Scottish Sanitary Survey Programme

Sanitary Survey Review

Forth Estuary: Pittenweem & Anstruther

FF 073 & FF 068

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Cefas

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Review Specification and Introduction

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

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

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

As specified by the Food Standards Agency, this review is comprised of a brief desktop search of publicly available information together with a shoreline survey. No additional queries are submitted to organisations or agencies.

The review is intended to identify whether there have been 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 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 restricted sanitary survey was undertaken for Forth Estuary: Pittenweem in 2008 and a full sanitary survey was conducted for Forth Estuary: Anstruther in 2013. Further to the sanitary survey being undertaken for Anstruther, it was decided by FSAS and Cefas that this review of the Pittenweem sanitary survey should consider the possibility for a combined production area to cover both of the present production areas at Pittenweem and Anstruther. The present review has therefore considered relevant information present in both sanitary survey reports alongside other information collated specifically for the review.

The present report is not intended to present detailed information relating to pollution sources that were identified in the 2008 Pittenweem and 2013 Anstruther sanitary survey reports. Therefore, this review should be read in conjunction with those reports.

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APPENDICES

Sampling Plan – Firth of Forth: North

	2008 Pittenweem report	2013 Anstruther report	2013 Review	Changes
PRODUCTION AREA	Forth Estuary: Pittenweem	Forth Estuary: Anstruther	Firth of Forth: North	Amended to include combined Pittenweem and Anstruther fisheries
SITE NAME	Pittenweem Surfs & Pittenweem	Anstruther	Pittenweem Surfs, Pittenweem & Anstruther	
SIN	FF-073-819-19 & FF-073-189-19	FF-068-184-19	TBD	
SPECIES	Surf clams			No change
TYPE OF FISHERY	Wild			
NGR OF RMZ	Area within lines drawn between NO 5374 0188 to NO 5373 0160 to NO 5676 0206 to NO 5669 0234	Area within lines drawn between NO 5863 0354, NO 5953 0474, NO 5976 0456 and NO 5887 0336	Area within lines drawn from NO 5900 0440 to NO 5929 0400 to NO 5643 0195 to NO 5614 0236	Single RMZ for combined area
METHOD OF SAMPLING	Dredging			No change
FREQUENCY OF SAMPLING	Monthly			
LOCAL AUTHORITY	Fife Council			
AUTHORISED SAMPLER(S)	Sandy Duncan			
PRODUCTION AREA	Area bounded by lines drawn between NO 5619 0300 and NO 5700 0300 and between NO 5700 0300 and NO 5700 0000 and between NO 5700 0000 and NO 5024 0000 extending to MHWS excluding St Monans and Pittenweem harbours	Area bounded by lines drawn between NO 5700 0348 and NO 5700 0200 and NO 6400 0200 and NO 6400 0700 and NO 6108 0700 and between NO 5773 0375 and NO 5770 0374, extending to MHWS	Area bounded by lines drawn from NO 6108 0700 to NO 6400 0700 to NO 6400 0272 to NT 56439953 to NT 5100 9953 to NO 5089 0073 and extending to MHWS.	New area combining Pittenweem and Anstruther.

1. Area and Fishery

The Firth of Forth is located on the east coast of Scotland at the mouth of the Forth Estuary where it opens into the North Sea. The Pittenweem and Anstruther production areas are situated on the northeast side of the Firth of Forth and stretch from west of the town of St Monans (at the southwestern end of the Pittenweem production area) eastward to the western edge of the town of Crail (at the northeastern end of the Anstruther production area). The depth over the extent of the production areas increases with distance from shore, to a maximum of approximately 30 metres. The locations of the Pittenweem and Anstruther areas are displayed in Figure 1.1.

The fishery consists of a dredged wild surf clam bed which extends 12 km offshore. The extent of the bed was estimated for the 2013 Anstruther sanitary survey report using a species distribution information, bathymetric data and historical sampling locations.

Three shoreline surveys have been undertaken in the area. The surf clam bed is sub-tidal and therefore no physical observations of the location and extent were undertaken during the shoreline surveys. The 2008 Pittenweem sanitary survey report identified that dredging of the clams was undertaken year round. The 2013 Anstruther shoreline survey identified there were three fishing areas where dredging was possible: the Pittenweem and Anstruther areas and further northeast at the Caiplie Cave area between Anstruther and Crail. No further fishery information was obtained during the 2014 shoreline survey.

The current fisheries classified by FSAS are listed in Table 1.1 together with the production area boundaries and recommended Representative Monitoring Zones (RMZs).

Table 1.1 Current classified fishery at Forth Estuary: Pittenweem and Anstruther

Production area	Site	SIN	Species	Recommended RMZs
Forth Estuary: Pittenweem	Pittenweem Surfs	FF-073-819-19	Surf clams	Area bounded by lines drawn between NO 5374 0188, NO 5373 0160, NO 5676 0206 & NO 5669 0234[1]
	Pittenweem	FF-073-189-19		
Forth Estuary: Anstruther	Anstruther	FF-068-184-19		Area within lines drawn between: NO 5863 0354, NO 5953 0474, NO 5976 0456 & NO 5887 0336[2]

[1]From the 2008 Pittenweem sanitary survey report [2]From the 2013 Anstruther sanitary survey report

Figure 1.2 displays the production areas and recommended RMZs.

Figure 1.1 Location of the Pittenweem and Anstruther areas in the Firth of Forth

Figure 1.2 Current Pittenweem fishery production area and RMZ, with the 2013 recommended production area and RMZ from the Anstruther report and estimated extent of the surf clam bed

2. Population and Human Sewage Impacts

2.1 Population

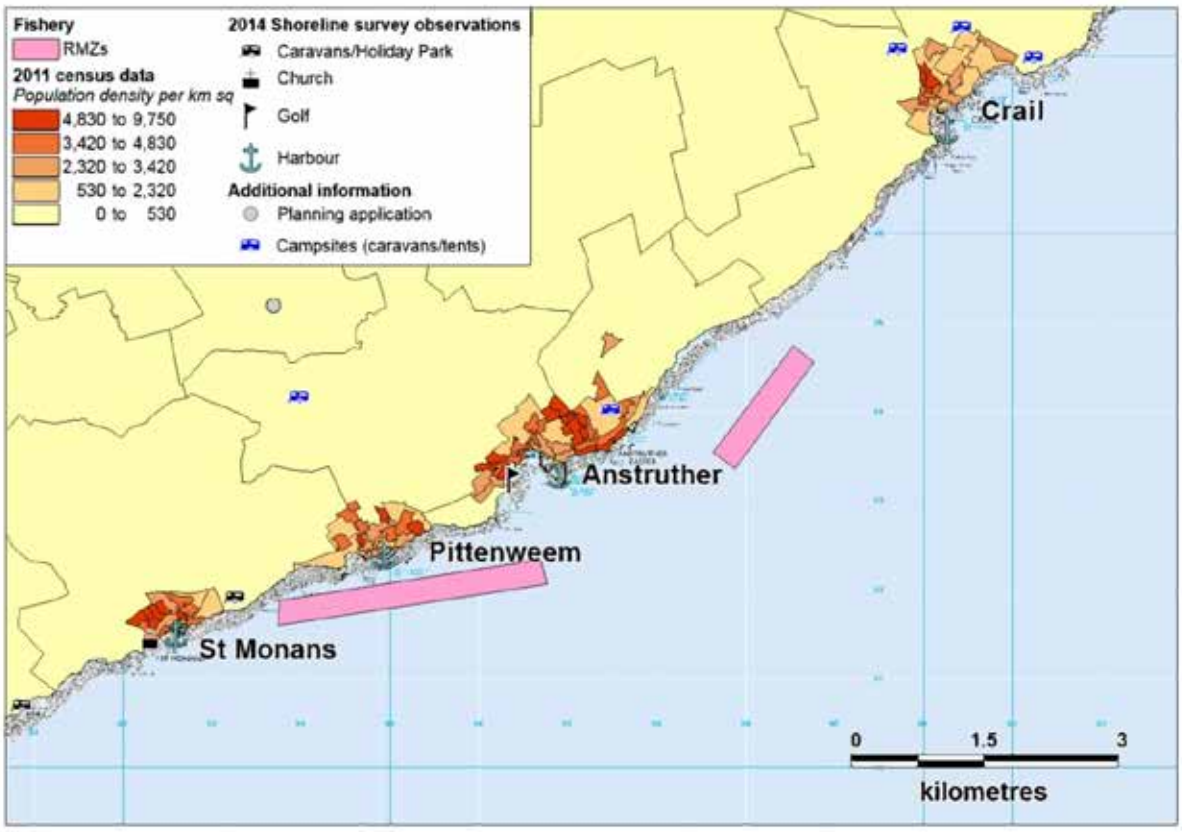

Figure 2.1 Current distribution of human population around the Pittenweem and Anstruther area according to 2011 census data

The main population settlements are located at St Monans, Pittenweem, Anstruther and Crail. Population counts for the main settlements for 2001 and 2011 population censuses from the General Register Office for Scotland are listed in Table 2.1.

Table 2.1 Population census output data from 2001 and 2011 for the five major settlements around the Pittenweem and Anstruther areas

Area	Population data		Change	
	2001	2011	Number	%
St Monans	1435	1265	-170	-12
Pittenweem	1747	1382	-365	-21
Anstruther	3442	3385	-57	-2
Crail	1695	1639	-56	-3
TOTAL	**9261**	**8348**	**-913**	**-10**

Human populations in all five settlements have decreased between 2001 and 2011, with the greatest decrease reported in Pittenweem. The highest population continues

to reside within Anstruther, which also had the highest population density (Figure 2.1).

Since the 2008 Pittenweem report, there have been a large number of planning applications to the St Monans, Pittenweem, Anstruther and Crail areas. They were accessed in February 2014 from the Fife Council planning portal (http://planning.fife.gov.uk/online/search.do?action=simple). The majority of planning applications were for dwelling house extensions and will not be considered further in this review.

In total, 29 applications for new dwelling-houses or conversions from existing use to living/ancillary accommodation were found and are listed in Appendix 1. Of these, only one represented a new sewage input, with all other applications identifying plans to connect to the public sewage network or to use an existing connection. The new sewage input was associated with a new office building set approximately 3 km inland from Pittenweem and is displayed in Figure 2.1. Plans were for foul drainage processing via a new package sewage treatment plant, with outflow receiving tertiary treatment via partial soakaway before discharging to an existing culvert. The anticipated population equivalent (PE) and/or flow for the discharge were not identified in the planning application.

Harbours are located at St Monans, Pittenweem, Anstruther and Crail, with all except Pittenweem suitable for pleasure vessels as well as fishing boats. The 2014 survey noted 28 working boats and 19 other boats berthed at Pittenweem Harbour. St Monans Harbour consisted of west and east harbours: four fishing boats were berthed in the west and five recreational boats were onshore on hard standings; six recreational boats were berthed in the east harbour with a further 19 recreational boats on hard standings onshore.

Additional information obtained through the internet search for this review indicated that Anstruther Sailing Club hosts an annual harbour festival in August (http://www.anstrutherharbourfestival.co.uk/). This festival includes a muster with over 50 visiting boats, with resident boats also taking part. The festival is stated as the biggest gathering of yachts on the east coast of Scotland, with increasing numbers of visitors over the last few years. Boat trips to the Isle of May also operate from Anstruther harbour daily, between the months of April to September (http://www.isleofmayferry.com/times.php).

The Fife coastline is served by a coastal path that is particularly popular with tourists during the summer months. Visitor accommodation is available in the four major settlements, with the 2014 survey indicating Anstruther had the most tourist accommodation in the surveyed area. Caravan parks and campsites have also been noted in Crail, Pittenweem and in Anstruther Wester where it was noted in the 2013 report that the campsite owners had plans to expand in the future. During the 2014

shoreline survey, St. Monans Holiday Park was noted to contain a mixture of both static and touring caravan pitches and tent pitches.

2.2 Sewage Discharges

The 2008 Pittenweem restricted sanitary survey report concluded that St. Monans STW and Billowness STW, two major sewage works in the area, discharged screened, untreated sewage into the production area. Of these, Billowness is located nearer to Anstruther and further offshore. The report also identified that there were a number of discharges carried via Dreel Burn, including screened sewage from Arncroach STW. A further sewage discharge was identified within the Forth Estuary: Anstruther production area.

New sewage discharge information was provided by Scottish Water and the Scottish Environment Protection Agency (SEPA) for the 2013 Anstruther sanitary survey report. The report highlighted that the waters of the shellfishery received continuous discharge of screened effluent from Cornceres WWTW as well as storm overflows and both continuous and intermittent discharges carried via Dreel Burn. Six continuous and 19 intermittent outfalls discharge within 3 km of the production area. An internet search for sewage network upgrades in the area showed no current upgrades in work to the east of Kirkcaldy (http://intranet.scottishwatersolutions.co.uk/portal/page/portal/SWS_PUB_ABOUT_US/SWSE_PGE_MAP_AND_DATA?map_id=11&type=INF&phase=2, Accessed 28/04/2014). Full details of these discharges can be found in the 2013 Anstruther sanitary survey report. Locations of Scottish Water and SEPA discharges considered in the 2013 report are displayed in Figure 2.2.

Figure 2.2 Map of sewage discharges considered in the Anstruther sanitary survey report

Sewage related infrastructure observed during the 2014 shoreline survey are listed in Table 2.2 with locations displayed in Figure 2.2. The observations relate only to the area between Anstruther and St Monans as this was the subject of that shoreline survey.

Table 2.2 Potential sewage related observations from the 2014 shoreline survey

No.	NGR	Description of potential sewage discharge
1	NO 5275 0162	Large pipe in concrete casing out falling on lower shore issuing from circular concrete inspection unit with manhole access cover. Large manhole covers x4 and electricity supply point on roadside above.
2	NO 5464 0241	Large reinforced pipe leading far out to sea. Origin could not be determined. Seawater sample taken nearby gave a result of 76 *E. coli* cfu/100 ml
3	NO 5507 0247	Manhole with clay pipe leading onto shore. No sample taken from pipe as no flow. Pipe diameter - 15 cm
4	NO 5512 0248	Plastic pipe running down side of wall next to shore with houses behind, no flow. Pipe diameter - 15 cm
5	NO 5546 0274	Possible sewage related structure on shore above pipe. Houses and fields next to structure. Possible community septic tank, some smell of sewage
6	NO 5547 0272	Broken pipe flowing heavily, smell of sewage. Pipe diameter - 30 cm, water width - 12 cm, depth - 2 cm, flow - 45L/min, sample result 10000 *E. coli* cfu/100 ml
7	NO 5602 0276	Manhole cover on shore. Two small boarded up brick buildings not in use above on the golf course
8	NO 5611 0283	Large green metal building most likely the sewage treatment plant as stated by Alex Gardner (boat owner). Five metal manhole covers next to it. No evidence of pipes or outflows. Another five manhole covers closer to the shore about 30 m from the green building
9	NO 5640 0322	Large concrete structure with concrete encased pipe going out to sea. Seawater sample result 200 *E. coli* cfu/100 ml

Sewage related infrastructure was observed in close proximity to several community sewerage systems, including East Shore CSO (observation 1), West Shore CSO (observation 2), Gyles CSO (observation 3) and Bankwell CSO (observation 9). The majority of these discharges were either not seen to be flowing or were underwater at the time of the survey.

A seawater sample taken at the end of the pipe considered to come from West Shore CSO returned a result of 76 *E. coli* cfu/100 ml, indicating moderate faecal contamination within the vicinity of the pipe. The seawater sample taken at the end of the pipe considered to be Bankwell CSO returned a higher result of 200 *E. coli* cfu/100 ml. This was taken on a separate day, following heavy rainfall over the previous evening.

Observation 6 appeared to be a leaking pipe, most likely associated with Mayview PS. This was in the same location as an overflowing pipe observed during the 2008 shoreline survey. The associated water sample returned a result of 10,000 *E. coli* cfu/100 ml.

Conclusions

Overall, the main sources of contamination are still continuous discharges from St Monans, Billowness and Cornceres WWTWs, as well as intermittent discharges from numerous CSOs in the vicinity of the clam bed. An increase in contamination from moored boats is expected at Anstruther harbour during their annual boat festival in August.

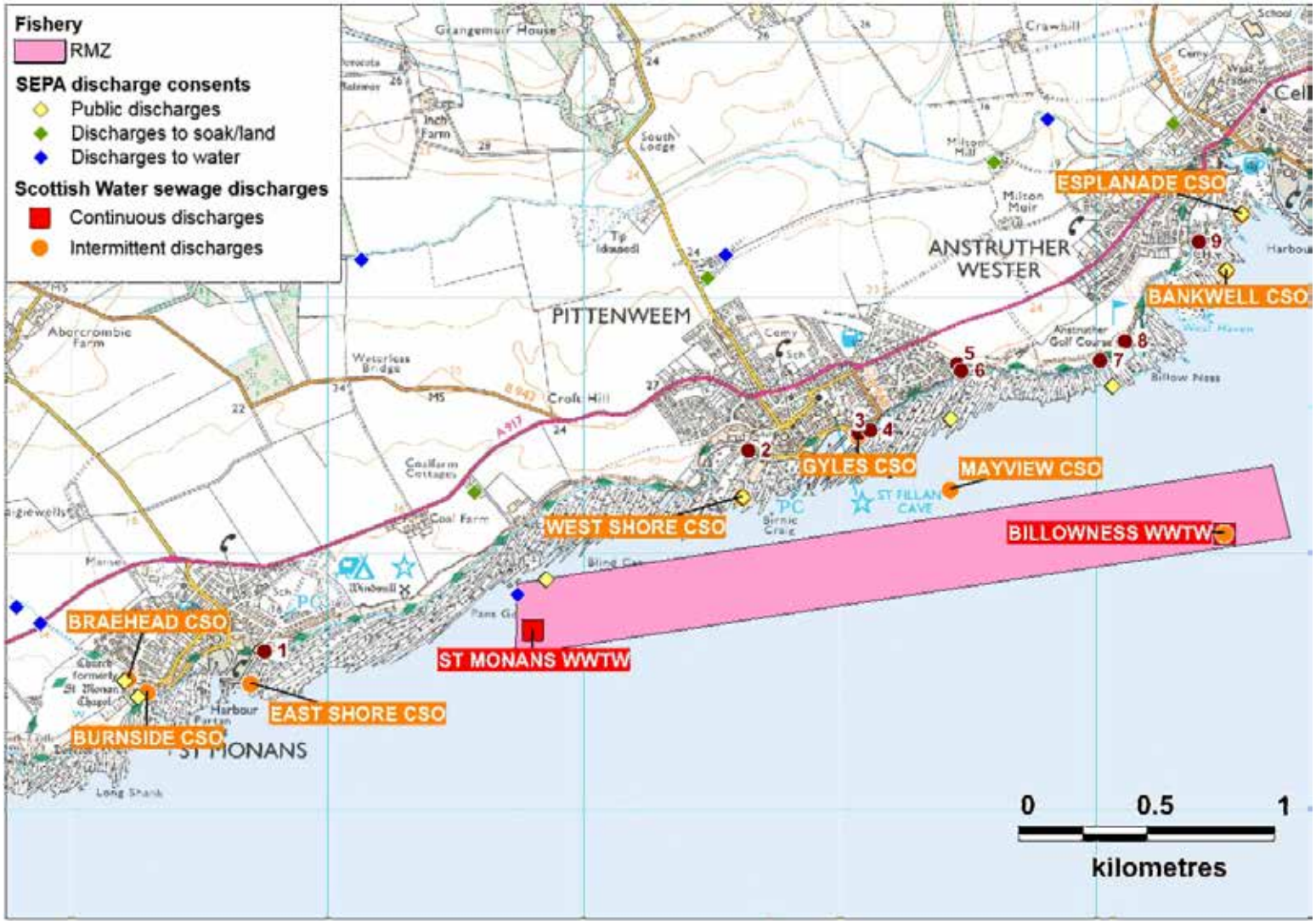

Figure 2.3 Map of sewage discharges in the Pittenweem area (from the 2013 Anstruther sanitary survey report) and 2014 shoreline survey observations

3. Farm Animal Population and Agricultural Impacts

Information on agricultural practices around the Pittenweem and Anstruther areas have been obtained from the 2008 Pittenweem and 2013 Anstruther sanitary survey reports and accompanying shoreline surveys, as well as the 2014 Pittenweem shoreline survey and an accompanying desk-based internet search undertaken for this review. Shoreline survey observations only relate to the time of the surveys, undertaken in September 2008, January 2013 and January 2014. Agriculture-related observations from the 2014 survey are displayed in Figure 3.1, alongside pertinent agricultural information from the 2013 sanitary survey.

The presence of a pig farm near Cellardyke was noted in the 2008 sanitary survey. In the 2013 shoreline survey report this was reported to contain >100 pigs, although it was noted that more could have been out of sight within the pig pens. Both sanitary survey reports considered this pig farm to be a significant potential contamination source to the shellfishery, with slurry generated expected to be washed from the land during periods of heavy rainfall. Inland areas were reported to be almost exclusively arable farmland, with small numbers of livestock on land close to the shoreline. Slurry spreading on arable land was stated to occur during spring to summer months.

The 2014 shoreline survey noted two farms located either side of St Monans; Ardross Farm (southwest) and Coal Farm (northeast). Ardross Farm was located near to the shoreline and appeared to be the larger of the two farms, comprising of several cottages and outbuildings. Hay bales and a smell of silage were noted around the farm land and 30 sheep were seen in a fenced field to the east of the main farm buildings. A seawater sample taken in front of Ardross Farm returned a high result of 1,600 *E. coli* cfu/100 ml, indicating significant contamination inputs in the vicinity. However, there are other identified sources (watercourses and intermittent discharges) that could have affected the *E. coli* result at this location. Coal Farm is associated with the Pathhead garden nurseries and has buildings set back from the shoreline. Aerial imagery (Bing Maps and Google Maps), as well as the Ordnance Survey 1:25000 map, shows that much of the land away from the shore consists of cultivated fields. Some of these are covered with polytunnels.

Contamination from agricultural sources is expected to arise from Ardross Farm, to the southwest of the fisheries, as well from the pig farm near Cellardyke. Slurry may also represent a contamination source during spring-summer months and is likely to be carried to the fisher via watercourses and areas of land drainage.

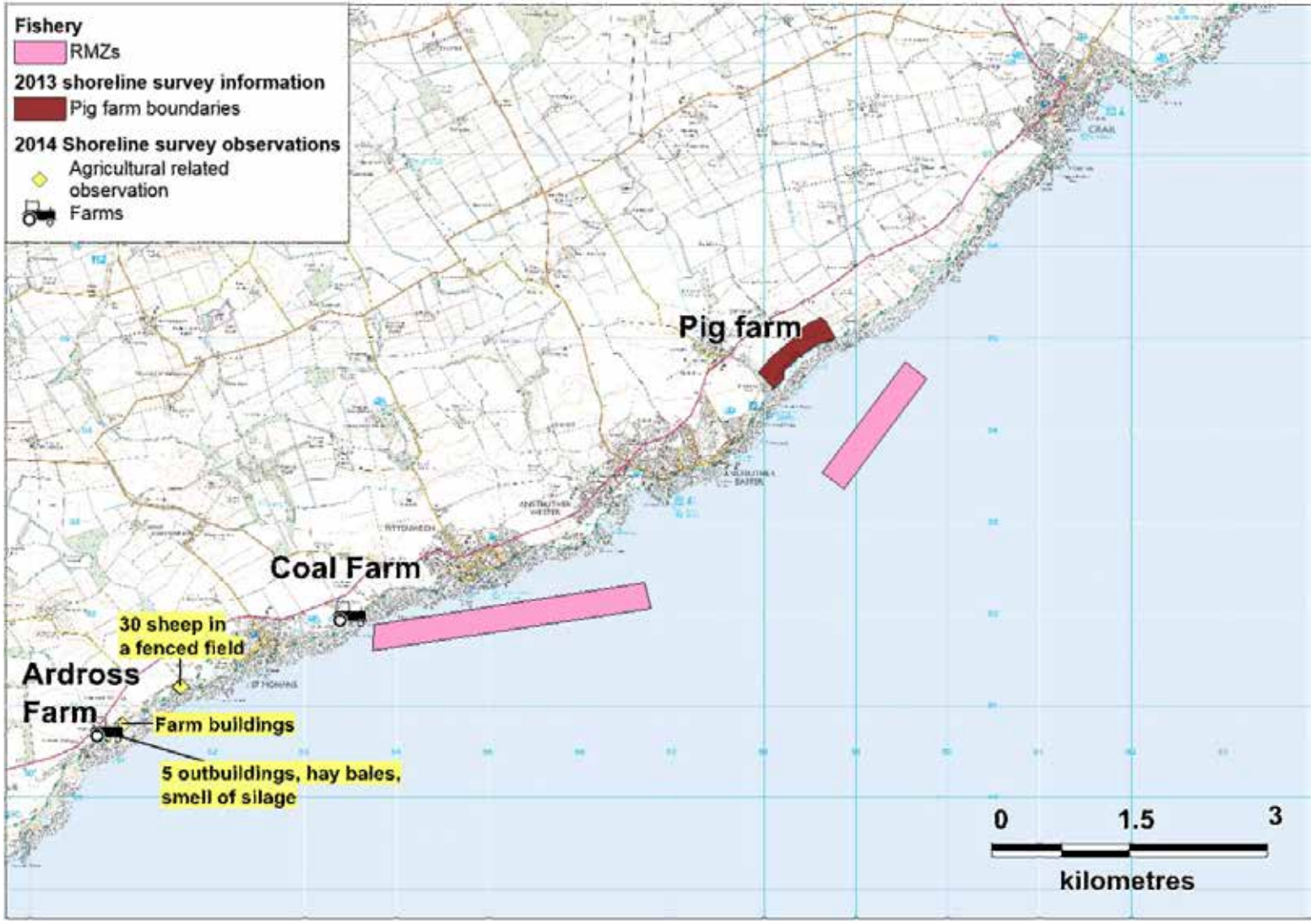

Figure 3.1 Map of 2014 agricultural related observations, together with pig farm boundaries from the 2013 Anstruther sanitary survey

4. Wildlife

Information on wildlife has been obtained from the 2008 and 2013 sanitary survey reports as well as through the shoreline surveys conducted in 2008, 2013 and 2014 and a desk-based internet search undertaken in this review. Shoreline survey observation information only relates to the time of the surveys undertaken in September 2008, January 2013 and January 2014. Wildlife observations from the 2014 survey are displayed in Figure 4.1.

The 2008 Pittenweem sanitary survey noted that The Firth of Forth is an important site for migratory birds and that the during the breeding season the Isle of May is host for several species of seabird. It was also noted that the island is a breeding area for grey seals.

The 2013 Anstruther sanitary survey report expanded on the information relating to the Isle of May, identifying that there were very large numbers of seabirds breeding on the island (> 100,000). The report concluded that, although a number of wildlife species are found in the Firth of Forth, due to the proximity of the shellfishery to shore and inhabited areas, wildlife were unlikely to contribute significantly to faecal contamination in the area.

Birds were the only wildlife observed during both the 2008 and 2013 shoreline surveys,. Whilst the 2008 shoreline survey did not identify particular concentrations of birds, the 2013 shoreline survey recorded >200 gulls around the pig farm near Cellardyke. Birds were the main wildlife observed during the 2014 shoreline survey.

No further information was uncovered during an internet-based search.A large number of birds were noted at Pittenweem Harbour, including 114 eider ducks .

Overall, wildlife impacts are not anticipated to have changed significantly since the 2008 or 2013 sanitary survey reports. Birds continue to represent the most significant potential wildlife contamination source to the area, with particular inputs expected to be associated with the harbours and pig farm. Although large numbers of birds and seals will be present at the Isle of May during the summer months, it is not anticipated that contamination from this area will significantly affect the shellfish bed.

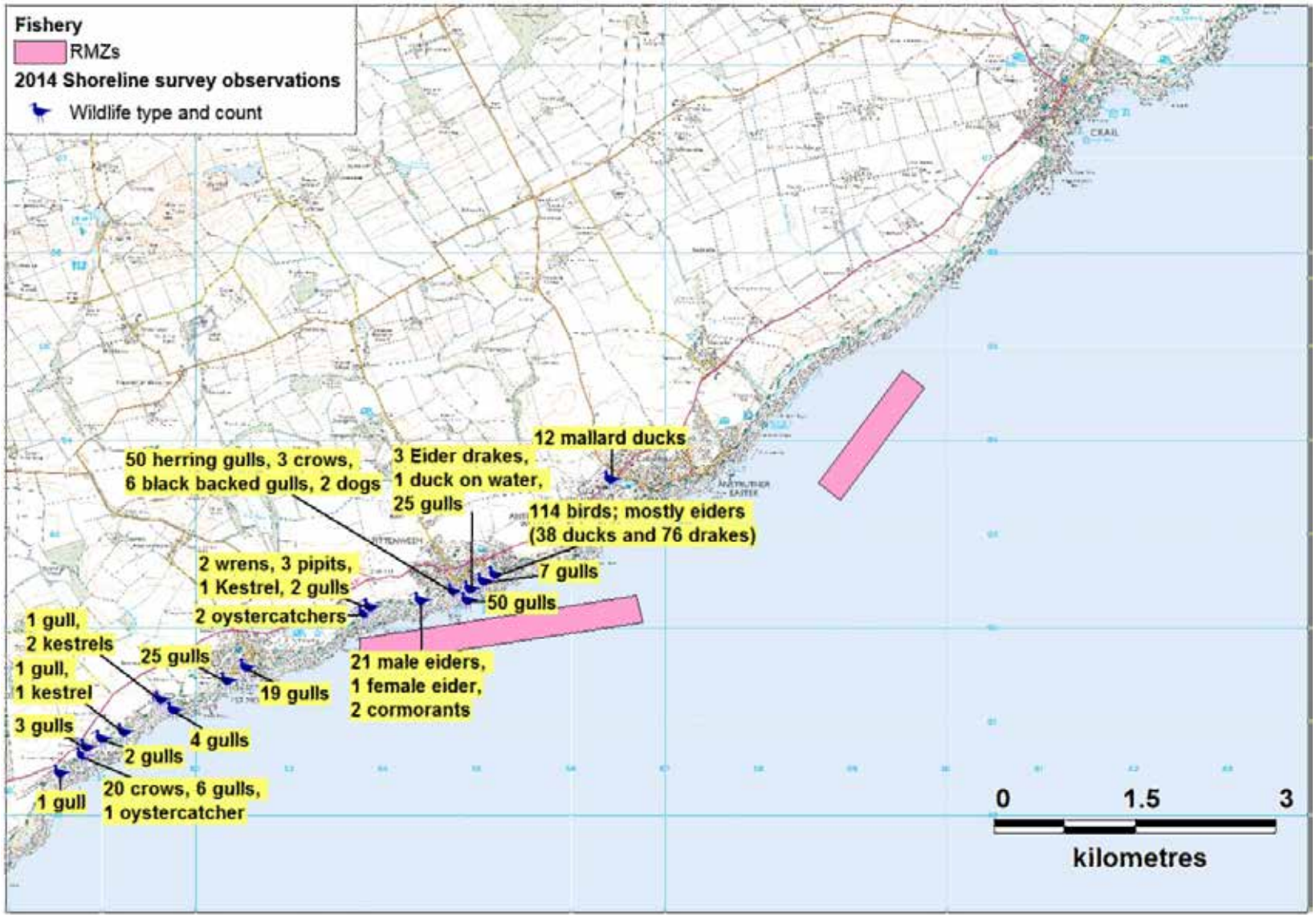

Figure 4.1 Wildlife observations from 2014 shoreline survey

5. Watercourses

A comparison of watercourse loadings estimated on the basis of the 2008, 2013 and 2014 shoreline survey measurements and *E. coli* concentrations are displayed in Table 5.1. Only Dreel Burn was measured and sampled in the 2008 survey, and whilst eight other watercourses were measured and sampled in the 2013 Anstruther shoreline survey, Dreel Burn was not sampled and therefore comparisons of loadings from this watercourse are only possible between 2008 and 2014 surveys. A full list of the 2013 watercourse loadings between Anstruther and Crail are available in the Anstruther sanitary survey report. Eight freshwater flows not associated with probable sewage discharges were sampled and measured during the 2014 shoreline survey. Two of these were related to burns while the others were related to flows from pipes: these were assumed to represent surface water. The locations of the observations, together with the estimated loadings are listed in Table 5.1. The observations related to the 2013 and 2014 shoreline surveys are displayed in Figure 5.1. The recorded flow measurements and sample results from the 2014 shoreline survey can be found in the observations table in Appendix 2. Full details of watercourse measurements and freshwater sample results used to calculate the loadings given for 2008 and 2013 can be found in the respective sanitary survey reports.

Table 5.1 Watercourse loadings to the Pittenweem and Anstruther areas, estimated from measurements taken during the 2008, 2013 and 2014 shoreline surveys

No.	Description	NGR	Loading (*E. coli* per day)[1]		
			2008	2013	2014
1	Sample from pipe	NO 5061 0052	-	-	$<2.6x10^5$
2	Inverie Burn	NO 5229 0145	-	-	$1.6x10^{12}$
3	Sample from pipe	NO 5297 0171	-	-	$<8.6x10^5$
4	Sample from concrete drain	NO 5312 0175	-	-	$1.1x10^7$
5	Sample from pipe	NO 5313 0175	-	-	$2.3x10^7$
6	Sample from pipe	NO 5349 0190	-	-	$2.2x10^8$
7	Sample from pipe	NO 5380 0213	-	-	$<8.6x10^5$
8	Dreel Burn	NO 5643 0357	$6.3x10^{12}$	Not Determined[2]	$1.8x10^{12}$
9	Kilrenny Burn	NO 5812 0448	-	$< 9.5x10^9$	-
10	Stream	NO 5929 0529	-	$9.1x10^9$	-
11	Dennet Burn	NO 5975 0563	-	$8.9x10^{11}$	-
12	Burn	NO 6012 0596	-	$9.9x10^{10}$	-
13	Stream	NO 6100 0692	-	Not Determined[2]	-
14	Stream	NO 6152 0759	-	$1.4x10^{10}$	-
15	Stream outflow over harbour wall	NO 6164 0777	-	$1.3x10^{10}$	

[1]Where an *E. coli* result was denoted with a <, the limit of detection value was used to calculate loading
[2]Recorded but no sample taken.

The estimated loading in Dreel Burn was slightly lower in the 2014 shoreline survey than the 2008 shoreline survey. However, the difference may be within the combined measurement uncertainty of the flows and microbiological testing. Loading from Inverie Burn which enters just west of St Monans was also found to be high in 2014 and that from Dennet Burn, between Anstruther and Crail, was found to be high in 2013.

Overall, there is a general tendency for watercourses with a higher loading to be located along the coast within the Anstruther production area rather than in the Pittenweem production area, although Dreel Burn will impact on both areas and Inverie Burn will affect the southwestern end of the Pittenweem production area.

Figure 5.1 Watercourse loadings estimated from the 2013 and 2014 shoreline survey measurements

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

6. Meteorological data

Rainfall data only had been purchased from the Meteorological Office for the survey period 01/01/2003-31/12/2007 for the analyses undertaken in the 2008 Pittenweem Sanitary Survey Report: the data used in that report were taken from the Belliston weather station, which lays 10 km west-northwest of the Forth Estuary Pittenweem production area. Although more recent data from that location have been relatively complete, there were several missing values from the earlier data set used for the Pittenweem sanitary survey report. Therefore, the data set for Toldrie, approximately 6 km northeast of the Anstruther production area, was purchased from the Meteorological Office for analysis within this review. Data was available up to 31/12/13. Wind roses for Edinburgh Gogarbank were also purchased from the Meteorological Office.

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 and Morgan, 2003).

The Belliston weather station rainfall dataset for 2008-2012 is presented by year in Figure 6.1 and by month in Figure 6.2.

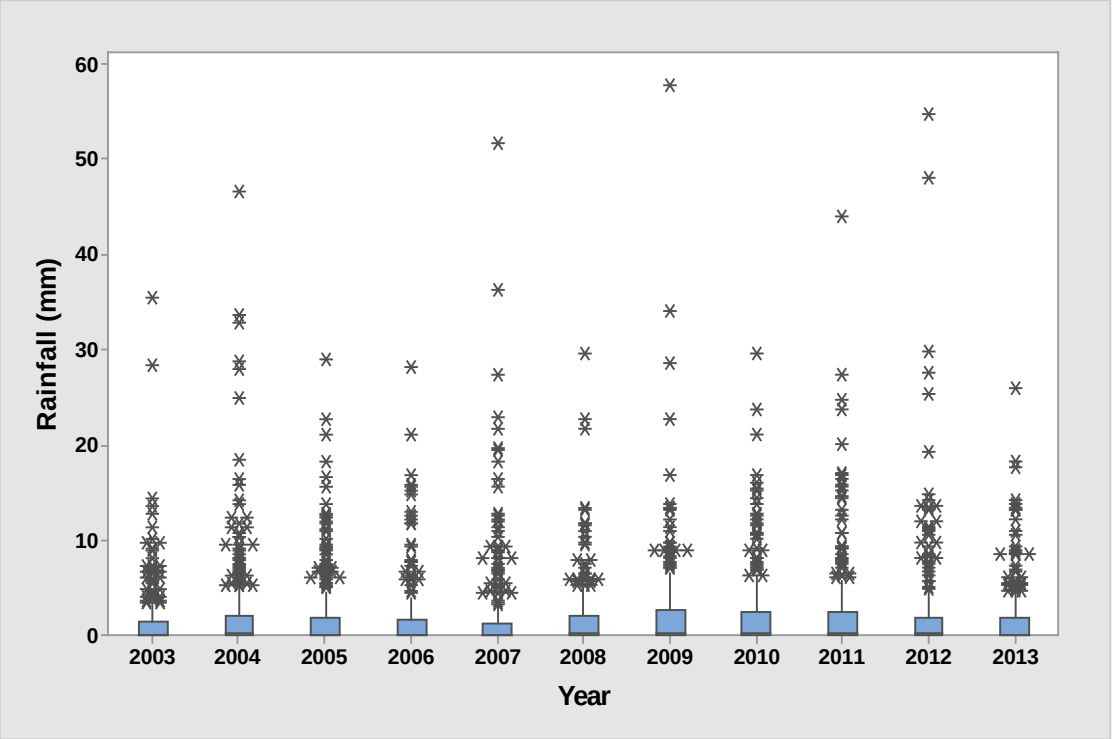

Figure 6.1 Boxplot of daily rainfall at Toldrie by year (2003-2013)

The bulk of the observations are below 10 mm rainfall/day. In the 2008 Pittenweem report total annual rainfall was presented, with the driest year being 2003 (584 mm) and the wettest year 2005 (837 mm). From the 2007-2012 data set analysed for the Anstruther sanitary survey report (excluding 2012 as the dataset was incomplete), 2007 was the driest year (833.3 mm) and 2011 the wettest year (931.5 mm. In the Toldrie data set, 2003 was also the driest year (516 mm) and 2011 the wettest (905 mm). At Toldrie, rainfall events exceeding 30 mm/day occurred in all years except 2010 and 2013 .Very occasional rainfall events exceeding 50 mm/day were seen (three in total).

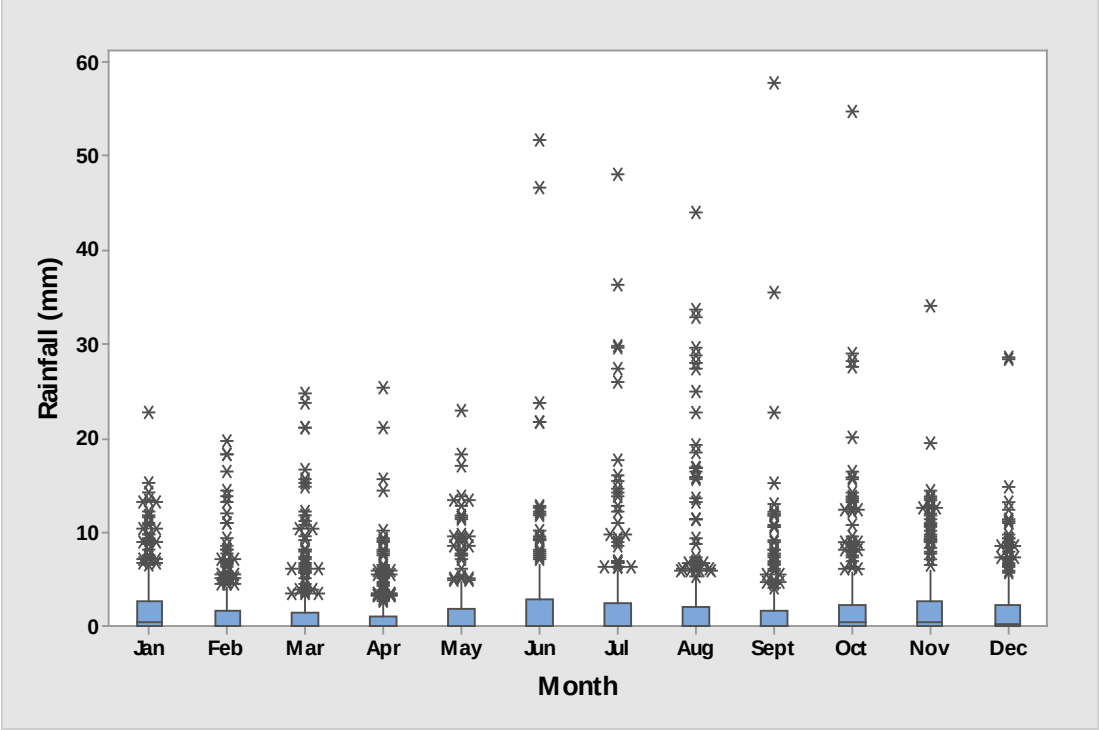

Figure 6.2 Boxplot of daily rainfall at Toldrie by month (2003-2013)

In the 2008 Pittenweem report, months October and June were identified as the wettest, with months February and April the driest. Figure 7.2 highlights that for this fuller data set at Toldrie, higher levels of rainfall tended to be seen between June and January although it varied even within this period. Rainfall events >30 mm/day occurred from June to November.

6.2 Wind

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

Figure 6.3 shows seasonal wind roses for Edinburgh Gogarbank for the period 2004-2013 while Figure 6.4 shows the annual wind rose for the same period. The local topography at Pittenweem/Anstruther may result in slightly differing wind patterns to

those shown in the wind roses (Edinburgh Gogarbank is located approximately 50 km west of the Pittenweem/Anstruther area, further up the Firth of Forth Estuary). No wind data was presented in the 2008 Pittenweem report, so no comparisons by period have been possible in this review.

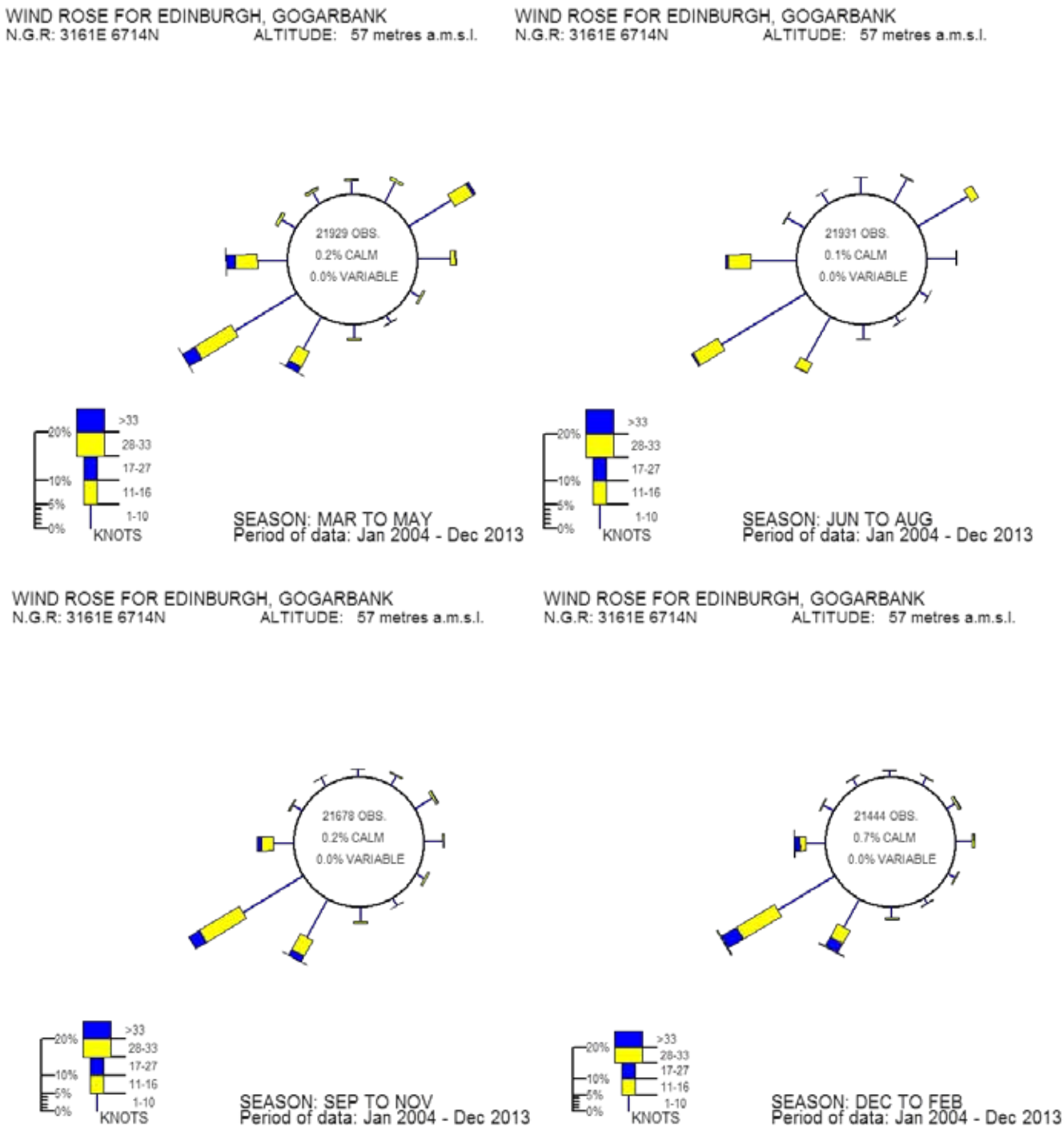

Figure reproduced under license from Meteorological Office. Crown Copyright 2014.

Figure 6.3 Seasonal wind roses for Edinburgh Gogarbank (2004-2013)

Prevailing winds throughout all four seasons appears to be from the west-southwest, with the strongest winds in spring and winter. Summer has the lightest winds. In the spring and summer, a significant proportion of winds blow from the northeast, although these tend to be lighter than those from the west-southwest.

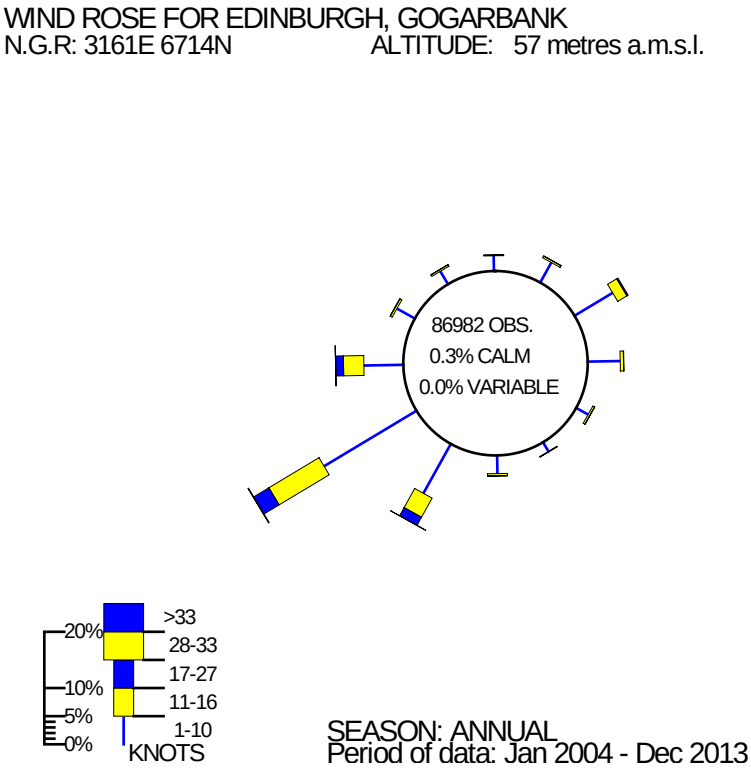

Figure 6.4 Annual wind rose at Edinburgh Gogarbank (2004-2013)

The wind rose in Figure 6.4 shows that the overall prevailing annual wind direction is from the west-southwest, blowing generally along the axis of the firth.

7. Historical *E.* coli Data

Results for surf clams assigned against the Forth Estuary: Pittenweem and Forth Estuary: Anstruther production areas between 01/01/2009 and 13/02/2014 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. Data was extracted from the database in February 2014. Historical *E. coli* data used in the 2008 report had already been extracted and validated. For the purposes of this review, results from samples pre-dating 2001 were excluded from the analyses.

Results have been identified against two sites within the Pittenweem production area, Pittenweem and Pittenweem Surfs. However, the sites were not clearly separated by recorded sampling location (where these were given) and so the data from both Pittenweem sites has been considered together. All *E. coli* results were reported as most probable number per 100 g of shellfish flesh and intravalvular fluid. *E. coli* results for all areas reported as <20 were reassigned a value of 10 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

Pittenweem

Two sample results were reported in the database as rejected and were excluded from further analysis. Three other samples lay on land >100 m from the production area boundaries and were also excluded from further analysis. The remaining 45 samples were received within 48 hours of collection.

Anstruther

Two sample results were reported in the database as rejected and were excluded from further analysis. Five samples plotted on land >100 m outside of the production area boundaries and were also excluded from further analysis. The remaining 43 samples were received within 48 hours of collection.

7.1 Summary of microbiological results

Summary results are displayed for surf clam results at Forth Estuary: Pittenweem and Anstruther in Table 7.1.

Table 7.1 Sampling summary results for Forth Estuary: Pittenweem and Anstruther surf clam fisheries between 2009 and 2014

Sampling Summary								
Production area	Forth Estuary: Pittenweem				Forth Estuary: Anstruther			
Site	Pittenweem and Pittenweem Surfs				Anstruther			
Species	Surf clams							
SIN	FF-073-189-19 and FF-073-819-19				FF-088-184-19			
Location	Various							
Years	2001-2008		2009-2014		2001-2008		2009-2014	
Total no. of samples	31		45		56		43	
	No. 2001	0	No. 2009	3	No. 2001	10	No. 2009	7
	No. 2002	0	No. 2010	7	No. 2002	4	No. 2010	4
	No. 2003	4	No. 2011	11	No. 2003	12	No. 2011	10
	No. 2004	10	No. 2012	12	No. 2004	3	No. 2012	12
	No. 2005	3	No. 2013	11	No. 2005	7	No. 2013	9
	No. 2006	7	No. 2014	1	No. 2006	3	No. 2014	1
	No. 2007	1			No. 2007	11		
	No. 2008	6			No. 2008	6		
Minimum	20		<20		<20		50	
Maximum	3500		5400		9100		2200	
Median	310		460		220		230	
Geometric mean	263		424		262		291	
90 Percentile	1300		2840		2050		1620	
95 Percentile	2950		3500		2675		2100	
No. exceeding 230/100g	17 (68%)		27 (60%)		27 (54%)		18 (42%)	
No. exceeding 1000/100g	6 (24%)		16 (36%)		8 (16%)		9 (21%)	
No. exceeding 4600/100g	0		1 (2%)		2 (4%)		0	
No. exceeding 18000/100g	0		0		0		0	

The sampling rate has been variable in the past but has been more consistent at both sites since 2011. There has been no marked difference in results between the two sites or between the two periods (2001-2008 and 2009-2014). The highest result prior to 2009 was seen in the Anstruther data set (9100 *E. coli* MPN/100 g) while since then the highest result was assigned to Pittenweem (5400 *E. coli* MPN/100 g).

7.2 Geographical patterns of results

The location of the current RMZs, the estimated location of the clam bed taken from the 2013 Anstruther report and sampling locations from both Forth Estuary Pittenweem and Anstruther for the period 01/01/2009 – 13/02/2014 are shown in Figure 7.1. The symbols for the sample locations are shown thematically graduated in proportion to the magnitude of the *E. coli* result. Eighteen samples assigned to Pittenweem were unverified samples, although six of the 18 had NGRs which were used to plot the results in Figure 7.1. Two of these six samples had incorrect letter prefixes which were replaced with NO. Fourteen samples from the Anstruther production area were recorded as unverified, with NGRs being recorded against four of these. The two letter NGR prefix was corrected for two of these prior to plotting.

Generally, sample results were taken within their respective production areas, except for one sample recorded against Pittenweem which plotted within the Anstruther production area.

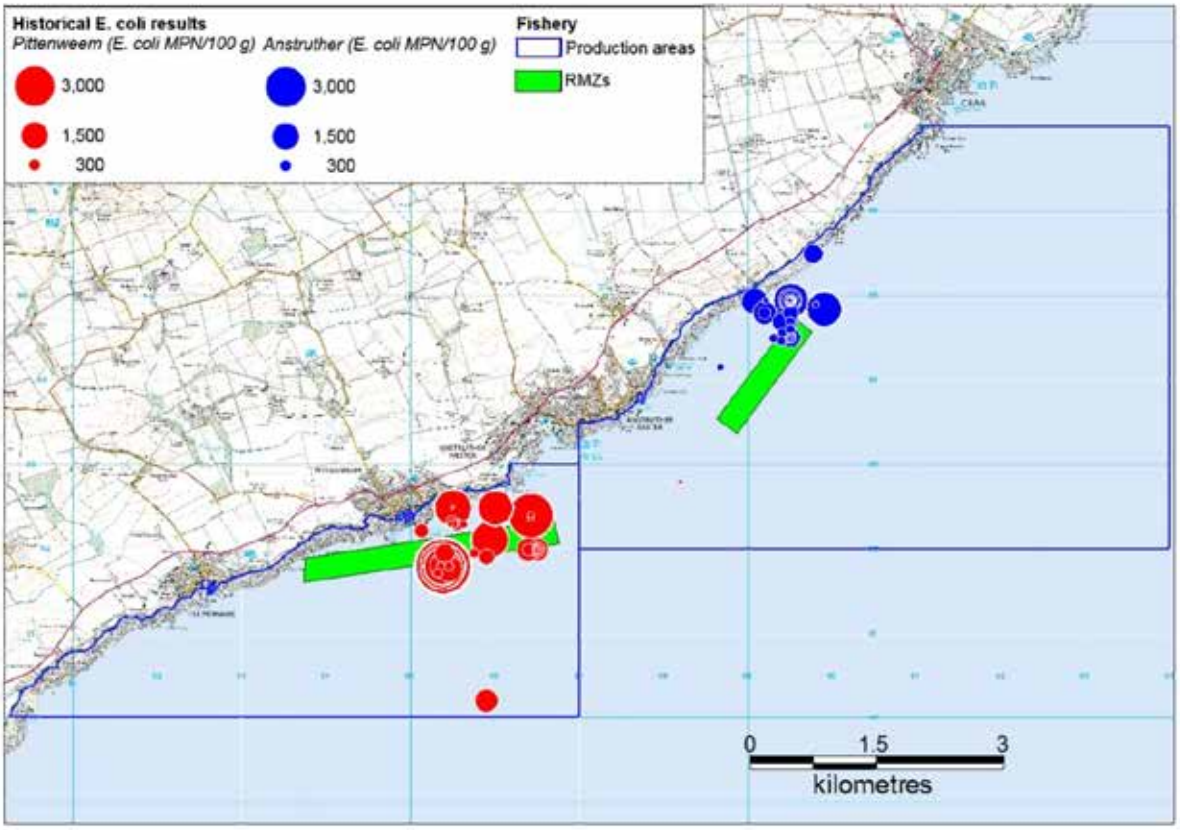

Figure 7.1 Sample locations, graduated by magnitude of *E. coli* result, at Forth Estuary: Pittenweem and Anstruther

Spatial trends in surf clam *E. coli* results in Forth Estuary: Pittenweem and Anstruther had been analysed in the 2008 Pittenweem report for the years between 2001 and 2008. A t-test showed no significant difference in *E. coli* results between

production areas (t-test, T = -0.02, p = 0.987). A further t-test undertaken for the dataset between 01/01/09-13/02/14 also showed no significant difference in *E. coli* results between production areas (t-test, T = -1.39, p = 1.168). It should be noted that a spatial analysis undertaken for the 2008 sanitary survey showed trends toward higher results at some points within the two production areas and that the locations showing these higher trends were in the vicinity of the main sewage outfalls.

7.3 Temporal patterns of results

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

Pittenweem

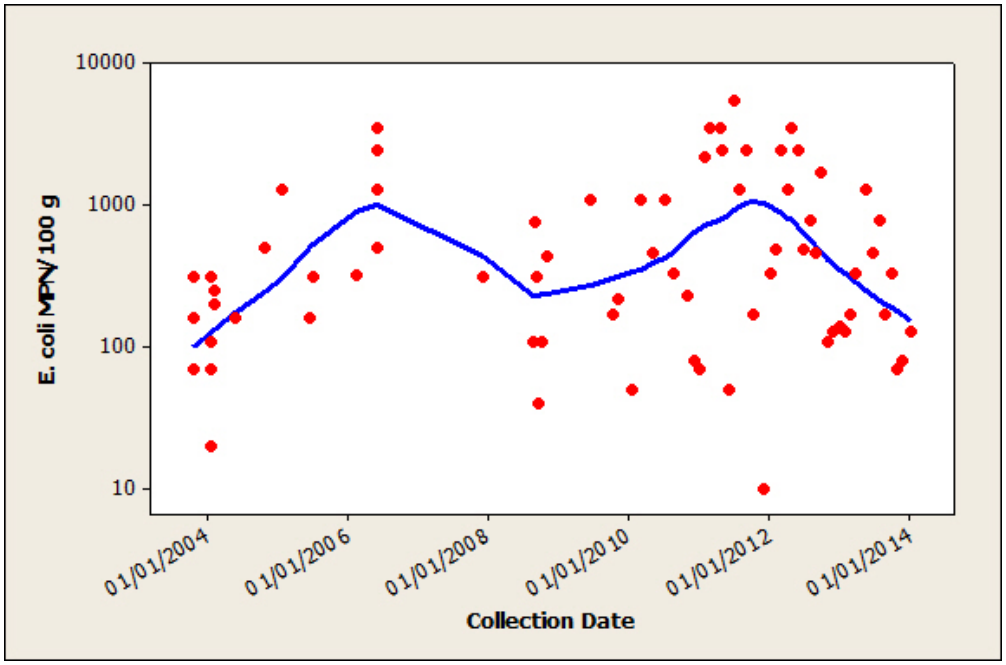

Figure 7.2 Scatterplot of Forth Estuary: Pittenweem surf clam *E. coli* results by date (2001-2014)

Contamination levels at Pittenweem increased from 2001 to early 2006. There was then a break in sampling. Results from late 2007 to late 2009 were of a similar magnitude to those seen in 2005/early 2006 before increasing again in 2011/12. Since that peak, the results have again declined.

Table 7.2 Chi-squared test results above and below 230 and 1000 *E. coli* MPN/100 g for Pittenweem surf clam *E. coli* results

		E. coli MPN/100g			*E. coli* MPN/100g		
		≤230	>230	**Total**	≤1000	>1000	**Total**
2001-2008	Observed	14	17	31	25	6	31
2009-2014	Observed	18	27	45	29	16	45
Total		32	44	76	54	22	76

No statistically significant difference was found between sampling results ≤230 *E. coli* MPN/100 g and >230 *E. coli* MPN/100 g between sampling periods (Chi-square test, $X^2 = 0.201$, DF = 1, p = 0.654).

No statistically significant difference was found between sampling results ≤1000 *E. coli* MPN/100 g and >1000 *E. coli* MPN/100 g between sampling periods (Chi-square test, $X^2 = 2.342$, DF = 1, p = 0.126).

Anstruther

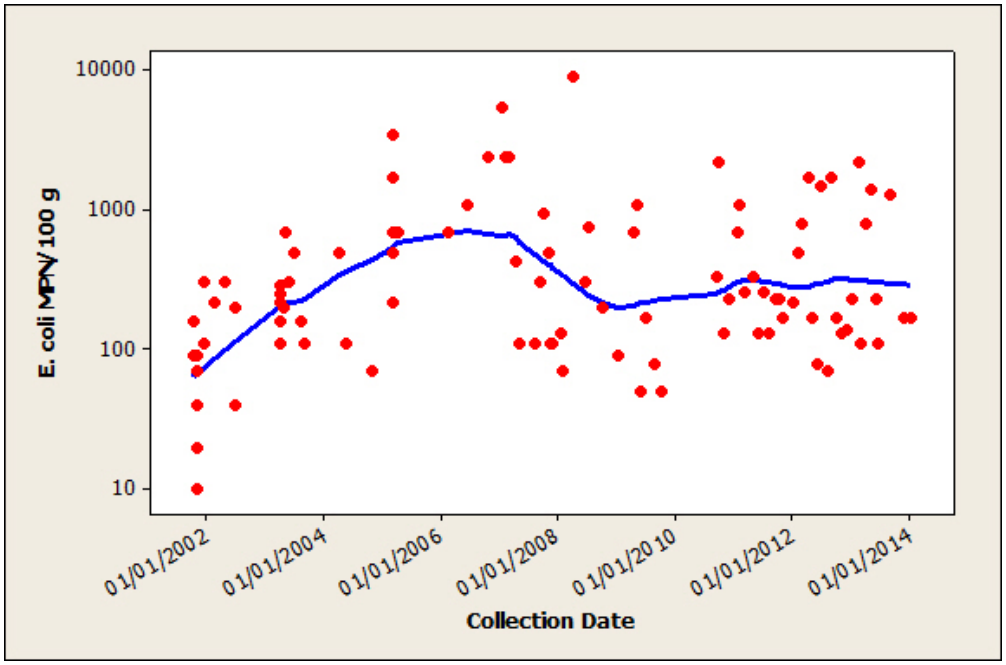

Figure 7.3 Scatterplot of Forth Estuary: Anstruther surf clam *E. coli* results by date (2001-2014)

Contamination levels gradually increased from 2001 to 2007 before declining. The levels were then relatively stable from the beginning of 2009 to early 2014.

Table 7.3 Chi-squared test results above and below 230 and 1000 *E. coli* MPN/100 g for Anstruther surf clam *E. coli* results

		***E. coli* MPN/100g**			***E. coli* MPN/100g**		
		≤230	>230	**Total**	≤1000	>1000	**Total**
2001-2008	Observed	29	27	56	48	8	56
2009-2014	Observed	25	18	43	34	9	43
	Total	54	45	99	82	17	99

No statistically significant difference was found between sampling results ≤230 *E. coli* MPN/100 g and >230 *E. coli* MPN/100 g between sampling periods (Chi-square test, $X^2 = 0.396$, DF = 1, p = 0.529).

No statistically significant difference was found between sampling results ≤1000 *E. coli* MPN/100 g and >1000 *E. coli* MPN/100 g between sampling periods (Chi-square test, $X^2 = 0.755$, DF = 1, p = 0.385).

Overall, no statistically significant difference in contamination levels was found between sites in the 2009-2014 sampling period. And no statistically significant difference was found between contamination levels attributed to either Pittenweem or Anstruther and sampling period.

Conclusions

No statistically significant difference was seen in the surf clam *E. coli* results between production areas or between sampling periods. The trend lines for the results from both production areas showed an increase in results from 2001 to 2006 before declining. More recently, the results at Anstruther have shown little change while those at Pittenweem showed a second peak at the end of 2011/beginning of 2012.

8. Movement of contaminants

The information on movements of contaminants from the 2013 Anstruther sanitary survey report superseded that given in the 2008 Pittenweem restricted sanitary survey report. The main conclusions from the 2013 report were as follows:

- Surface currents flow in alignment with the shore line
- Maximum tidal excursion at the surface will be 6.3 km at spring tides and just over 3 km at neap tides
- Tidal excursion during a flood/ebb phase of the tide is higher during mean springs than mean neaps
- Contaminants in the surface layers would follow the bathymetric contours of the site
- There is a weak (0.02 m/s) residual flow west to east
- Westerly winds will aid residual flow and enhance vertical mixing

No additional information on tidal flow direction or expected excursion distance has been found during the desk based study for this review. Offshore CTD casts undertaken at the time of the shoreline survey gave salinity results of approximately 33.6 pps at various depths between sub-surface and 8 m (see Appendix 3).

9. Overall Assessment

This assessment principally considers information presented in this review of the 2008 Pittenweem and 2013 Anstruther sanitary survey reports.

Human sewage Impacts

The majority of the human population continues to reside within the four large villages of St Monans, Pittenweem, Anstruther and Crail. Census data indicated populations in all four of these areas had declined between 2001 and 2011. The largest population in the area is still found in Anstruther, which is where most of the tourist accommodation is also located. Boating activity remains largely unchanged since the 2013 report with harbours serving each four of the villages. An increased potential impact is expected in August when the Anstruther Sailing Clubs annual boat festival occurs, with over 50 visiting boats using the harbour. No sewage pump out facilities have been identified in these harbours, increasing the likelihood of overboard discharges from these boats.

Information on sewage discharges to the area from the 2013 Anstruther report indicates that the clam bed will be significantly impacted by both continuous and intermittent discharges to the area. The most significant contributions will be from the long sea outfalls from St Monans, Billowness and Cornceres WWTWs. In wet weather, additional contamination will arise from the CSOs associated with these WWTWs as well as those associated with PSs.

Agricultural impacts

The pig farm near Cellardyke continues to represent a significant potential input of agricultural-source faecal contamination, particularly to the shellfish bed northeast of Anstruther . Identification of two farms to the southwest extent of the clam bed is also significant, with the farm at Ardross representing a significant contamination source to thesouthwest of Pittenweem. Application of slurry to the arable farmland inland of the towns is likely to contribute significantly to faecal indicator loadings found in watercourses draining the catchment, particularly during the spring to summer months.

Wildlife Impacts

Wildlife is not anticipated to have a significant impact on the area. Birds are anticipated to be the most significant contributing group. Harbour areas were shown to represent potentially significant areas of input during the 2014 survey, as well as large concentrations observed around the pig farm near Cellardyke.

Seasonal Variation

There is expected to be a seasonal influx of tourists during the summer months. Tourist accommodation is situated in all four villages, with Anstruther hosting the most accommodation, though campsites were also noted at St Monans, Pittenweem and Crail. Anstruther Sailing Club festival in August is also anticipated to cause an increase in sewage inputs from boats, with no information on pump-out facilities found during this review. Slurry application is also noted to take place between spring and summer. Seasonal variation was also shown in statistical results taken at Pittenweem, and for most years in results taken at Anstruther, though to a lesser order of magnitude than at Pittenweem. Rainfall events >30 mm/day occurred from June to November.

Watercourses

Freshwater-borne contamination is expected to have a moderate impact on the shellfish bed. Highest freshwater contamination enters from Dreel Burn and Inverie Burn, which are expected to impact the mid and southwest extent of the clam bed. Both these watercourses are expected to carry diffuse agricultural-source contamination from farm land further up their catchments as well as surface water runoff from the developed areas near their mouths.

Movement of contaminants

No additional information on current direction and transport distance was available following the 2013 report. Movement of contaminants is therefore considered to remain the same as that identified in 2013: that is, a maximum tidal excursion at the surface of 6.3 km at spring tides and just over 3 km at neap tides, with tidal flows parallel to the coast. CTD casts performed during the shoreline survey showed no evidence for stratification.

Analysis of Results

Historical *E. coli* results

Statistical analysis showed no significant difference in the surf clam *E. coli* results between production areas or between sampling periods. However, previous analysis has shown that higher results tend to occur closer to the main sewage outfalls.

Shoreline Survey results

No shellfish samples were taken owing to the sub-tidal nature of the fishery.

Seawater sample results indicated moderate to high levels of contamination at a number of locations. The highest result (1,600 *E. coli* cfu/100 ml) was obtained from a sample taken from the shoreline adjacent to Ardross Farm at the southwest extent

of the shellfish bed.. High results were also obtained from samples taken adjacent to Coal Farm, to the east of St. Monans (400 *E. coli* cfu/100 ml) near Bankwell Road CSO,to the west of Anstruther (200 *E. coli* cfu/100 ml) and from adjacent to St Monans village (100 *E. coli* cfu/100 ml).

Conclusions

The conclusions from the 2008 Pittenweem and 2013 Anstruther reports are listed in Table 9.1, alongside conclusions made from this review.

This review has concluded impacts from continuous and intermittent sewage discharges represent the most significant contamination input to the area between west of St Monans to just west of Crail. In particular, continuous flows from St Monans, Billowness and Cornceres WWTWs which are reported to receive only preliminary screening prior to discharging will have the greatest impacts on the surf clam bed, owing to the location of their long sea outfalls which will discharge final effluent directly into the clam bed.

Intermittent discharges are also expected from the many CSOs located along the shoreline surrounding shoreline. This includes the broken pipe associated with Mayview PS CSO. The overflowing manhole discharging to Dreel Burn is not thought to continue to pose as a significant discharge input. Sewage from boats associated with the four main harbours in the settlements Crail, Anstruther, Pittenweem and St Monans are expected to have some level of impact on the fishery, particularly during the summer months when touring/visiting boats are likely to increase in the area. Anstruther harbour boat festival in August will particularly experience an influx of sewage contamination owing to a lack of pump-out facilities.

Other inputs of significance include agricultural sources; the pig farm near Cellardyke and the farm and associated land south at Ardross. Slurry generated from the pig farm is expected to leach from the land to the shoreline during periods of heavy rainfall, whilst it is unclear whether there will be seasonality in contamination entering from the Ardross farming area. Although Coal Farm represents another farm close to the shoreline, it was unclear from the recent survey whether it represented a significant contamination source.

Freshwater inputs from Dreel Burn in Anstruther remain high and inputs from Inverie Burn west of St Monans are now shown to contain similarly high levels of contamination. There are a large number of freshwater land drainage areas between St Monans and Crail that are also likely to represent contamination sources during periods of heavy rainfall. In land, watercourse catchment areas contain highly fertile agricultural land, which is expected to pose as a potential significant contamination input source particularly during slurry spreading between spring and summer months.

Rainfall data also indicates that the recent period has reported much wetter years than previously recorded, which could mean that contamination levels entering the clam bed from land sources may increase in the future, if this trend in rainfall increases similarly continues.

Table 9.1 Conclusions of the main sources of faecal contamination to the surf clam bed from the 2008 and 2013 reports and the 2014 review

2008	2013	2014
· *Outfalls from St Monans and Anstruther Billowness STW* · *Contamination levels in Dreel Burn* · *Potential contamination from heavy boat traffic in and around Pittenweem and Anstruther Harbours and the Firth of Forth (commercial shipping area), with no pump out facilities available* · *Potential for overflows at sewage pumping stations*	· *Significant continuous and intermittent human sewage inputs to the shellfish bed as well as to adjacent waters, which will be carried some distance away from source* · *Cornceres STW and CSOs* · *The overflowing manhole observed discharging into Dreel Burn, which was considered to be associated with Lamont Terrace PS CSO* · *A pig farm adjacent to the shoreline northeast of Cellardyke* · *Watercourses, though their impact on the fishery is likely to be dependent upon the level of mixing and distance from shore* · *Tidal impacts on the movement of contaminants* · *Rainfall*	· *Sewage inputs from long sea outfalls from continuous discharges at St Monans, Billowness and Cornceres WWTW's* · *Inputs from the Ardross farm area* · *Diffuse agricultural pollution from the pig farm near Cellardyke* · *Overboard discharges associated with the four harbours serving the main villages. In particular at Anstruther Harbour during August when they host a boat festival and up to 50 boats or more may berth in the harbour* · *Rainfall*

10. Recommendations

The 2014 review of the Pittenweem and Anstruther areas has concluded that the shellfish bed should be considered as one production area, owing to the surf clam bed extending continuously across the area and that some of the significant sources of faecal contamination impact across both of the presently classified production areas. The following recommendations therefore apply to this combined area.

Production area

Given the number of significant sources of pollution, and their relationship to the surf clam bed, it is not possible to define the production area to exclude the known point sources. The combined production area is recommended to be defined as: The area bounded by lines drawn from NO 6108 0700 to NO 6400 0700 to NO 6400 0272 to NT 56439953 to NT 5100 9953 to NO 5089 0073 and extending to MHWS. It is recommended that the combined production area be renamed Firth of Forth: North in keeping with its location outwith the Forth Estuary.

RMZ

A combined RMZ is recommended to reflect the largest contaminating influences within the combined production area. The recommended RMZ is: the area within lines drawn from NO 5900 0440 to NO 5929 0400 to NO 5643 0195 to NO 5614 0236. This incorporates the area between the Billowness and Cornceres WWTW outfalls.

Tolerance

As the RMZ approach is taken, no further sampling tolerance is considered appropriate.

Depth

Not applicable.

Frequency

It is recommended that sampling frequency remain as monthly.

Figure 10.1 Map of recommended production area boundaries and RMZ for Pittenweem-Anstruther surf clam fishery

11. References

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12. List of Figures and Tables

Appendices

1. List of planning applications

2. Shoreline Survey Report 2013

3. CTD casts – data summaries

Appendix 1 List of Planning Applications

St Monans				
Ref No.	**Date**	**Description**	**Location**	**Foul drainage plans**
13/03485/CLP	Nov-13	Certificate of Lawful Use for storage and processing facility for shellfish	4 Virgin Square, St Monans, KY10 2AA	To public sewerage system
13/03199/PPP	Oct-13	Planning permission in principle for the erection of one dwellinghouse (renewal of 06/00127/EOPP and 10/02345/PPP)	West End, St Monans Fife	NA
13/03005/FULL	Oct-13	Erection of 3 storey mixed use development (classes 1, 2,and 4) with associated car parking, including demolition of existing storage/workshop buildings	15 Station Road, St Monans, KY10 2BL	To public sewerage system
13/01212/FULL	Apr-13	Change of Use from storage (Class 6) to Assembly and Leisure (Class 11) including external alterations (Partially Retrospective).	Harbour House 4 Mid Shore, St Monans, KY10 2BA	Not necessary
12/04826/FULL	Nov-12	Change of use from former police station to dwellinghouse (including external alterations)	St Monans Police Station, 43 Station Road St Monans, KY10 2BP	None stated
12/02972/FULL	Jul-12	Erection of dwellinghouse	Timber Workshop 24 George Terrace, St Monans, KY10 2AY	To public sewerage system
11/01078/FULL	Feb-11	Erection of agricultural storage building/steading	Abercrombie Farm, North Of St Monans	Not necessary

Pittenweem

Ref No.	Date	Description	Location	Foul drainage plans
13/01508/FULL	May-13	Change of use from garage/store to dwellinghouse including external alterations.	8A School Wynd, Pittenweem, KY10 2PN	NA
12/04552/FULL	Nov-12	Erection of dwellinghouse and single domestic garage (renewal of 07/00485/EFULL)	Laburnum Cottage 44 James Street, Pittenweem, KY10 2QN	NA
12/03491/FULL	Aug-12	Planning permission in principle for erection of dwellinghouse and alterations to access (renewal of permission 09/00997/EOPP)	Land Opposite No 48 James Street, Pittenweem	To public sewerage system
12/01812/FULL	May-12	Erection of modular office building (Class 4) formation of car parking and ancillary private drainage system	The Forge Ovenstone, Pittenweem, KY10 2RR	The foul drainage from will be taken to a new package sewage treatment plant. The outflow from the treatment plant will be given tertiary treatment by means of a partial soakaway before being discharged to an existing culvert
11/03485/FULL	Jun-11	Change of use from flat and steading building to dwellinghouse with granny flat including external alterations	The Old Mill Steading, Balcaskie, Pittenweem	discharge to land soakaway
11/03314/FULL	Jun-11	Conversion and extension of garage to dwelling	1 Seaview Row, Pittenweem, KY10 2PQ	To public sewerage system
10/04588/FULL	Dec-10	Erection of church building with associated hall/café (Class 10) and formation of car parking area	21 Session Street, Pittenweem, KY10 2QL	To public sewerage system
10/03690/FULL	Oct-10	Demolition of existing outhouse and erection of dwellinghouse	22 Abbey Wall Road, Pittenweem, KY10 2ND	No details
09/02901/FULL	Dec-09	Erection of two storey dwellinghouse	Land At Station Court Pittenweem	To public sewerage system
09/01383/EFULL	Jun-09	Change of use of outbuilding to form ancillary accommodation.	1 Milton Road Pittenweem, KY10 2LN	To public sewerage system

Cellardyke

Ref No.	Date	Description	Location	Foul drainage plans
13/00018/FULL	Jan-13	Erection of dwellinghouse	Land West Of 42 George Street Cellardyke	To public sewerage system
12/04081/FULL	Sep-12	Erection of dental surgery and associated car parking (amended design 11/02105/FULL)	Land To North Of Skeith Road, Cellardyke	To public sewerage system
12/00486/FULL	Feb-12	Alterations to outbuilding to form ancillary living accommodation	64 James Street, Cellardyke, KY10 3AY	No details
12/00038/FULL	Jan-12	Change of use of shop to flat	32A James Street, Cellardyke, KY10 3AY	To public sewerage system
11/06654/FULL	Dec-11	Erection of two dwellinghouses (including demolition of existing building on site)	Site Adjacent To Old School House Rodger Street Cellardyke Fife	To public sewerage system
11/05429/FULL	Oct-11	Alterations and conversion of public toilets to single dwellinghouse	James Street P C James Street Cellardyke Fife	To public sewerage system
11/01491/PPP	Mar-11	Planning permission in principle for erection of 2 dwellinghouses	Garage Site Toll Road Cellardyke Fife	To public sewerage system

Anstruther

Ref No.	Date	Description	Location	Foul drainage plans
14/00055/FULL	Jan-14	Change of use and sub-division of hotel into four dwellings	The Smugglers Inn High Street East Anstruther Fife KY10 3DQ	To public sewerage system
13/03343/LBC	Nov-13	Listed building consent for formation of boundary fence, reinstatement of jetty and annexe outbuilding including internal/external alterations, installation of rooflights, windows and doors	Old Manse 5 Esplanade, High Street West, KY10 3DY	NA
11/04339/LBC	Aug-11	Listed building consent for single storey rear extension to pharmacy to provide staff room and toilet	23 Rodger Street, Anstruther KY10 3DU	No details
10/02695/FULL	Aug-10	Change of 5 holiday letting units into 9 holiday letting units	25 High Street East Anstruther KY10 3DQ	NA
09/01816/EFULL	Jun-09	Part Change of Use from Class 1 (retail) to Class 1 (retail)/Class 3 (food and drink)	9 Rodger Street Anstruther Fife KY10 3DU	To public sewerage system

Appendix 2 Shoreline Survey Report 2014

Report Title	Forth Estuary Pittenweem
Project Name	Shellfish Sanitary Surveys
Client/Customer	Cefas
SRSL Project Reference	00561_B0067

Document Number	B0067_Shoreline 0026

Revision History

Revision	Changes	Date
A	Issue for internal review	04/02/2014
01	First formal issue to Cefas	10/02/2014
02	Second issue incorporating corrections from Issue 01	20/02/2014
03	Third issue resolving comments on additional waypoints.	26/02/2014

	Name & Position	Date
Author	Eilidh Cole, Peter Lamont	04/01/2014
Checked	Andrea Veszelovszki	25/02/2014
Approved	John Hausrath	26/02/2014

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Shoreline Survey Report

Production area:	Forth Estuary: Pittenweem
Site name:	Pittenweem
SIN:	FF-073-189-19
Species:	Surf clams
Harvester:	Unknown
Local Authority:	Fife Council
Status:	Survey Review
Date Surveyed:	21st – 23rd January 2014
Surveyed by:	Eilidh Cole, Peter Lamont
Existing RMP:	Area bounded by lines drawn between
	NO 5374 0188, NO 5373 0160
	NO 5676 0206, NO 5669 0234

Area Surveyed:

Section 1: Starting at Ardross Cottages south of St. Monans heading north-east through St. Monans ending at the harbour at Pittenweem.

Section 2: Starting at Pittenweem Harbour, heading north-east beyond the golf course towards Anstruther, finishing at Anstruther Wester. This section also included a water sample from the Dreel Burn.

Weather

Only very light rain has been recorded in the 48 hours prior to the survey.

21st January 2014: 70% cloud cover, wind southerly with a speed of approximately 15 mph. Air temperature approximately 6°C. Good visibility. Sea state: rough. No precipitation during the survey but rain the previous morning.

22nd January 2014: 70% cloud cover, wind south easterly, approximately 18 mph. Air temperature approximately 5°C. Good visibility. Sea state: rough. No rain during the survey day but some heavy showers the night before.

23rd January 2014: 75% cloud cover, wind southerly, approximately 10 mph. Air temperature approximately 6°C. Good visibility. Sea state: moderate. No rain during the survey.

Stakeholder engagement during the survey

Contact was made with Mr Sandy Duncan, the local area sampling officer, prior to the survey. It was not possible to meet with him on any of the survey days due to his commitments, although he provided helpful information prior to the survey.

Shellfish samples were not required to be taken in this area due to previous lack of cooperation from the local fishermen. A boat-hire from Mr Alex Gardner, skipper of the Osprey of Anstruther (10m RIB) was needed to complete offshore sampling. Mr Gardner took the survey team out on a newly acquired six metre rib to undertake seawater sampling and CTD casts.

Fishery

The Pittenweem fishery is classified for the harvest of surf clams via dredging. The production area lies between Anstruther Wester to the north and Elie to the south. No shellfish samples were required for this survey.

Sewage Sources

There are three densely populated villages which span the coastline of the production area. Anstruther lies to the north and is the largest, Pittenweem lies approximately 2 km to the SW and St Monans, the smallest village, lies a further 3 km SW. Several manholes and discharge pipes were observed and noted during the survey. A possible community septic tank was observed towards the NE side of Pittenweem and a water sample was taken from a pipe close to this. A sewage treatment plant was also observed on the shore just south of Anstruther but no pipes or outflows were observed associated with this building.

Public toilet buildings were observed just south of Pittenweem and just south of Anstruther but again, no pipes or discharges were associated with these.

On the shore above the three villages lies agricultural land, but very few livestock were observed. Ardross Farm lies to the SW of St Monans but there was no evidence of livestock in the nearby vicinity. Thirty sheep were observed in a field further along the coastline.

St Monans Holiday Park lies to the NE of the village and has shower and toilet facilities on site. No outfalls associated with this caravan site were observed by the survey team.

Seasonal Population

Hotels, B&Bs and holiday homes were present in the survey area at all three villages with the largest number in Anstruther. Information obtained by the team from local sources indicated that the area experiences a very seasonal population flux with an increase in visitors over the spring and summer, due to tourism and golf, with second homes tending to be concentrated at the waterfronts of the villages. There is a golf course located between Pittenweem and Anstruther therefore population increase is also likely to coincide with the start of the golfing season.

A relatively large caravan park, St Monans Holiday Park, is located just north-east of St Monans. This park contains static caravans as well as spaces for tents and mobile caravans. Guests did not appear to be staying at the park at the time of the survey and the reception area was locked although the park itself seemed well kept and clean.

Boats/Shipping

St Monans, Pittenweem and Anstruther all have harbours with a lot of boat activity. In the west side of St Monans harbour, four fishing boats were observed on the water and six boats were on the water in the east side of the harbour (Fig. 11). Eleven boats were observed on hard standing out of the water. Forty seven boats in total were observed at Pittenweem harbour most of which were fishing/working boats including trawlers (e.g. Fig. 16). Very few boats were observed out at sea which is probably due to the high winds during the survey days. The survey walk did not extend to the harbour at Anstruther, however the team observed that this was a larger harbour than Pittenweem or St Monans and had a large number of working vessels including recreational boats, as well as, RIBs and was the main harbour from which trips to the Isle of May operate.

Farming and Livestock

Fife, generally, consists of rich productive farmland. In the vicinity of the shoreline survey area there are a small number of farms and former farm cottages between the villages of St. Monans, Pittenweem and Anstruther. Two of these farms have diversified: Ardross Farm (Fig. 5) markets Fife agricultural produce through a successful farm shop, visited by the team, and Pathhead has a nursery business (not visited by the survey team). Ardross sells local beef, mutton, pork, chicken and pheasant, however the only livestock observed by the team from the A917 between the villages or from the shore walk were thirty sheep in a small field above the coastal path (Fig. 7, Waypoint 9). A slight silage smell was noticed from the seaward outbuildings at Ardross, but there was no sign of any run-off, or sight or sound of enclosed livestock.

Land Use

Agriculture in the vicinity of the shore walk and on either side of the A917 consists of open arable fields. At the time of the survey the only crop observed was a single field of winter cabbage and other vegetables.

Field boundaries were sparse with no thick hedging and little or no cover for wildlife. The Fife coastal path runs alongside the entire coastline surveyed and appears to be popular for recreational use. Despite being January and out of season, the team observed about thirty people using the path during the relatively short time of the survey. Some in dedicated walking gear appeared to be visitors but the majority were locals with a number exercising dogs. Dog faeces were seen beside the path on several occasions. On the first part of the shore walk south west of St. Monans some off road motorcycle tracks were seen on the coastal path and on the slopes above, indicating limited leisure use for this purpose.

Two municipal outdoor swimming pools constructed on the high shore, one at St. Monans and one at Pittenweem were encountered. Both had signage indicating that they were no longer maintained by Fife Council (e.g. Fig. 14, Waypoint 40).

Land Cover

There were no wooded areas adjacent to the shore walk. Vegetation in the vicinity of the shore consisted mainly of rough grass with slopes often covered by bramble. The farmland above the shore and for the observable distance (as seen from the A917) back from the coast, comprised open, arable fields with few stock fences and sparse hedging or small ditches as boundaries.

Watercourses

The Inverie Burn in St. Monans and the Dreel Burn in Anstruther were the only significant watercourses encountered by the team (Figs. 8 and 24). All other water flows were much smaller in flow volume and associated with either small-scale, presumed land drainage or outfall pipes.

Wildlife/Birds

The predominance of long ridges of bedrock on the shore along most of the survey area creates sheltered lagoons of seawater, with many of the sea bird aggregations the team observed resting in these areas during the survey. Early on the shore walk, at Waypoint 4, about twenty black crows had been seen overhead. Herring gulls were common overhead during the shore walk, mainly as one or a few individuals, and a group of about fifty with six black-back gulls were seen resting on intertidal rocks at Pittenweem on Day 1 (Waypoint 44) along with six black crows. Eiders were commonly encountered along the shore walk. Two cormorants were seen with a smaller eider flock at Waypoint 40 below St. Monans Caravan Park. The inner harbours of St. Monans, Pittenweem and Anstruther all contained eiders in small numbers. A large flock of eiders, seen on Day 2 just east of Pittenweem, was estimated at 114 individuals with an approximate ratio of drake to duck of 2:1 (Waypoint 64).

The team visit to St. Monans, Pittenweem and Anstruther coincided with low water when working boats were tied up and there were no fishing boat movements into or out of the harbours to attract attention and activity from gulls.

Kestrels were observed hunting above the shore southwest of St. Monans. First, one bird, then a pair but it is not certain if the first observed was one of the subsequent pair (Waypoints 7 and 9). A single kestrel was also seen later the same day hunting north east of St. Monans at Waypoint 37. Two wrens in brambles and three rock pipets on the shore were seen at the same location and were the only smaller birds seen between the villages.

Fresh molehills were seen in a field containing sheep and a few outside adjacent to the coastal path (Fig. 7, Waypoint 9). Although the above shore habitat in many places along the surveyed route seems suitable, no rabbits or rabbit droppings were observed.

Shoreline Survey Maps

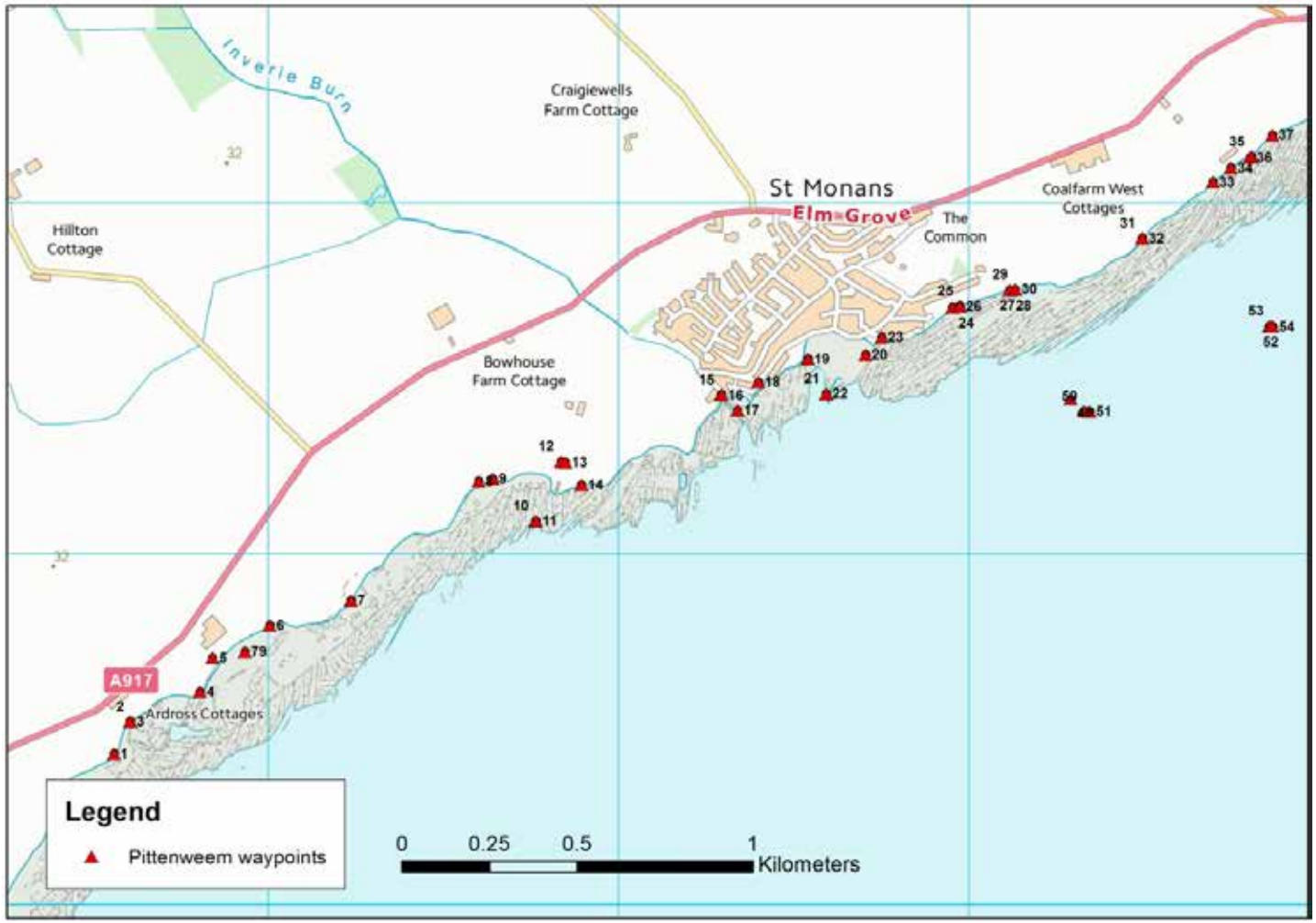

Figure 1. Pittenweem SW Waypoints

Figure 2. Pittenweem Samples SW

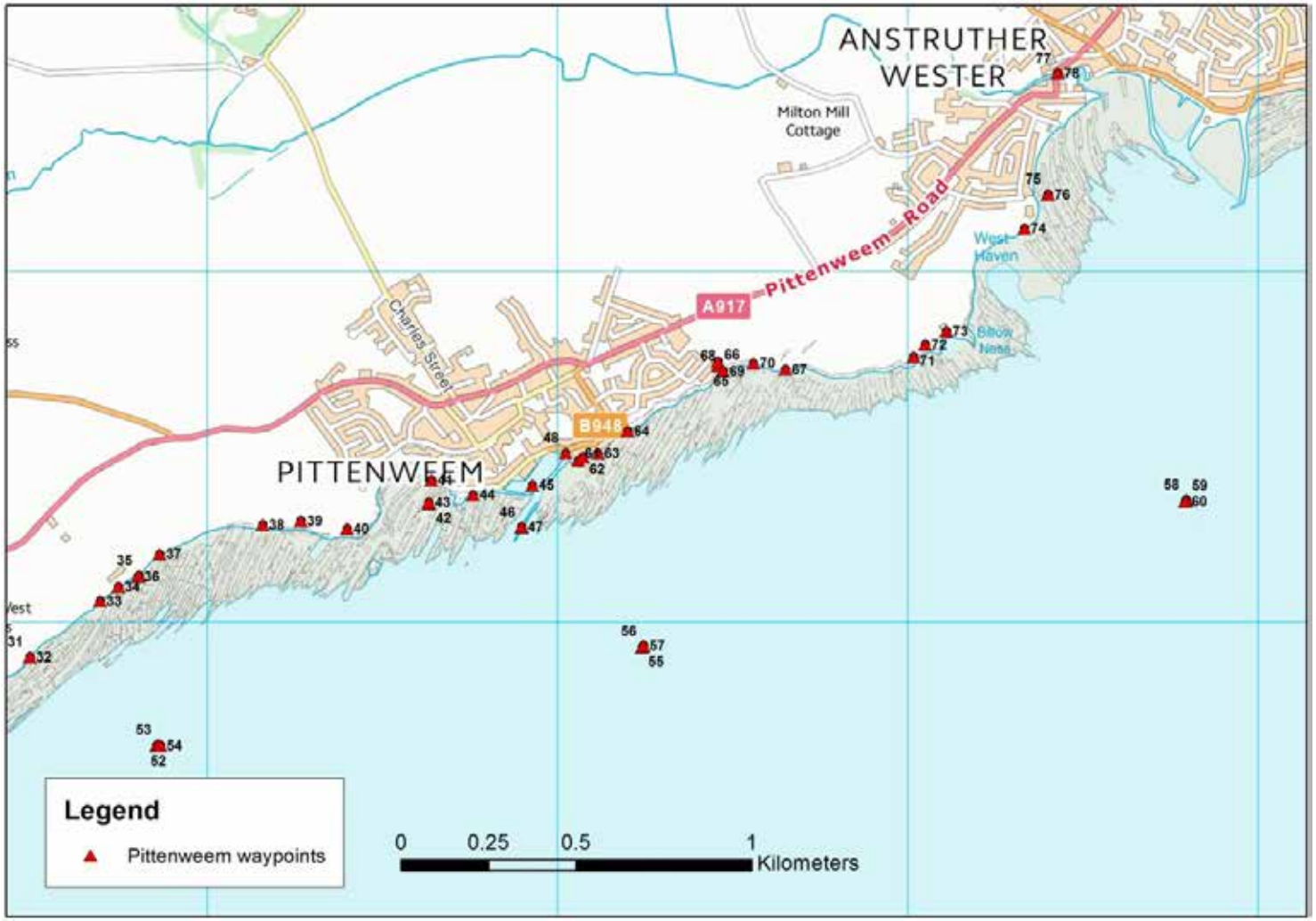

Figure 3. Pittenweem NE Waypoints

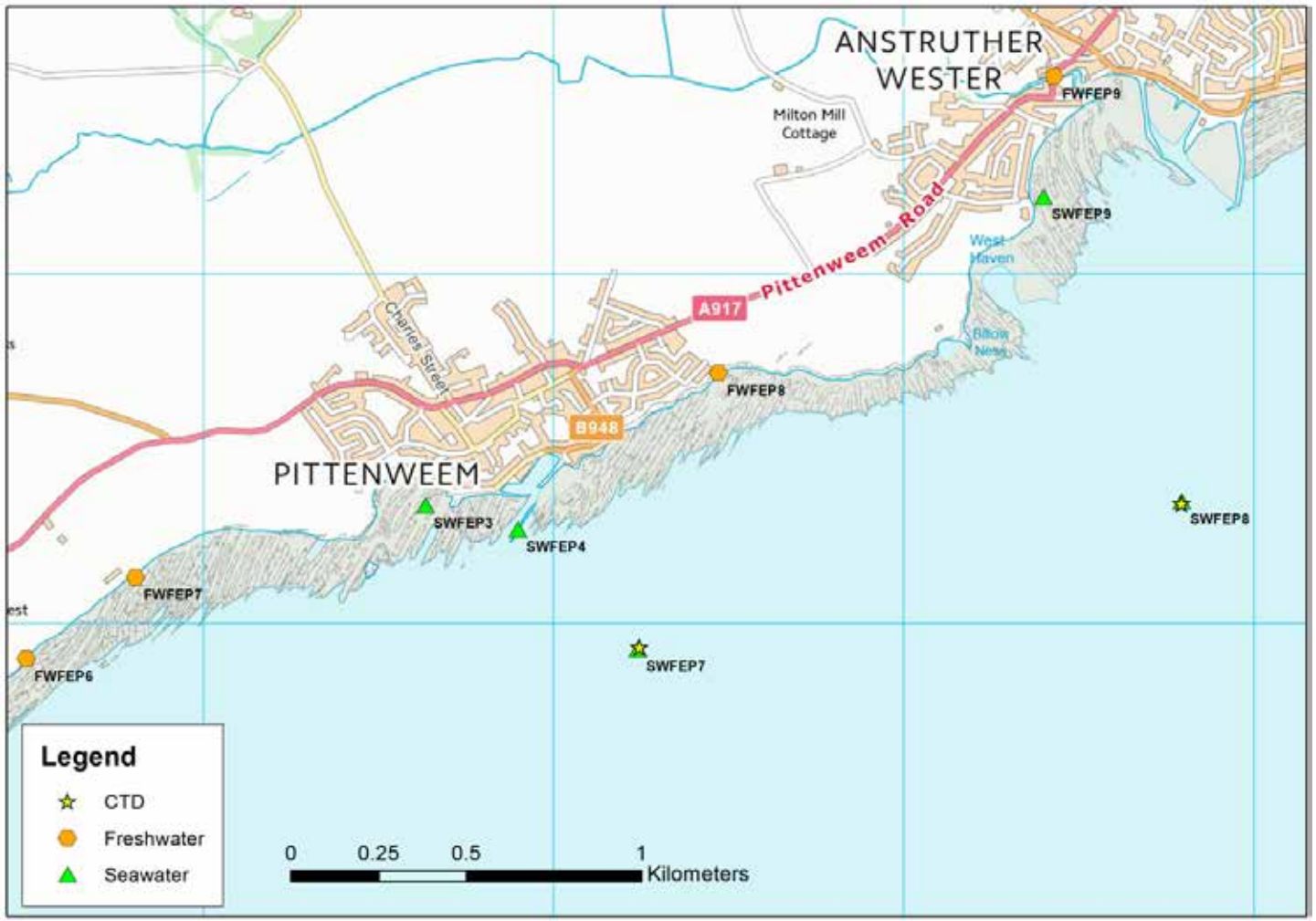

Figure 4. Pittenweem Samples NE

Table 1. Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	21/01/2014	9:22	NO 50560 00430	350560	700430	Figure 5		Start of survey at corner of fence next to Ardross Cottages. Sandy and rocky shore. Two houses directly behind shore across fields. No livestock observed on farmland. One seagull overhead. Fishing gear and general litter on beach.
2	21/01/2014	9:29	NO 50607 00522	350607	700522		FWFEP1	Freshwater sample, unplanned. Taken from pipe.
3	21/01/2014	9:35	NO 50606 00523	350607	700523			Observations associated with waypoint 2. Pipe flowing under coastal footpath running onto shore. Pipe diameter - 18 cm. Width of flow - 8 cm, depth - 1 cm, flow rate - 0.3 L in 10 seconds (using jug and timer). Wire over outlet made measurement approximate.
4	21/01/2014	9:40	NO 50806 00607	350806	700608			Twenty crows and six gulls overhead. One oystercatcher on shore.
5	21/01/2014	9:45	NO 50842 00704	350842	700704	Figure 6		Farm building above shore with dwelling house (Ardross Farm). Five outbuildings observed. No livestock present but hay bales seen by team. No outfalls observed onshore. Three gulls overhead. Smell of silage. Two static caravans next to farm.
6	21/01/2014	9:51	NO 51005 00796	351005	700797			Shore below farm buildings. No outfalls observed. Two gulls on shore.
7	21/01/2014	9:57	NO 51236 00867	351236	700868			Motorcycle (scrambler/trials) tracks above shore. One gull and kestrel (hunting) overhead.
8	21/01/2014	10:19	NO 51601 01207	351602	701208			Field drain, slotted plastic, running under coastal path onto shore. No flow. One gull overhead.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
9	21/01/2014	10:22	NO 51640 01214	351641	701215	Figure 7		Thirty sheep fenced in small field above shore next to castle ruins. Two kestrels hunting above shore side fields. Many molehills observed in field with sheep and some outside the fence.
10	21/01/2014	10:37	NO 51763 01094	351764	701094		SWFEP1	Seawater sample, planned. Sample taken from shore opposite Newark castle ruins.
11	21/01/2014	10:38	NO 51764 01094	351764	701094			Four gulls on rocks. Associated with waypoint 10.
12	21/01/2014	10:45	NO 51835 01263	351836	701264			Newark castle ruins approach path with sign indicating high tide alternative route.
13	21/01/2014	10:47	NO 51848 01261	351848	701262			Apparently disused installation bearing the notice "Chemical closet emptying point". No evidence of pipe or outfall draining onto shore. Freshwater flushing pipe is open ended with no flow. Two houses in field behind.
14	21/01/2014	10:49	NO 51894 01197	351894	701198			Campfire hearth on shore.
15	21/01/2014	11:02	NO 52293 01453	352293	701454	Figure 8	FWFEP2	Freshwater sample, planned. Taken from Inverie Burn.
16	21/01/2014	11:04	NO 52294 01453	352294	701454	Figure 8		Burn observations associated with waypoint 15. Burn width - 1.80 m, depth - 10 cm, flow - 0.011 m/s SD - 0 0.013. On opposite shore; depth - 18 cm, flow - 0.713 m/s, SD - 0.041. St. Monans church situated immediately to the west of the stream with nine houses on the east side of the stream.
17	21/01/2014	11:13	NO 52340 01409	352340	701410	Figure 9		Iron pipe broken with no flow follows the Inverie Burn down to the shore. Green algae growing on rocks in the stream. Twenty five gulls overhead.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
18	21/01/2014	11:19	NO 52399 01490	352400	701490			Two manhole covers on road above shore. No visible outflows on shore but vigorous flow heard below first manhole cover.
19	21/01/2014	11:25	NO 52540 01556	352541	701557	Figure 10		Harbour at St. Monans. West harbour four fishing boats berthed and five recreational boats on hard standing above. Nineteen gulls overhead and one in the water. Shore wall of west harbour with five square storm drains and six circular pipes all with no flow.
20	21/01/2014	11:38	NO 52705 01568	352706	701568	Figure 11		East harbour. Nineteen boats on hard standings with six boats afloat and berthed, all recreational.
21	21/01/2014	11:54	NO 52593 01456	352593	701457		SWFEP2	Seawater sample, planned. Sample taken from the end of St. Monans pier. No birds or wildlife observed.
22	21/01/2014	11:55	NO 52592 01456	352593	701457			Waypoint taken – but not used.
23	21/01/2014	12:07	NO 52750 01617	352751	701618	Figure 12		Large pipe in concrete casing out falling on lower shore issuing from circular concrete inspection unit with manhole access cover. Large manhole covers (four of) and electricity supply point on roadside above.
24	21/01/2014	12:14	NO 52952 01702	352952	701702			Plastic corrugated field drainage pipe (diameter - 15 cm) issuing from top of bank above shore. Dripping. No sample taken.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
25	21/01/2014	12:16	NO 52974 01707	352974	701708	Figure 13		Observations associated with waypoint 26. Plastic corrugated field drainage pipe (diameter - 15 cm) issuing from top of bank above shore with no flow. Two metres to west is an old iron pipe, partially blocked with stained deposit below. Pipe diameter – approx. 10 cm, depth – approx. 1 cm, Flow – approx. 6L/min (using jug and timer). Measurements were difficult to take due to the pipe being partially obstructed.
26	21/01/2014	12:21	NO 52973 01705	352974	701705	Figure 13	FWFEP3	Freshwater sample, unplanned. Sample taken from iron pipe associated with Waypoint 25.
27	21/01/2014	12:26	NO 53117 01752	353118	701753		FWFEP4	Freshwater sample, planned.
28	21/01/2014	12:30	NO 53115 01751	353116	701752			Observations associated with waypoint 27. Square concrete drain below St. Monans Holiday Park which has mainly static caravans but also space for mobile caravans. Width - 40 cm, flow - 20L per min (using jug and timer), depth - 2 cm.
29	21/01/2014	12:34	NO 53131 01753	353131	701754		FWFEP5	Freshwater sample, unplanned. Sample taken from iron pipe.
30	21/01/2014	12:36	NO 53131 01754	353131	701755			Observations associated with waypoint 29. Freshwater sample from iron pipe with caravan site above. Pipe diameter - 20 cm, depth - 1 cm, width - 10 cm, flow - 40 L/m (using jug and timer). Open air swimming pool immediately to the east signed as no longer maintained by Fife Council.
31	21/01/2014	12:47	NO 53494 01900	353494	701900		FWFEP6	Freshwater sample, unplanned. Sample taken from ceramic pipe.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
32	21/01/2014	12:51	NO 53494 01900	353495	701900			Observations associated with waypoint 31. Ceramic pipe flowing heavily onto shore. Green algae on rocks below. Pipe diameter - 30 cm, depth - 7 cm, width - 15 cm, flow - 1.028 m/s, SD - 0.011.
33	21/01/2014	12:58	NO 53695 02060	353696	702060			Two plastic slotted yellow field drains with no flow draining coastal footpath.
34	21/01/2014	13:02	NO 53747 02100	353747	702101			Coalfarm cottages associated with Pathhead Nurseries. No outfalls to shore observed.
35	21/01/2014	13:07	NO 53806 02132	353806	702133		FWFEP7	Freshwater sample, unplanned.
36	21/01/2014	13:08	NO 53802 02130	353802	702130			Observations associated with waypoint 35. Sample taken from field drain with buildings above and inshore. Pipe diameter - 25 cm, flow depth - 2 cm, width - 9 cm, flow - 6 L/min (using jug and timer). Two oystercatchers observed on shore.
37	21/01/2014	13:15	NO 53865 02194	353865	702194			Two wrens in brambles beside coastal path. Three pipits on the shore. Kestrel hunting and two gulls.
38	21/01/2014	13:22	NO 54158 02277	354159	702278			Nine inch slotted plastic field drain. No sample, difficult to access.
39	21/01/2014	13:25	NO 54267 02289	354267	702289			Square shaped brick structure next to path above shore. Can hear running water. Also observed a pipe below which looks like field drainage with no flow.
40	21/01/2014	13:33	NO 54399 02266	354400	702266	Figure 14		Disused open water pool. Park shelter with bench seats, above. No pipes. Twenty one male eiders on rocks and 1 female eider, two cormorants. Play park and toilet block above shore. No outflows observed.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
41	21/01/2014	13:47	NO 54639 02405	354640	702405			Large reinforced pipe leading far out to sea. Origin (i.e. source) could not be determined.
42	21/01/2014	13:52	NO 54634 02337	354635	702337	Figure 15	SWFEP3	Seawater, unplanned extra sample. Sample taken from near end of large pipe as cannot see if flowing or not. Houses behind. No birds or wildlife observed at this location.
43	21/01/2014	13:56	NO 54632 02341	354633	702342			Waypoint taken but not used.
44	21/01/2014	14:01	NO 54759 02363	354760	702364			Fifty herring gulls and three crows on rocks on shore. Six black backed gulls. Dog walkers on coastal path with two dogs.
45	21/01/2014	14:05	NO 54928 02391	354929	702391			Twenty eight working boats including trawlers in harbour bay. Three eider drakes and one duck on water. Twenty five seagulls.
46	21/01/2014	14:30	NO 54898 02270	354899	702270		SWFEP4	Seawater sample, planned. Sample taken at Pittenweem harbour pier.
47	21/01/2014	14:31	NO 54897 02271	354898	702271			Fifty seagulls flying above.
48	21/01/2014	14:40	NO 55023 02482	355023	702482	Figure 16		Nineteen boats in Pittenweem harbour bay.
49	22/01/2014	9:51	NO 53290 01441	353290	701441		SWFEP5	Seawater sample, planned. Sample taken from boat off coast of St. Monans.
50	22/01/2014	9:53	NO 53329 01406	353329	701406			Waypoint taken but not used.
51	22/01/2014	9:53	NO 53344 01406	353345	701406			CTD cast 1.
52	22/01/2014	10:11	NO 53856 01647	353856	701648		SWFEP6	Seawater sample, planned. Seawater sample taken from the boat opposite Coal Farm.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
53	22/01/2014	10:11	NO 53861 01650	353861	701650			Waypoint taken but not used.
54	22/01/2014	10:12	NO 53866 01647	353867	701648			CTD cast 2.
55	22/01/2014	10:29	NO 55241 01928	355241	701928	Figure 17	SWFEP7	Seawater sample, planned. Sample taken from the boat off the coast of Pittenweem.
56	22/01/2014	10:29	NO 55245 01931	355246	701931			Waypoint taken but not used.
57	22/01/2014	10:29	NO 55245 01933	355245	701934	Figure 17		CTD cast 3.
58	22/01/2014	10:54	NO 56794 02349	356794	702350	Figure 18, 19	SWFEP8	Seawater sample, planned. Sample taken from boat off the coast opposite Anstruther Golf Course.
59	22/01/2014	10:54	NO 56793 02347	356793	702347			Waypoint taken but not used.
60	22/01/2014	10:54	NO 56792 02343	356792	702344	Figure 18, 19		CTD cast 4.
61	22/01/2014	13:48	NO 55059 02460	355060	702461			Start of survey walk, day 2 at Pittenweem Harbour east.
62	22/01/2014	13:50	NO 55072 02470	355073	702471			Manhole with clay pipe leading onto shore. No sample taken from pipe as no flow. Pipe diameter - 15 cm. Seven seagulls overhead.
63	22/01/2014	13:55	NO 55115 02481	355115	702482			Plastic pipe running down side of wall next to shore with houses behind, no flow. Pipe diameter - 15 cm.
64	22/01/2014	13:59	NO 55200 02545	355201	702545			Birds on water, one hundred and fourteen in total. Mostly male and female eiders (thirty eight ducks and seventy six drakes).
65	22/01/2014	14:18	NO 55459 02730	355459	702731	Figure 20		Large metal pipe heading out to sea for a long distance. Pipe outflow later accessed and sampled (waypoint 68).

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
66	22/01/2014	14:19	NO 55457 02742	355458	702743			Possible sewage related structure on shore above pipe from waypoint 65. Houses and fields next to structure. Possible community septic tank, some smell of sewage.
67	22/01/2014	14:26	NO 55651 02720	355652	702721			Drainage culvert next to golf course. Not flowing, end of pipe partially obscured.
68	22/01/2014	14:36	NO 55471 02715	355472	702716	Figure 21	FWFEP8	Freshwater sample, planned.
69	22/01/2014	14:36	NO 55472 02715	355473	702716	Figure 21		Observations associated with waypoints 65 & 68. Pipe revisited from waypoint 65 as shore access obtained. Pipe is broken and flowing heavily. Smell of sewage. Pipe diameter - 30 cm, water width - 12 cm, Depth - 2 cm, Flow - 45L/min (measured using jug and timer).
70	22/01/2014	14:46	NO 55559 02738	355559	702738			Land seepage, not sampled.
71	22/01/2014	14:54	NO 56015 02757	356015	702757			Manhole cover on shore. Two small brick buildings above on the golf course. Buildings are boarded up and not in use.
72	22/01/2014	14:59	NO 56049 02791	356050	702791			Field drainage flowing lightly under golf course onto shore, not sampled.
73	22/01/2014	15:04	NO 56110 02829	356111	702830			Large green metal building most likely the sewage treatment plant as stated by Alex Gardner (boat owner). Five metal manhole covers next to it. No evidence of pipes or outflows. Another five manhole covers closer to the shore about 30 metres from the green building.
74	22/01/2014	15:11	NO 56333 03123	356333	703123			Public toilets. No signs of pipes or outflows. Situated at golf club building at Anstruther.

No.	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
75	22/01/2014	15:16	NO 56399 03219	356399	703220	Figure 22, 23	SWFEP9	Seawater sample, planned. Large concrete structure with concrete encased pipe going out to sea. Cannot see end of pipe to take freshwater sample so seawater sample taken.
76	22/01/2014	15:16	NO 56400 03219	356400	703220			Waypoint taken but not used.
77	22/01/2014	15:36	NO 56429 03564	356429	703564	Figure 24	FWFEP9	Freshwater sample, planned. Sample taken from Dreel Burn.
78	22/01/2014	15:36	NO 56428 03565	356428	703565	Figure 24		Burn observations associated with waypoint 77. Freshwater sample taken from Dreel Burn. Width - 5m 35 cm, Depth - 40cm, Flow - 0.524 m/s, SD - 0.014. Depth 2 - 30cm, Flow 2 - 1.932 m/s, SD 2 - 0.034. Twelve mallard ducks on water.
79	23/01/2014	8:44	NO 50934 00722	350935	700722		SWFEP10	Seawater sample, planned. Associated with waypoint 5. Seawater sample taken from below Ardross Farm as this was missed on first survey day.

Sampling

Water samples were collected at sites marked on the Forth Estuary Pittenweem maps shown in Figures 2 and 4.

All samples were transferred to Biotherm 10 boxes with ice packs and posted to Glasgow Scientific Services (GSS) for *E. coli* analysis. All samples were received and analysed the day after sample collection. The sample temperatures on arrival at the laboratory ranged between 1.8˚C and 2.4˚C.

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

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

No shellfish samples were required to be taken for this survey.

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	*E. coli* (cfu/100ml)	Salinity (ppt)
1	21/01/2014	FWFEP1	NO 50607 00522	Freshwater	<10	-
2	21/01/2014	SWFEP1	NO 51763 01094	Seawater	72	36.13
3	21/01/2014	FWFEP2	NO 52293 01453	Freshwater	20,000	-
4	21/01/2014	SWFEP2	NO 52593 01456	Seawater	91	35.77
5	21/01/2014	FWFEP3	NO 52973 01705	Freshwater	<10	-
6	21/01/2014	FWFEP4	NO 53117 01752	Freshwater	40	-
7	21/01/2014	FWFEP5	NO 53131 01753	Freshwater	40	-
8	21/01/2014	FWFEP6	NO 53494 01900	Freshwater	20	-
9	21/01/2014	FWFEP7	NO 53806 02132	Freshwater	<10	-
10	21/01/2014	SWFEP3	NO 54634 02337	Seawater	76	35.77
11	21/01/2014	SWFEP4	NO 54898 02270	Seawater	88	35.95
12	22/01/2014	SWFEP5	NO 53290 01441	Seawater	100	35.59
13	22/01/2014	SWFEP6	NO 53856 01647	Seawater	400	33.42
14	22/01/2014	SWFEP7	NO 55241 01928	Seawater	93	35.23
15	22/01/2014	SWFEP8	NO 56794 02349	Seawater	69	31.07
16	22/01/2014	FWFEP8	NO 55471 02715	Freshwater	10,000	-
17	22/01/2014	SWFEP9	NO 56399 03219	Seawater	200	32.52
18	22/01/2014	FWFEP9	NO 56429 03564	Freshwater	980	-
19	23/01/2014	SWFEP10	NO 50934 00722	Seawater	1,600	34.87

Photographs

Figure 5. Fishing gear and general litter on beach. Associated with waypoint 1

Figure 6. Ardross Farm building above shore with dwelling house. Associated with waypoint 5

Figure 7. Thirty sheep fenced in small field above shore next to castle ruins. Associated with waypoint 9

Figure 8. Inverie Burn. Associated with waypoint 16 and sample FWFEP2

Figure 9. Iron pipe broken with no flow follows the Inverie Burn down to the shore. Associated with waypoint 17

Figure 10. West harbour at St. Monans. Associated with waypoint 19

Figure 11. East harbour at St Monans. Associated with waypoint 20

Figure 12. Large pipe in concrete casing on lower shore issuing from circular concrete inspection unit with manhole access cover. Associated with waypoint 23

Figure 13. Old iron pipe, partially blocked with stained deposit below. Associated with waypoint 25 and sample FWFEP3

Figure 14. Open water municipal swimming pool, west side of Pittenweem. Associated with waypoint 40

Figure 15. Seawater sample taken from near end of large pipe. Associated with waypoint 43 and sample SWFEP3

Figure 16. Associated with waypoint 48. Nineteen boats in Pittenweem harbour bay

Figure 17. Seawater sample taken from the boat off the coast of Pittenweem. Associated with waypoint 55-57 and sample SWFEP7

Figure 18. Seawater sample taken from boat off the coast opposite Anstruther Golf Course. Associated with waypoint 58 and sample SWFEP8

Figure 19. Associated with waypoint 58 and sample SWFEP8. Seawater sample taken from boat off the coast opposite Anstruther Golf Course

Figure 20. Large metal pipe heading out to sea. Associated with waypoint 65

Figure 21. Pipe revisited from waypoint 65. Pipe is broken and flowing heavily. Associated with waypoints 65 & 68 and sample FWFEP8

Figure 22. Large concrete structure with concrete encased pipe going out to sea. Associated with waypoint 75

Figure 23. Concrete encased pipe going out to sea. Associated with waypoint 76 and sample SWFEP9

Figure 24. The Dreel Burn, Anstruther. Associated with waypoint 77 and sample FWFEP9

Appendix 3. Pittenweem CTD data

Data obtained during the shoreline survey. The location of the cast is shown in Figure A6.1.

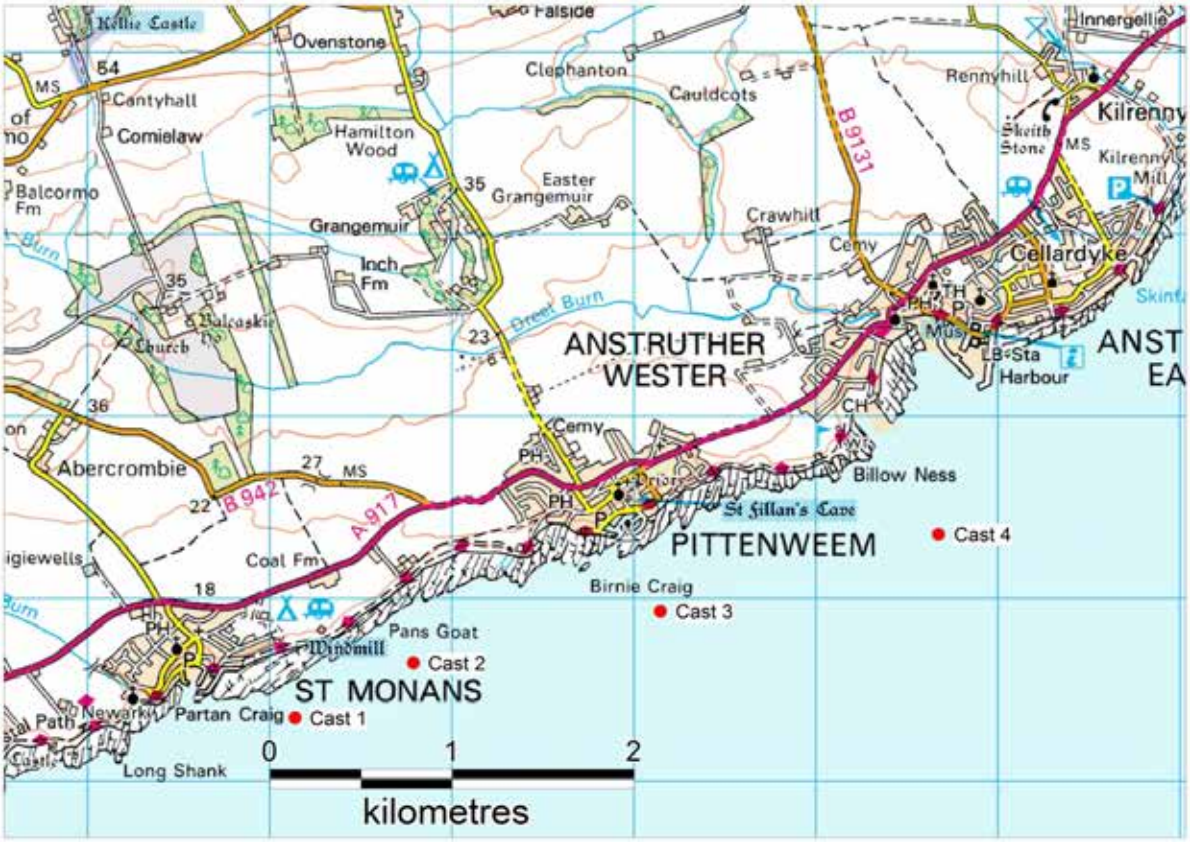

Figure A6.1 Location of CTD casts

CAST 1

Data Header

% Device	10G100653
% File name	10G100653_20140122_100104
% Cast time (local)	22/01/2014 10:01
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.202423
% Start longitude	-2.7553676
% Start GPS horizontal error(Meter)	1.779999971
% Start GPS vertical error(Meter)	2.410000086
% Start GPS number of satellites	7
% Cast duration (Seconds)	72
% 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)
0.14888503	6.290344165	33.59539
0.44664001	6.292430847	33.58901
0.744398961	6.288130515	33.60272
1.042158224	6.286770904	33.58235
1.33991906	6.289484622	33.58619
1.637680494	6.292267704	33.57501
1.935444088	6.295259328	33.56524
2.233210105	6.306163442	33.5531
2.530979368	6.307854444	33.53591
2.828749145	6.303883124	33.54523
3.126515376	6.30551073	33.56349
3.424275249	6.308984794	33.5986
3.722027929	6.312098888	33.62439
4.019775281	6.318083096	33.64363
4.317519151	6.327740869	33.65435
4.615260135	6.327068663	33.6673
4.913000479	6.328848021	33.6571
5.210741265	6.325087695	33.66011
5.508480956	6.326130344	33.66321
5.806221309	6.336256081	33.65315
6.103963125	6.340038678	33.64969
6.401704573	6.335194858	33.65317
6.699447989	6.340063301	33.62948
6.997194037	6.337677674	33.62758
7.294939126	6.336615352	33.63428
7.592683799	6.345528072	33.62949
7.890426112	6.348744373	33.65388
8.234593588	6.345763055	33.62544

CAST 2

Data Header

% Device	10G100653
% File name	10G100653_20140122_101239
% Cast time (local)	22/01/2014 10:12
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.2052013
% Start longitude	-2.7449373
% Start GPS horizontal error(Meter)	5.960000038
% Start GPS vertical error(Meter)	9.550000191
% Start GPS number of satellites	6
% Cast duration (Seconds)	64.8
% 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)
0.148886107	6.328441727	33.59064
0.446642845	6.330694892	33.59519
0.744403855	6.328601247	33.59324
1.042164888	6.329488067	33.59177
1.339926024	6.33086033	33.58971
1.637687012	6.33337343	33.59069
1.935447273	6.334424858	33.59362
2.233206807	6.340501558	33.59519
2.530965267	6.336956417	33.6004
2.82872307	6.337080317	33.59737
3.126480189	6.336876487	33.60335
3.424235601	6.336766212	33.60922
3.721989354	6.339876579	33.61533
4.019742046	6.343647618	33.6166
4.317493437	6.344828358	33.6245
4.615242611	6.343832022	33.63298
4.912989909	6.34531057	33.63796
5.210735929	6.353623622	33.64274
5.508480075	6.354379835	33.65281
5.806223261	6.356190866	33.64854
6.103965794	6.357595854	33.65604
6.401706616	6.359267286	33.66097
6.699446887	6.363154043	33.65876
6.997187363	6.365239114	33.65714
7.294927563	6.360894204	33.6578
7.592667806	6.361674576	33.65317
7.890408609	6.360898168	33.6499
8.157716127	6.364041388	33.66111

CAST 3

Data Header

% Device	10G100653
% File name	10G100653_20140122_102949
% Cast time (local)	22/01/2014 10:29
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.2078922
% Start longitude	-2.7230954
% Start GPS horizontal error(Meter)	3.539999962
% Start GPS vertical error(Meter)	5.159999847
% Start GPS number of satellites	6
% Cast duration (Seconds)	67.8
% 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)
0.148885767	6.371284322	33.60151
0.446640279	6.37192004	33.61208
0.744398582	6.371906741	33.61081
1.042156006	6.372737226	33.61689
1.339912495	6.371740843	33.61594
1.637669432	6.372872769	33.60998
1.935426313	6.371662264	33.61341
2.233183315	6.372906998	33.60591
2.530940398	6.372906503	33.60989
2.828697104	6.373179406	33.60624
3.126453859	6.373193799	33.6065
3.424209914	6.373395315	33.60938
3.721965309	6.373377925	33.60929
4.019719954	6.372304446	33.61275
4.317474019	6.374558747	33.61153
4.615228485	6.37353843	33.60644
4.912983478	6.373349093	33.60371
5.210737889	6.375026259	33.60875
5.50849196	6.374773233	33.60391
5.806247458	6.373920323	33.59309
6.104003776	6.374438015	33.59368
6.401758422	6.374906025	33.60485
6.699510994	6.374733411	33.60884
7.05687631	6.374721885	33.61007

CAST 4

Data Header

% Device	10G100653
% File name	10G100653_20140122_105309
% Cast time (local)	22/01/2014 10:53:00
% Sample type	Cast
% Cast data	Processed
% Location source	GPS
% Start latitude	56.2118346
% Start longitude	-2.698519
% Start GPS horizontal error(Meter)	4.849999905
% Start GPS vertical error(Meter)	5.650000095
% Start GPS number of satellites	5
% Cast duration (Seconds)	78.6
% 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)
0.148876663	6.444250184	33.69301
0.446614457	6.450476785	33.68925
0.744357703	6.446240498	33.68877
1.042100588	6.448818549	33.68911
1.339842519	6.447811892	33.69436
1.637584005	6.447036133	33.6897
1.935326129	6.445225277	33.68534
2.233068257	6.444309784	33.6862
2.530809993	6.444184606	33.68558
2.828551169	6.444656529	33.68814
3.126292401	6.444861398	33.6822
3.424033104	6.445355356	33.68987
3.721773009	6.447654878	33.68663
4.019512875	6.44835004	33.68769
4.317252988	6.447246551	33.68139
4.614993125	6.447901152	33.6844
4.912732484	6.449027274	33.68548
5.210473744	6.450235961	33.66515
5.508214591	6.450196551	33.68627
5.805957946	6.450170638	33.64021
6.103700631	6.450562169	33.68918
6.401438111	6.45011758	33.68269
6.699175385	6.448013659	33.68754
6.996910482	6.44845096	33.69843
7.29464229	6.462359063	33.71566
7.557435092	6.479465564	33.71896