 33.38/9.2, 3m 30.98/7.4, surface 30.49/7.2. Planned mussel/seawater sampling point, however no mussels located at the end of this line.
18	26/11/2014 10:16	HU 26337 50283	426337	1150283		GRU-MUSS-03 & GRU-SW-04	NE Browland Voe North site. Mussel and seawater sample collected, 4 buoys down from corner on same line as planned sample. Mussel sample collected from within the top 3m of dropper.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
19	26/11/2014 10:26	HU 27487 49685	427487	1149685			SW corner of Selivoe Shellfish's Scutta Voe mussel lines. The fishery consists of 2 x 100m lines with 4m droppers, situated near the entrance of Scutta Voe, adjacent to the northern coastline. It is understood this site is used as a spat site only.
20	26/11/2014 10:27	HU 27491 49705	427491	1149705	Figure 6		NW corner of Scutta Voe fishery. 1 common gull on buoys. Some bird faeces on buoys. Photo looking south east across fishery.
21	26/11/2014 10:28	HU 27592 49733	427592	1149733			NE corner of Scutta Voe fishery.
22	26/11/2014 10:29	HU 27593 49707	427593	1149707		GRU-SW-05	SE corner of Scutta Voe fishery. Planned seawater sample collected. Planned mussels sampling point, however only mussel spat on this site, no sample obtained. Salinity Profile 2 collected (ppt/°C): 10m N/A, 5m 33.48/8.6, 3m 32.35/7.9, surface 31.99/7.8.
23	26/11/2014 11:34	HU 27487 48544	427487	1148544		GRU-FW-01	Start of shoreline walk from Gruting to Bridge of Walls. Rough grazing fields beyond start point of survey. High embankment gives way to stony beach. Planned freshwater sample collected (No 7. in Table 4 of plan) from unnamed watercourse running onto pebbled beach. Flow measurements recorded; Dimensions: 15cm wide, 5cm deep. Flow 0.542cm/s and SD 0.04cm/s. Fenced grazing field with no access to shore. A narrow strip of grassland between fenced area and shoreline is accessible from further along the coastline. Some boggy areas noted. Pony faeces in field.
24	26/11/2014 11:43	HU 27459 48659	427459	1148659			Small field drain within above field. Flow measurements recorded; Dimensions: 10cm wide, 5cm deep. Flow 0.2cm/s and SD 0.005cm/s. 1 small open boat hauled up on beach.
25	26/11/2014 11:46	HU 27448 48726	427448	1148726	Figure 8		2 photos taken of Quilse sites; the first of southernmost fishery and the second of northernmost fishery from the shoreline looking west.
26	26/11/2014 11:48	HU 27471 48787	427471	1148787			Fenced field above stony beach with no access to shoreline. Sheep faeces present in field. A narrow strip of grassland between fence and beach accessible by livestock further along

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
							to the north of the coastline.
27	26/11/2014 11:51	HU 27482 48854	427482	1148854			Field drain flowing into sea. Flow measurements recorded; 25cm wide, 6cm deep. Flow 0.69cm/s and SD 0.015cm/s. Derelict house above on hillside.
28	26/11/2014 11:52	HU 27479 48874	427479	1148874			Fenced field above shoreline. Sheep faeces present. No access to shore from field but beach is accessible from a point further north.
29	26/11/2014 11:53	HU 27458 48938	427458	1148938			Accessible narrow strip of grass above shoreline. Fenced field above with no access. 1 common gull noted.
30	26/11/2014 11:54	HU 27439 48992	427439	1148992			Shorefront is open grassland above a shingle beach, sheep faeces present. Empty boat noosts at shoreline. 2 dwelling houses and 3 agricultural sheds on hill above away from the shore. 22 sheep in field above shoreline with no access to beach. 18 grey lag geese disturbed from field + 6 more in field.
31	26/11/2014 11:59	HU 27452 49046	427452	1149046			Silted up, shallow watercourse (photo taken). Goose faeces present nearby.
32	26/11/2014 12:02	HU 27472 49113	427472	1149113			Fenced field, cut for silage, above stony beach with no access to shoreline. 6 sheep in field. Goose faeces in field.
33	26/11/2014 12:08	HU 27509 49314	427509	1149314			Open field to shoreline, sheep faeces present above beach. 1 dwelling house on hillside above.
34	26/11/2014 12:11	HU 27558 49475	427558	1149475			Fenced field close to shoreline, sheep faeces present in field. No access to shore. Shoreline is characterised by low grassy banks. Photo taken looking north to Scutta Voe fishery.
35	26/11/2014 12:14	HU 27566 49475	427566	1149475		GRU-FW-02	Planned freshwater sample collected from small, unnamed watercourse running to shore (No. 6 in table 4 of plan). Some vegetation growth visible in watercourse (photo). Flow measurements recorded; Dimensions: 14cm wide, 5cm deep. Flow 0.124cm/s and SD 0.021cm/s. Planticrub near shoreline beyond.
36	26/11/2014 12:23	HU 27660 49488	427660	1149488			Small watercourse running into sea (photo). Flow measurements recorded; Dimensions: 15cm wide, 5cm deep. Flow 0.176cm/s and SD 0.019cm/s.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
37	26/11/2014 12:26	HU 27729 49505	427729	1149505			Fenced grazing field above shoreline, 10 sheep with no access to shore. 1 dwelling house on hill above a good way up from coastline.
38	26/11/2014 12:30	HU 27833 49569	427833	1149569			Low level shingle beach. Sheep faeces present on beach. Fenced field above, some boggy patches. 2 dwelling houses on hill above a good way from coastline.
39	26/11/2014 12:32	HU 27871 49596	427871	1149596			Field drain running into sea (photo). Flow measurements recorded; Dimensions; 30cm wide, 4cm deep. Flow 0.161cm/s and SD 0.005cm/s
40	26/11/2014 12:36	HU 27964 49642	427964	1149642			Sheep faeces noted just above shoreline. Fenced field above also containing sheep faeces. 2 seals in water (photo). Large boggy area further north. 1 snipe at shoreline. 6 mallard ducks and 1 heron in flight.
41	26/11/2014 12:44	HU 28269 49714	428269	1149714		GRU-FW-03	Planned freshwater sample collected from Burn of Scutta Voe (No 5. in table 4 of plan) at head of Scutta Voe. Photo taken. Flow measurements recorded; Dimensions: 190cm wide, 24cm deep. Flow 0.235cm/s and SD 0.038cm/s
42	26/11/2014 12:52	HU 28191 49769	428191	1149769			Shingle/stony beach at head of Scutta Voe. Boggy area with iris growing above shoreline. Sheep faeces present.
43	26/11/2014 12:58	HU 28021 49844	428021	1149844	Figure 9 & Figure 10		Modern dwelling house above shoreline. No septic tank identified. Possible associated outlet pipe to the right of the property ending above beach, 2 photos taken. No obvious smell.
44	26/11/2014 13:03	HU 27944 49868	427944	1149868	Figure 17		Small floating pontoon (photo).
45	26/11/2014 13:05	HU 27908 49874	427908	1149874	Figure 11		Septic tank (associated with old Gruting school buildings) flowing to soakaway. The property lies in close proximity to the shore. The buildings have been converted into 1 dwelling house and a small community centre.
46	26/11/2014 13:07	HU 27911 49869	427911	1149869		GRU-SW-06	Planned seawater sample collected directly below septic tank.
47	26/11/2014	HU 27858	427858	1149875			Fenced field above shoreline. 15 sheep with no access to

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
	13:11	49875					shore.
48	26/11/2014 13:14	HU 27783 49894	427783	1149894		GRU-FW-04	Planned freshwater sample collected from unnamed watercourse running into Scutta Voe (No. 4 in table 4 of plan). Flow measurements recorded; Dimensions: 7cm wide, 7cm deep. Flow 0.177cm/s and SD 0.005cm/s. 4 lambs next to watercourse and a further 9 in field, no access to shoreline.
49	26/11/2014 13:18	HU 27758 49877	427758	1149877			Open field to hill above shoreline, sheep faces present above stony beach.
50	26/11/2014 13:22	HU 27555 49871	427555	1149871			Shell debris noted in close proximity to shoreline, possible bird feeding spot. 14 sheep on hill above with access to beach.
51	26/11/2014 13:27	HU 27350 49826	427350	1149826			Rocky beach. Fenced field above with access to shoreline. Sheep faeces present. 1 common gull.
52	26/11/2014 13:34	HU 26985 49894	426985	1149894			Open, rough grazing field with access to stony beach. 5 sheep. 1 snipe on beach.
53	26/11/2014 13:40	HU 26813 50159	426813	1150159			Approximately 15 sheep in open field above beach. 1 snipe. 1 dwelling house some distance above.
54	26/11/2014 13:45	HU 26759 50329	426759	1150329		GRU-FW-05	Planned freshwater sample collected from small unnamed watercourse running to shoreline (No. 3 in table 4 of plan). Flow measurements recorded; Dimensions: 12cm wide, 10cm deep. Flow 0.242cm/s and SD 0.033cm/s. Photo.
55	26/11/2014 13:54	HU 26656 50352	426656	1150352			Rough grazing area with access to stony beach. Boggy area near shoreline. 2 snipes, 1 common gull.
56	26/11/2014 14:00	HU 26615 50507	426615	1150507			Small field drain recorded, not enough flow to measure. 1 common gull.
57	26/11/2014 14:04	HU 26717 50627	426717	1150627			Rough grazing area. 15 sheep with access to shore. 6 ducks. 1 seal in water.
58	26/11/2014 14:10	HU 26890 50737	426890	1150737			Rocky shoreline. Fenced field above cut for silage. 20 sheep in field. 2 dwelling houses and 2 agricultural sheds on hill above, a good distance from coastline.
59	26/11/2014 14:13	HU 26974 50764	426974	1150764			Fenced field containing 13 sheep with no access to shore. 1 wren.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Figure	Associated Sample	Description
60	26/11/2014 14:19	HU 27136 50900	427136	1150900			Small burn running onto beach (photo). Flow measurements recorded; Dimensions: 15cm wide, 6cm deep. Flow 0.107cm/s and SD 0.012cm/s
61	26/11/2014 14:22	HU 27163 50951	427163	1150951		GRU-FW-06	Planned freshwater sample collected from tributary of Loch of Murraster (No. 2 in table 4 of plan) flowing through culvert under road near entrance to sea. Photo. Flow measurements recorded; Dimensions: 165cm wide, 3cm deep. Flow 0.947cm/s and SD 0.014cm/s.
62	26/11/2014 14:28	HU 27141 50955	427141	1150955			Grazing field with access to shore. Approximately 80 sheep present. 1 snipe, 1 mallard duck and 2 common gulls noted.
63	26/11/2014 14:38	HU 26659 51028	426659	1151028	Figure 12 & Figure 13		1 dwelling house (Shoreside holiday cottage) in close proximity to shoreline (photo). Piped outlet in surrounding wall with no flow (photo). 1 house on upper side of road above. 1 seal in water.
64	26/11/2014 14:45	HU 26527 51065	426527	1151065	Figure 14		Sewer pipe into sea below 1 dwelling house, end of pipe not visible underwater. 2 photos.
65	26/11/2014 14:46	HU 26509 51072	426509	1151072			Small field drain running onto beach. No flow readings available, watercourse too shallow.
66	26/11/2014 14:48	HU 26480 51072	426480	1151072	Figure 15		Septic tank near shoreline associated with 1 chalet above (photo). 1 house on upper side of road.
67	26/11/2014 14:51	HU 26418 51059	426418	1151059	Figure 16		1 dwelling house in close proximity to beach with piped outlet to sea. End of pipe not visible underwater. 2 Photos.
68	26/11/2014 14:53	HU 26355 51125	426355	1151125			Grazing field with 7 sheep, access to shore. 2 houses on upper side of road well away from shoreline.
69	26/11/2014 14:58	HU 26212 51194	426212	1151194			Grazing field with access to shore. 1 rabbit noted.
70	26/11/2014 15:03	HU 26071 51215	426071	1151215		GRU-FW-07	Planned freshwater sample from tributary of Loch of Brouster taken from bridge (No. 1 in table 4 of plan). No flow rates recorded - high state of tide and width of flow prevented access and accurate assessment.
71	26/11/2014 15:07	HU 26045 51191	426045	1151191			End of shoreline walk at Bridge of Walls.

Sampling

Water and shellfish samples were collected at the locations indicated in Figures 2 and 3. All of the seven freshwater and six seawater samples detailed in the survey plan/map were obtained. No additional water samples were collected. Three of the five mussels samples detailed in the survey plan were collected. There were no mature mussels at either the Maraness or Scutta Voe sites. All samples were transported initially by a cool backpack and then in a cool box to SSQC Ltd. for analysis within 24 hours of sample collection.

Bacteriology results are present in Table 2 and 3 and mapped in Figures 2 and 3.

Seawater samples were also tested for salinity at SSQC Ltd. In the field salinity profiles were collected using a YSI Professional Plus handheld meter and CT probe which had an accuracy of (± 0.35 ppt). Results are presented in Table 4 and locations of the profiles are mapped in Figure 2.

Table 2 Water sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type*	*E.coli* (cfu/100ml)	Salinity**
1	GRU-SW-01	26/11/2014 09:34	HU 26926 48753	SW	2	33.7
2	GRU-SW-02	26/11/2014 09:44	HU 27034 49145	SW	3	33.67
3	GRU-SW-03	26/11/2014 09:57	HU 26675 49714	SW	1	31.97
4	GRU-SW-04	26/11/2014 10:16	HU 26337 50283	SW	4	30.94
5	GRU-SW-05	26/11/2014 10:29	HU 27593 49707	SW	3	32.28
6	GRU-FW-01	26/11/2014 11:34	HU 27487 48544	FW	2	-
7	GRU-FW-02	26/11/2014 12:14	HU 27566 49475	FW	19	-
8	GRU-FW-03	26/11/2014 12:44	HU 28269 49714	FW	44	-
9	GRU-SW-06	26/11/2014 13:07	HU 27911 49869	SW	80	5.908
10	GRU-FW-04	26/11/2014 13:14	HU 27783 49894	FW	60	-
11	GRU-FW-05	26/11/2014 13:45	HU 26759 50329	FW	9	-
12	GRU-FW-06	26/11/2014 14:22	HU 27163 50951	FW	60	-
13	GRU-FW-07	26/11/2014 15:03	HU 26071 51215	FW	8	-

*FW = freshwater, SW = seawater **Practical Salinity Scale 1978 (PSS-78)

Table 3 Shellfish sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type	Depth	*E.coli* (MPN/100g)
1	GRU-MUSS-01	26/11/2014 09:34	HU 26926 48753	Common Mussels	Top 3m of dropper	330
2	GRU-MUSS-02	26/11/2014 09:57	HU 26675 49714	Common Mussels	Top 3m of dropper	45
3	GRU-MUSS-03	26/11/2014 10:16	HU 26337 50283	Common Mussels	Top 3m of dropper	230

Table 4 Salinity profiles

Profile	Date/Time (UT)	Position	Depth (m)	Salinity (ppt) (± 0.35 ppt)	Temperature (°C)
1	26/11/2014 10:10	HU 26322 50342	surface	30.49	7.2
			3	30.98	7.4
			5	33.38	9.2
			10	N/A	N/A
2	26/11/2014 10:29	HU 27593 49707	surface	31.99	7.8
			3	32.35	7.9
			5	33.48	8.6
			10	N/A	N/A

Figure 2 Map of water sample results and salinity profile locations Gruting Voe.

Figure 3 Map of shellfish sample results Gruting Voe.

Photographs

Figure 4 – Mussel lines at the Browland Voe North fishery looking southwest.

Figure 5 – Mussel lines at Browland Voe South fishery looking northeast.

Figure 6 – Mussel lines at Scutta Voe fishery looking southeast.

Figure 7 – Mussel lines at Maraness fishery looking south.

Figure 8 – Mussel lines at Quilse fishery, photo taken from Gruting shoreline.

Figure 9 – End of pipe exiting above beach on northern coast of Scutta Voe.

Figure 10 – Position of pipe (in figure 9) in relation to dwelling house.

Figure 11 – Concrete septic tank associated with dwelling house and small community centre above.

Figure 12 – Dwellings along shoreside at Bridge of Walls.

Figure 13 – Outlet pipe with no flow from dwelling house in close proximity to shoreline.

Figure 14 – Outlet pipe to sea below one house at Bridge of Walls.

Figure 15 – Concrete septic tank near shoreline below chalet at Bridge of Walls.

Figure 16 – Outlet pipe to sea below dwelling house at Bridge of Walls.

Figure 17 – Floating pontoon on north coastline of Scutta Voe.

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