Scottish Sanitary Survey Project

Restricted Sanitary Survey Report

Ettrick Bay

AB 389

September 2008

Cefas

FOOD STANDARDS AGENCY SCOTLAND
Buidheann Inbhe-Bìdhe an Alba

Report Distribution – Ettrick Bay

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1. Area Overview

Ettrick Bay is located on the southwest coastline of Scotland, on the west coastline of the Isle of Bute. Ettrick Bay is roughly 1.6km wide and 1km long. The depth of the bay varies from 0 – 5m in the shallows, to 30m at the central mouth of the bay. The bay is open to the southwest prevailing winds.

Figure 1.1 Location of Ettrick Bay

The land surrounding Ettrick Bay is mostly improved grassland with some patches of neutral grassland and is intensively farmed.

Ettrick Bay was identified as a bathing water in 1999. The bathing water achieved 'good' quality for the first time in 2005, and the improvement continued through 2006. SEPA reported that there are no significant sewage discharges in the vicinity of the beach, and the failure to meet required standards in previous seasons has been attributed solely to agricultural pollution, which reaches the bathing water via local streams that flow across the beach.

1.2 Human Population

Figure 1.2 shows the census output areas that are directly adjacent to Ettrick Bay. The two census output areas had a combined population of 298 in 2001 and the nearest settlements include St Colmac, and Kildavannan.

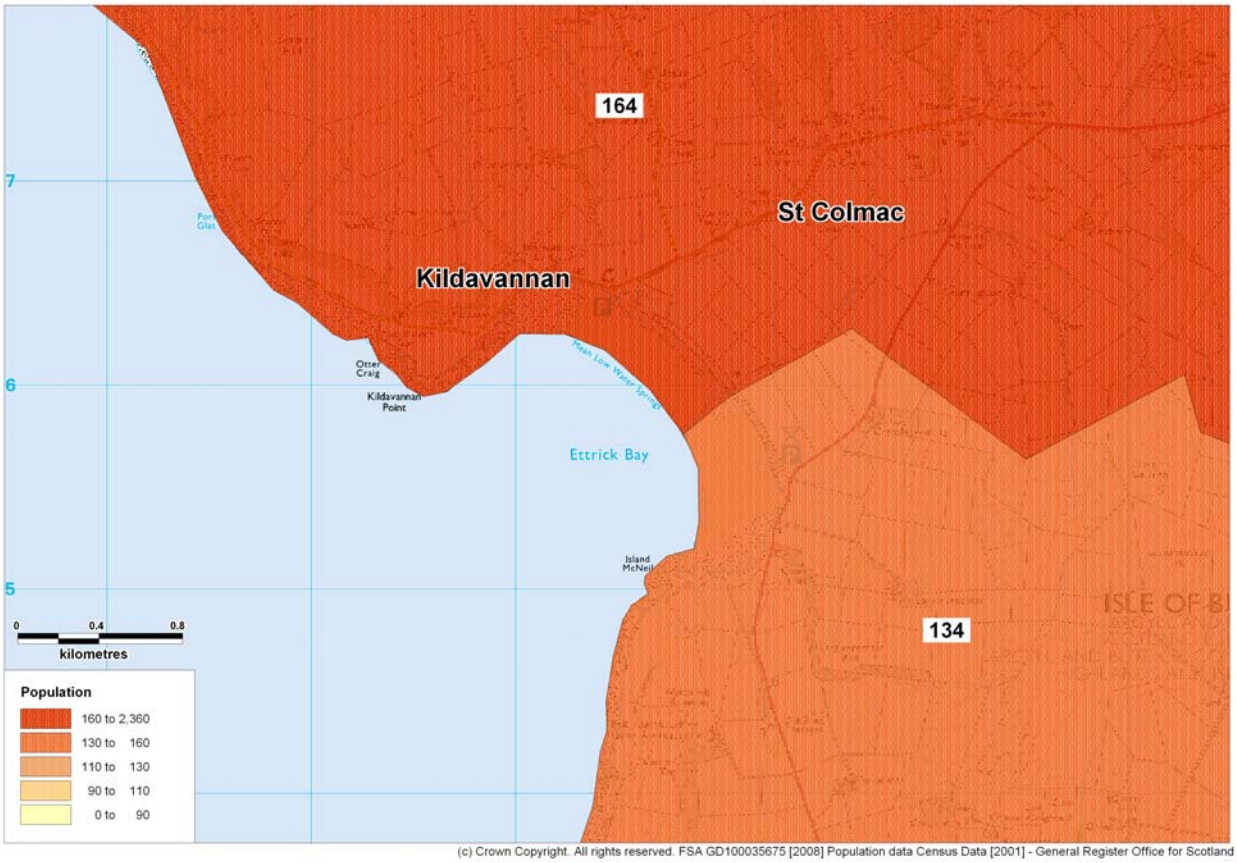

Figure 1.2 Human population of Ettrick Bay

2. Fishery

The fishery at Ettrick Bay is comprised of a wild Razor fish (Ensis spp.) bed, as listed in Table 2.1 below:

Table 2.1 Ettrick Bay shellfish bed

Site	SIN	Species
Ettrick Bay	AB 389 786 16	Razor fish

The current production area boundaries are given as the area bounded by lines drawn between NS 02600 66050 and NS 03630 64900 extending to MHWS.

There is currently no RMP assigned to this area. The bay does not fall within a designated Shellfish Growing Water, though it does lie immediately to the southeast of the Kyles of Bute Shellfish Growing Water (see Figure 2.1).

The actual shellfishery as identified by the harvester covers the area bounded by lines drawn between NS 02387 65803, NS 03043 66394, NS 04134 65441 and NS 03425 64800. The razor clams will be fished all year round (weather permitting) by hand and mechanical methods by divers from boats.

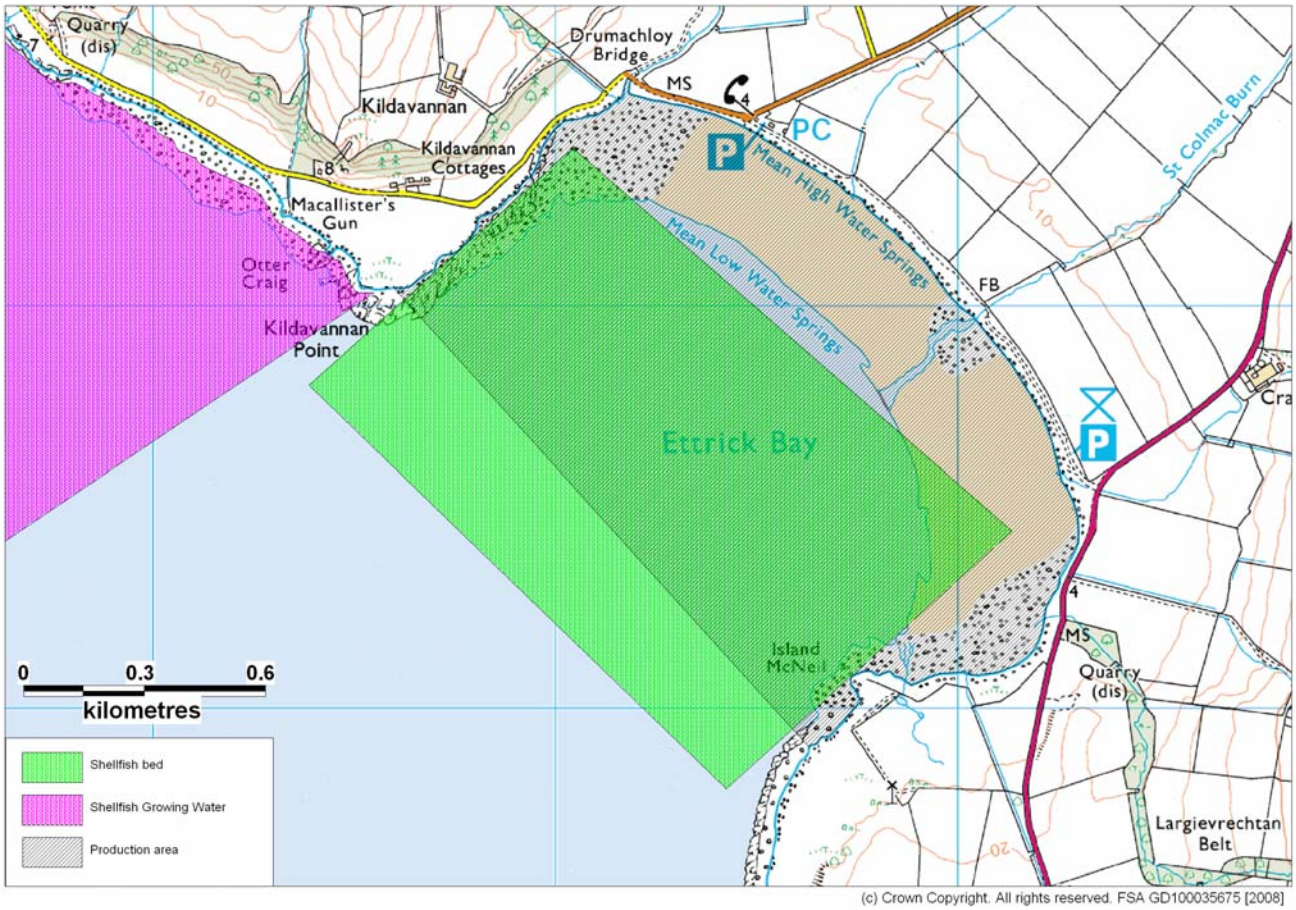

Figure 2.1 Ettrick Bay Fishery

3. Sewage Discharges

There are no community septic tanks or sewage discharges identified by Scottish Water for the area around Ettrick Bay.

There are several sewage discharge consents held by SEPA for this area, they are listed in Table 3.1 and mapped in Figure 3.1. Figure 3.1 shows the area north of Ettrick Bay due to no discharges being present south of this area.

Table 3.1 Discharge consent held by SEPA

Ref No.	NGR of discharge	Discharge type	Consented flow (DWF) m3/d	Consented/ design PE
CAR/L/1003715	NR 98027000	Sewage (Public) EO	196.82	757
CAR/L/1003717	NR 9804369998	Sewage (Public) CSO	197	757
CAR/R/1018585	NS 0049668482	Sewage (Private) Primary	-	8
CAR/R/1010405	NR 9914566402	Sewage (Private) Primary	-	8
CAR/R/1018189	NR 9894065980	Domestic	-	30

Observations of additional discharges including septic tanks and outfall pipes made during the shoreline survey are listed in Table 3.2. Their locations have been included in the mapped discharges in Figure 3.1. Further details can be found in the shoreline survey report in Appendix 2.

Table 3.2 Observations of potential sewage discharges

No.	Date	NGR	Description of potential sources of faecal contamination
1	11.09.08	NS 04212 65729	Sanitary debris in high tide mark
2	11.09.08	NS 03890 66147	Sanitary debris in high tide mark
3	11.09.08	NS 03479 66393	Outflow pipe (could not see end of pipe)
4	11.09.08	NS 03548 66441	Public Toilets
5	11.09.08	NS 03283 66497	Plastic onto cast iron water pipe, flowing, 20cm diameter, Freshwater 9 (0 *E. coli* cfu/100ml)
6	11.09.08	NS 03159 66382	Slurry tank to the north
7	11.09.08	NS 03171 66558	Slurry tank
8	11.09.08	NS 03321 66509	Slurry tank
9	11.09.08	NS 03418 66457	Cast iron pipe, not flowing, may be broken
10	11.09.08	NS 03514 66450	Septic tank for café & public toilets
11	11.09.08	NS 04285 65674	Dung heap in field

All of the noted discharges within Ettrick Bay itself are sufficiently close to the fishery to adversely impact water quality.

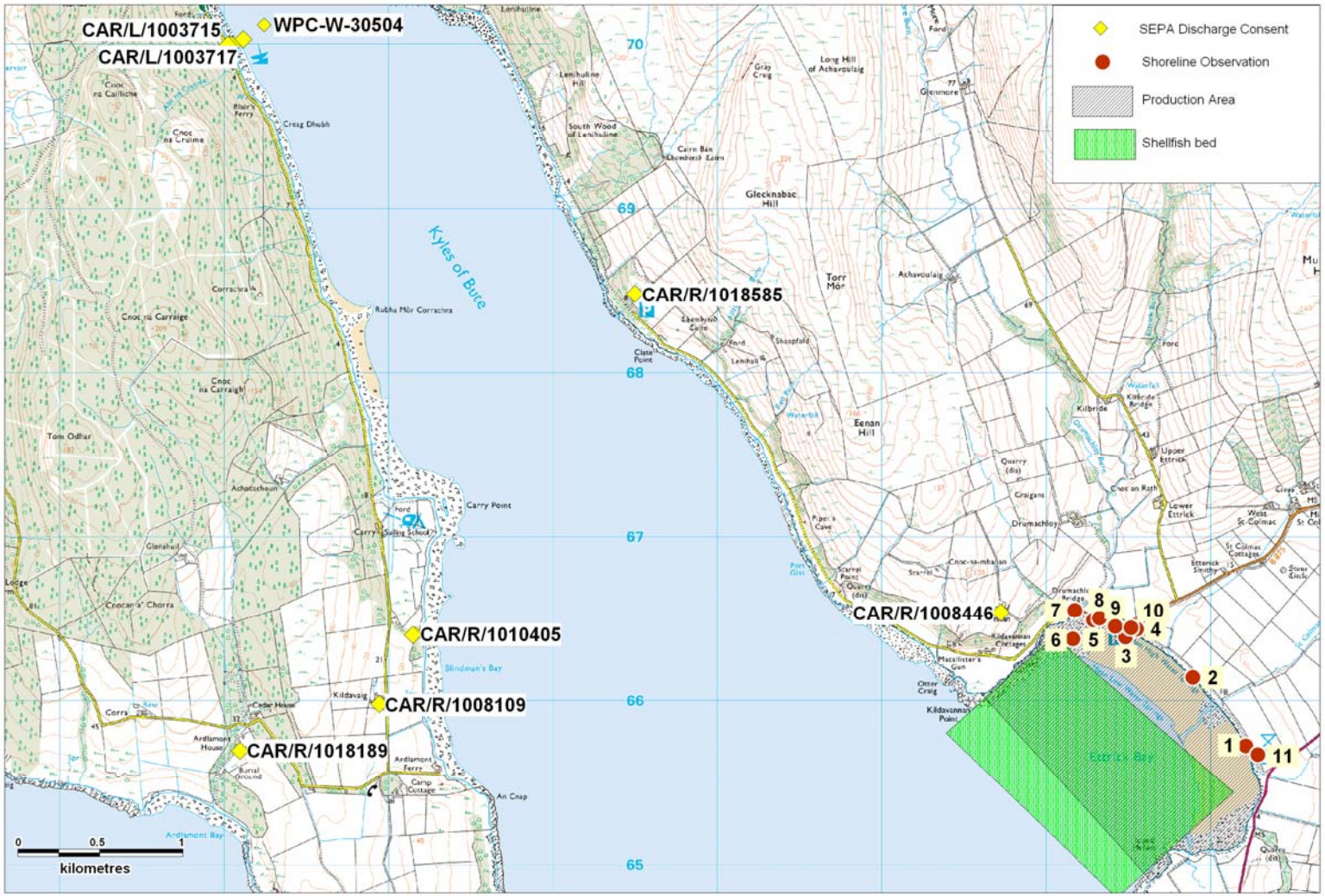

Figure 3.1 Sewage discharges at Ettrick Bay

4. Animals

4.1 Livestock

Information on livestock numbers in the area was obtained from the shoreline survey, the Local Authority and SEPA. The shoreline survey only relates to the time of the site visits on the 11th and 17th September.

The Local Authority identified that on the Isle of Bute there are an estimated 52 livestock farms, 18 of which are dairy, although most of the 52 have both beef and sheep. There are an estimated 10,500 cattle, of which roughly 2,700 are dairy cows. There are also an estimated 11,000 ewes (2004-2005), however this figure will be significantly higher in the summer months after lambing and before sales.

SEPA identified that the catchment discharging into Ettrick Bay is roughly 19 square kilometres. Approximately half of this land is in permanent pasture and the rest is farmed intensively, with over 900 dairy cows on 8 tenanted farms and a further 4 tenanted farms in beef and sheep production within the local area.

During the shoreline survey, approximately 350 cattle and 205 sheep were observed grazing in the fields surrounding Ettrick Bay (see Figure 4.1).

Three slurry pits were observed during the shoreline survey, though no information on the disposal or spreading of slurry on surrounding fields was available. Slurry spreading was observed on a field adjacent to St. Colmac Burn during the shoreline survey. A dung heap was observed at the southeastern end of the bay.

The shoreline survey identified that sheep grazed widely around the Ettrick Bay coastline. Livestock were concentrated at either end of the bay, with a larger number at the north-western end. Dairy cattle and sheep were also observed grazing close to St Colmac Burn, which runs across the sand to discharge in the middle of the bay.

The geographical spread of contamination at the shores of the bay is likely to be broadly evenly spread around the shoreline as livestock move about the area. Slurry is likely to impact St. Colmac's burn as well as other streams and runoff in the area and so the streams feeding into Ettrick Bay could be considered as point sources of contamination.

4.2 Wildlife

While the Isle of Bute does host some colonies of breeding seabirds, Ettrick Bay rarely hosts significant colonies. Seabirds such as gulls will always be present on the bay but their distribution is likely to be even over time and as such would not materially affect placement of an RMP. During the shoreline survey roughly 350 geese were spotted on the eastern shoreline in addition to 15 ducks, 100 gulls, 20 oystercatchers and 30 other wading birds at the far western end of the bay (see Figure 4.1).

The north of the Isle of Bute, where Ettrick Bay is located is the domain of feral mountain goats and roe deer, however no population numbers are available and none were observed during the shoreline survey.

Two species of pinniped (seals, sea lions, walruses) are commonly found around the coasts of Scotland: These are the European harbour, or common seal (*Phoca vitulina vitulina*) and the grey seal (*Halichoerus grypus*).

The amount of *E. coli* and other faecal indicator bacteria contained in seal faeces has been reported as being similar to that found in raw sewage, with counts showing up to 1.21 x 104 CFU (colony forming units) *E. coli* per gram dry weight of faeces (Lisle et al 2004).

Common seals surveys are conducted every 5 years and an estimate of minimum numbers is available through Scottish Natural Heritage. According to the Scottish Executive, in 2001 there were approximately 119, 00 grey seals in Scottish waters.

The Sea Mammal Research Unit has recorded a growing number of harbour seals on the Isle of Bute area over the past twenty years (Table 4.1). Grey seals have also been spotted but in very small numbers and were absent in 1996 (Table 4.2).

Table 4.1 Harbour Seal counts

Location		**Aug 1989**	**Aug 1996**	**Aug 2000**	**Aug 2007**
Isle of Bute	Ettrick Bay, Bute	0	0	0	0
	Bute and surrounds	13	121	100	60

Table 4.2 Grey Seal counts

Location		**Aug 1989**	**Aug 1996**	**Aug 2000**	**Aug 2007**
Isle of Bute	Ettrick Bay, Bute	0	0	0	0
	Bute and surrounds	8	0	8	23

As no seals have been reported in the immediate area of Ettrick Bay it is considered that the risk of faecal contamination from these animals is low.

Wildlife impact generally to the shellfish bed is likely to be minimal compared to the impact of diffuse pollution due to livestock. Wildlife impacts are further likely to be very localised and unpredictable. While some wildlife species can harbour bacteria and viruses that can cause illness in humans, their faeces are considered to pose a lower risk to human health than either human or livestock faecal contamination. Therefore this factor cannot be taken into account when identifying the location of a routine monitoring point (RMP).

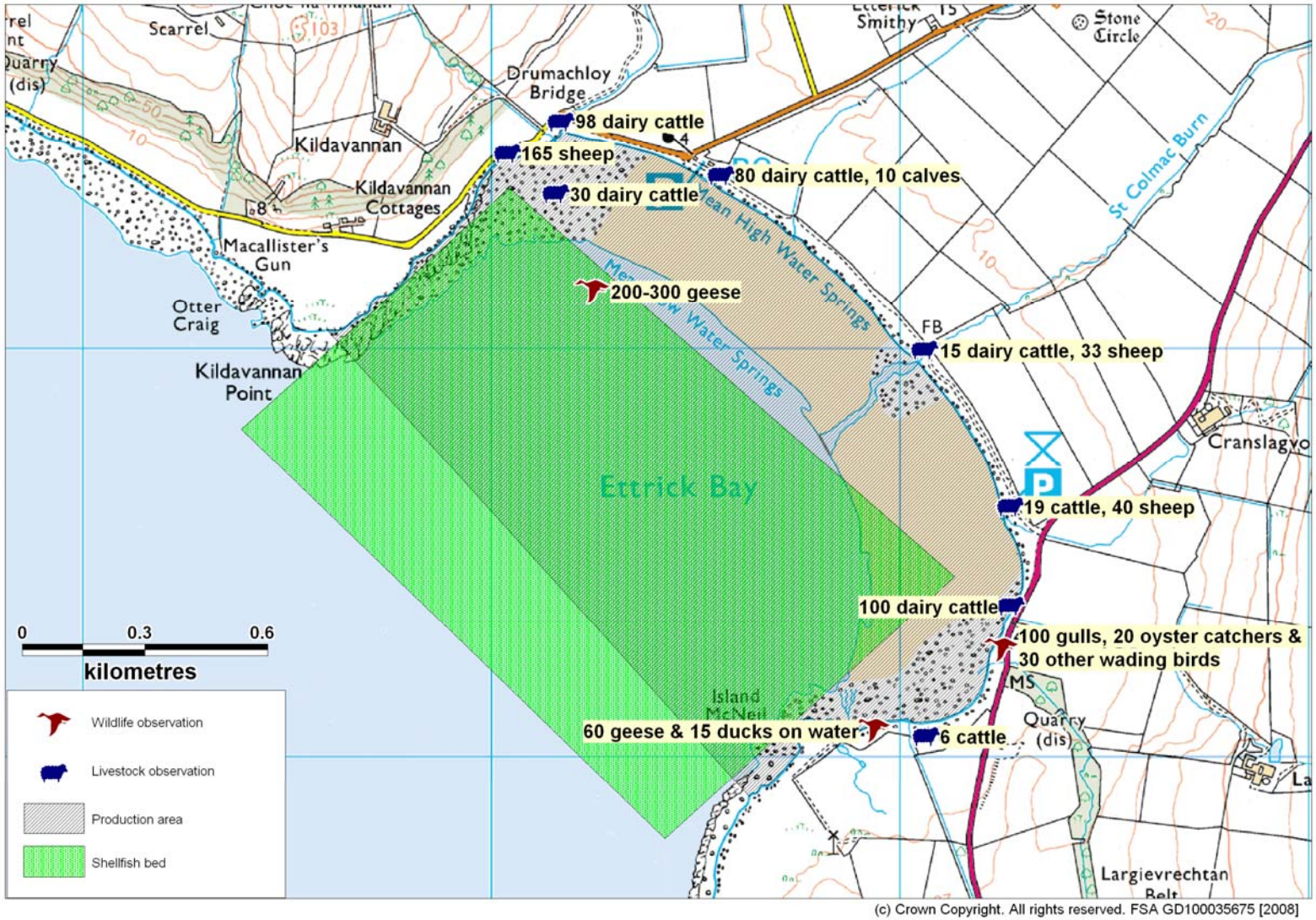

Figure 4.1 Wildlife and livestock observations at Ettrick Bay

5. Rainfall

The nearest weather station is located at Bute, Rothesay, approximately 4.6km southeast of the production area. Rainfall data was supplied for the period 01/01/03 to 30/11/07 (total daily rainfall in mm). For this period of 1795 days, total daily rainfall was not recorded for 8 days. It is likely that the rainfall experienced at Bute, Rothesay is very similar to that experienced at the production area due to their close proximity.

High rainfall and storm events are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or other animals are present, and through sewer and wastewater treatment plant overflows (e.g. Mallin et al, 2001; Lee & Morgan, 2003).

5.1 Rainfall at Bute Rothesay

As the rainfall records from Bute are nearly complete, total annual rainfall and mean monthly rainfall can be calculated, and are presented in Figures 5.1 and 5.2.

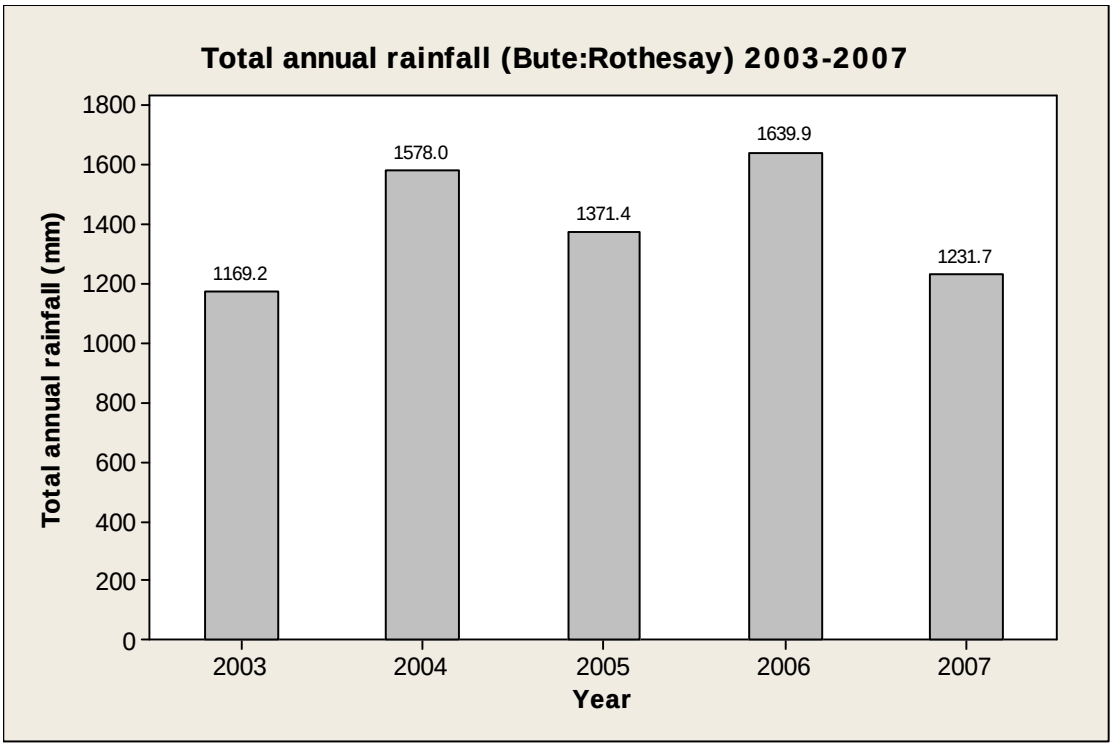

Figure 5.1 Total annual rainfall at Bute: Rothesay 2003 – 2007
(no records for December 2007, plus an additional 6 days in July & 2 days in September).

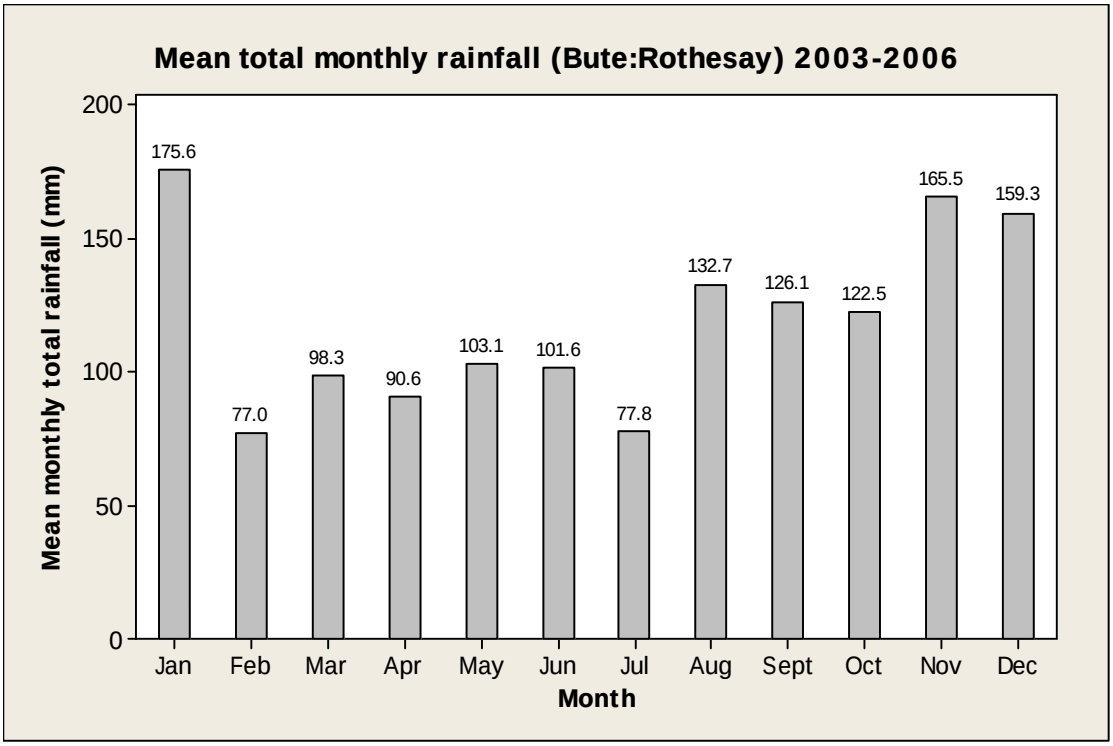

Figure 5.2 Mean total monthly rainfall at Bute: Rothesay 2003 – 2006 (2007 not included due to missing data)

The wettest months were January, November and December. For the period considered here (2003 – 2006), only 39.40% of the days experienced no rainfall. 9.38% of days experienced rainfall of 1mm or less.

It can be expected that levels of rainfall dependent faecal contamination entering the production area from these sources will be higher during the autumn and winter months. It is possible that faecal matter can build up on pastures during the drier summer months when stock levels are at their highest, leading to more significant faecal contamination of runoff at the onset of the wetter weather in the autumn.

6. River Flow

There is no river gauging station in the vicinity of Ettrick Bay. There are 8 streams discharging into Ettrick Bay and their locations can be seen in Figure 6.1. The following streams were sampled during the shoreline survey. These represented the largest freshwater inputs to Ettrick Bay.

Table 6.1 River flow and loadings – Ettrick Bay

No.	Grid Ref	Description	Width (m)	Depth (m)	Measured Flow (m/s)	Flow in m3/day	*E. coli* (cfu/ 100ml)	Loading (*E. coli* per day)
1	NS 04024 65063	Stream	1.15	0.15	0.562	8376.0	3600	3.0E+11
2	NS 04248 65235	Stream	3.30	0.10	0.543	15482.0	5000	7.7E+11
3	NS 04262 65580	Stream	1.20	0.50	0.202	10471.7	3700	3.9E+11
4	NS 04049 65968	St Colmac Burn	7.60	0.20	0.343	45045.5	1800	8.1E+11
5	NS 03730 66285	Stream	2.10	0.50	0.291	26399.5	3700	9.8E+11
6	NS 03164 66497	Stream	7.40	0.23	0.645	94849.1	1800	1.7E+12

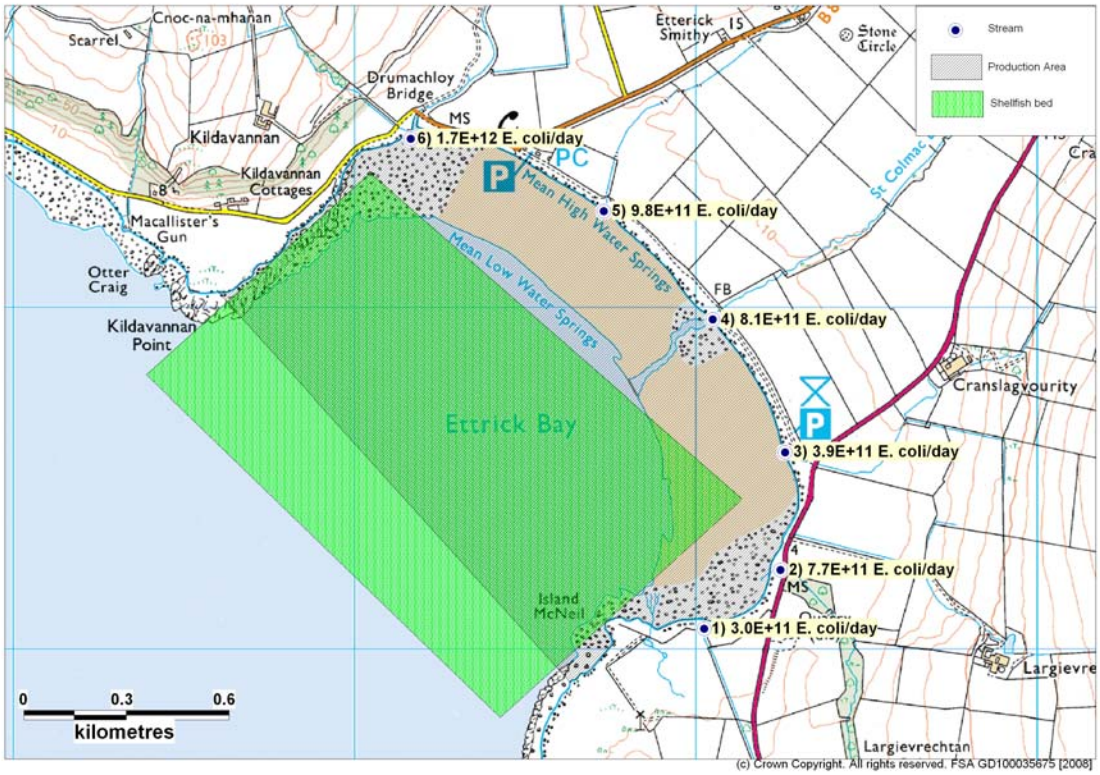

Figure 6.1 Location of river flows and loadings at Ettrick Bay

All of the streams sampled contained between 1800 and 5000 cfu *E.coli*/100 ml, which indicated significant levels of faecal contamination. Calculated loadings are based on the flows and dimensions observed during the shoreline survey only.

7. Historical Monitoring Results

Ettrick Bay has not been previously classified as a shellfish production area and is not a designated Shellfish Growing Water. As such, no historical monitoring data associated with these programs is available for this site.

Ettrick Bay is designated a Bathing Water and there are several years worth of monitoring data associated with this program. Ettrick Bay failed SEPA's bathing water directive standards from 1999 to 2004 due to poor water quality. It then achieved good water quality in 2005 and 2006 but failed again in 2007. In a study of the relationship between the exceedance of bathing water standard and antecedent rainfall, SEPA found that at Ettrick Bay there was a significant positive relationship between high rainfall in the 48 hours prior to sampling and faecal coliform levels sufficiently high to fail mandatory standards. This would seem to indicate that contaminating sources at Ettrick Bay are most likely to end up in rainfall runoff.

7.1 Analysis of bathing water results by recent rainfall

The nearest weather station is located at Bute Rothesay, approximately 4.6km southeast of the production area. Rainfall records were available for the period 01/01/03 to 30/11/07 (total daily rainfall in mm). For this period of 1795 days, total daily rainfall was not recorded for 8 days. Bathing water results were supplied by SEPA for the 2003-2006 period, sampled from the location shown in Figure 7.4. The coefficient of determination was calculated for bathing water results and rainfall in the previous 2 days at Bute Rothesay. Figure 7.1 presents a scatterplot of faecal coliform result and rainfall. Figure 7.2 presents a scatterplot of Faecal Streptoccoci and rainfall. Figure 7.3 presents a scatterplot of Total coliforms and rainfall.

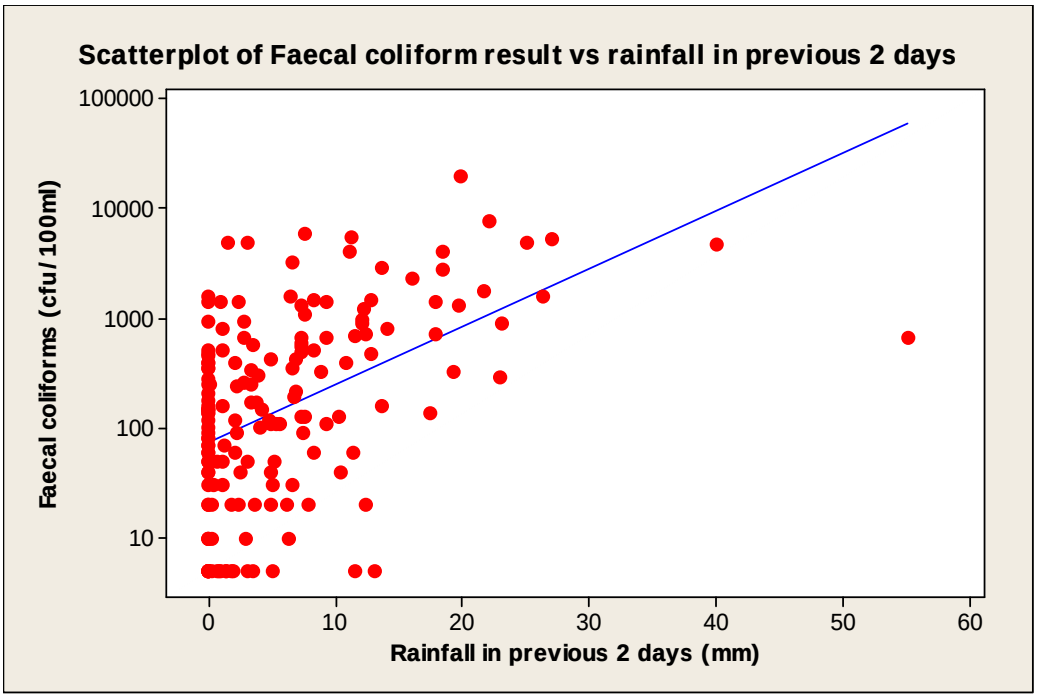

Figure 7.1 Scatterplot of Faecal Coliform results against rainfall in previous 2 days

The coefficient of determination indicates that there was a moderately strong positive relationship between the faecal coliform result and the rainfall in previous two days (Adjusted R-sq=22.5%, p=0.000 Appendix 3).

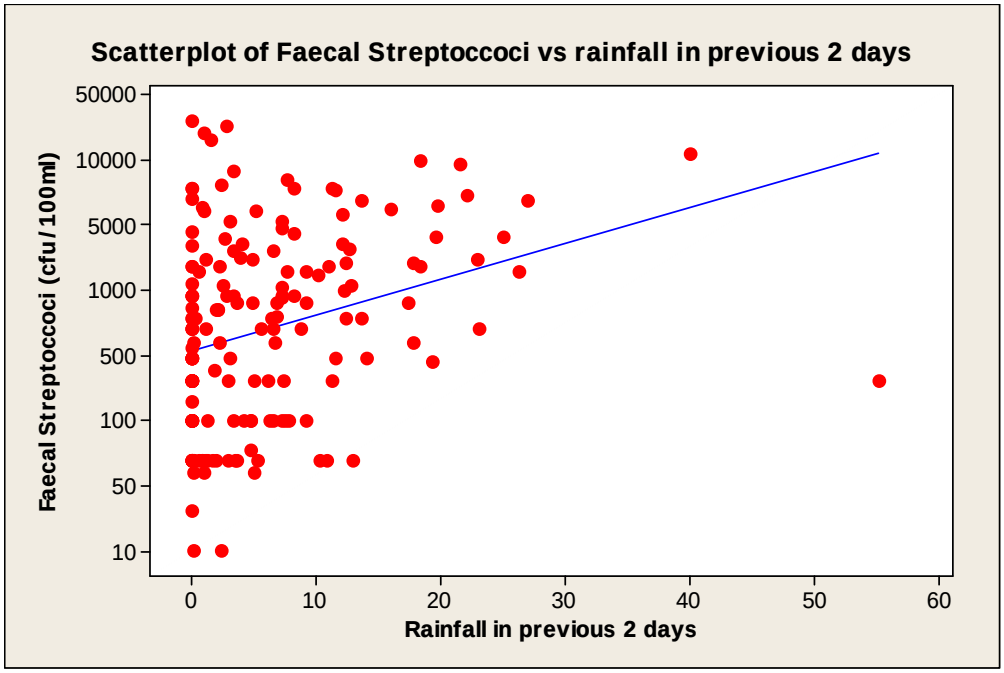

Figure 7.2 Scatterplot of Faecal Streptoccoci results against rainfall in previous 2 days

The coefficient of determination indicates that there was a weak positive relationship between the Faecal Streptoccoci result and the rainfall in previous two days (Adjusted R-sq=8.2%, p=0.000 Appendix 3).

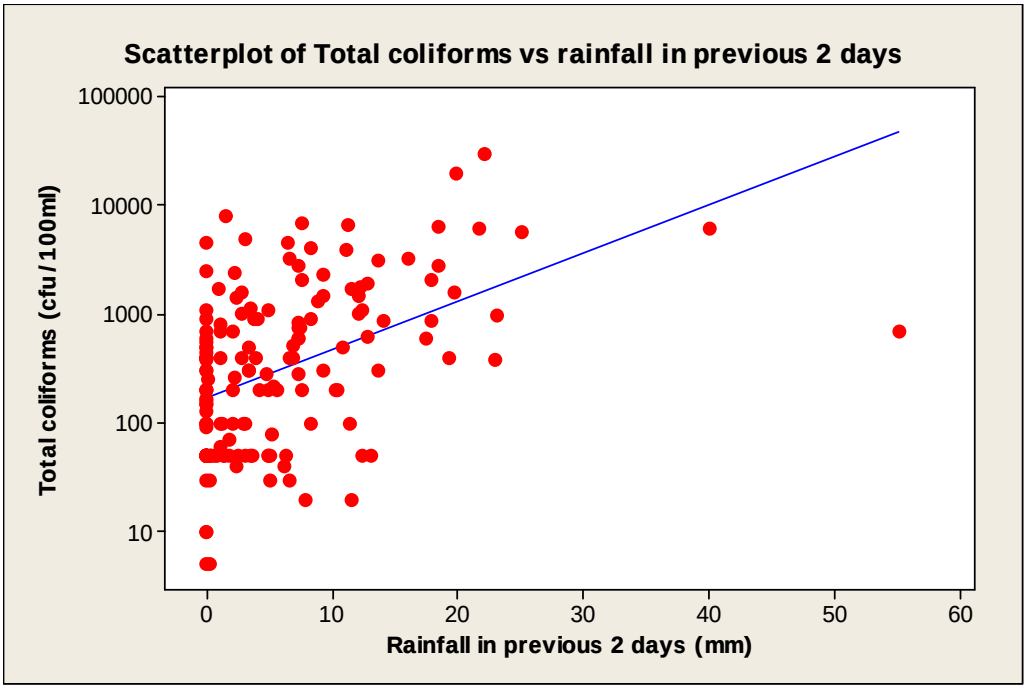

Figure 7.3 Scatterplot of Total Coliform results against rainfall in previous 2 days

The coefficient of determination indicates that there was a moderately strong positive relationship between the Total Coliform result and the rainfall in previous two days (Adjusted R-sq=20.7%, p=0.000 Appendix 3).

This analysis concurred with the Scottish Environment Protection Agency findings (SEPA 2001). Bathing waters data through 2001 were evaluated in relation to antecedent rainfall and a positive correlation between rainfall in the previous 48 hours and Bathing Water monitoring results at Ettrick Bay.

This result is consistent with diffuse pollution entering the fishery via runoff from land.

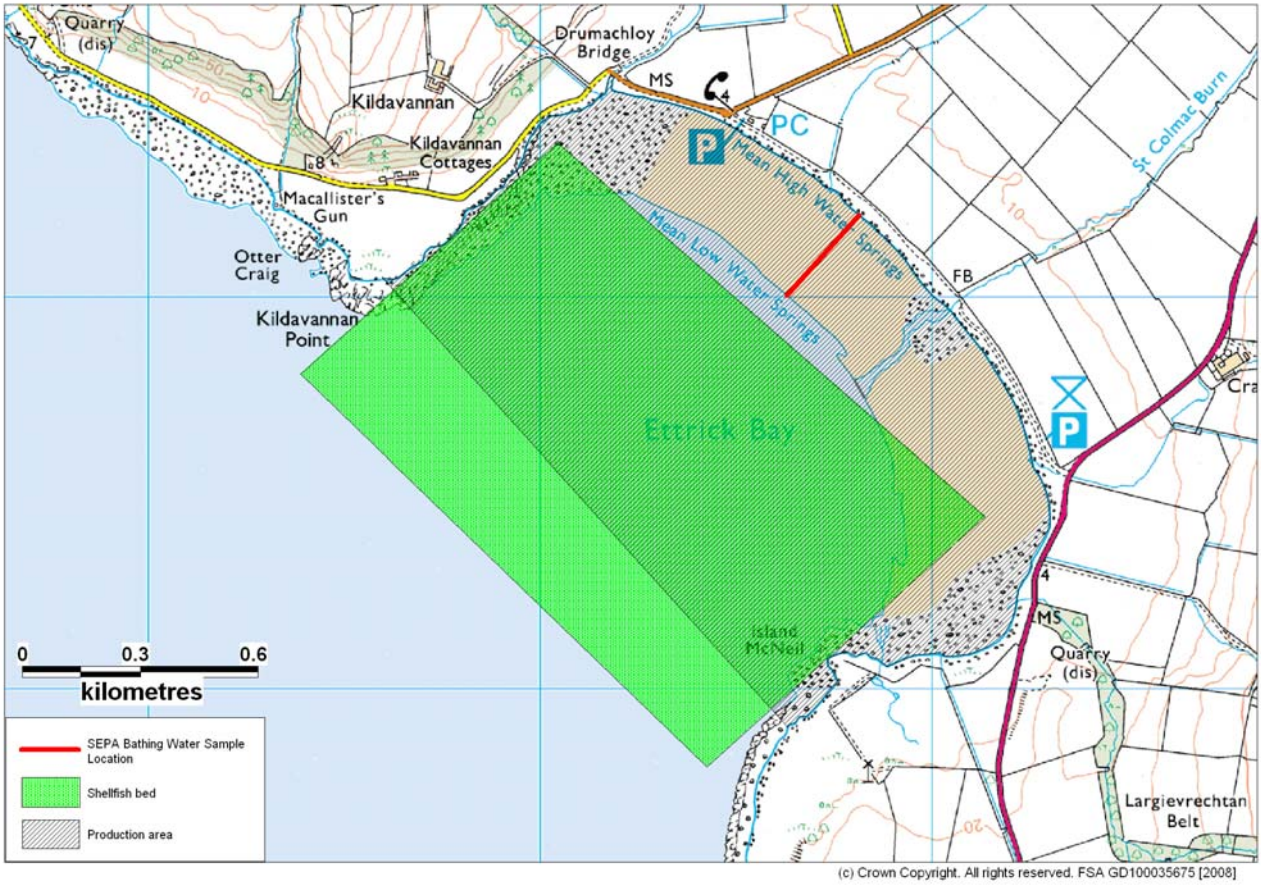

Figure 7.4 Location of the SEPA bathing water sample location

8. Bathymetry and Hydrodynamics

Figure 8.1 Ettrick Bay bathymetry

Figure 8.2 Ettrick Bay

The bathymetry chart in Figure 8.1 shows that there is a large intertidal area directly adjacent to the coastline. Beyond this the depth slopes away to 20 metres depth within 1km of the shoreline. Ettrick Bay has an open aspect to the southwest and would be expected to flush fully with each tidal cycle.

Figure 8.3 Bathymetry for wider vicinity around Ettrick Bay

A broader view of the area as illustrated in Figure 8.3 shows that the band of shallow depth curves runs very close to land, and the bottom profile beyond that slopes more gently to depths greater than 50 metres.

8.1 Tidal curve and description

The two tidal curves below are for the port of Millport, the nearest secondary port– they have been output from UKHO TotalTide. The first is for seven days beginning 00.00 GMT on 11th September 2008. The second is for seven days beginning 00.00 GMT on 19th September 2008. Together they show the predicted tidal heights over high/low water for a full neap/spring tidal cycle.

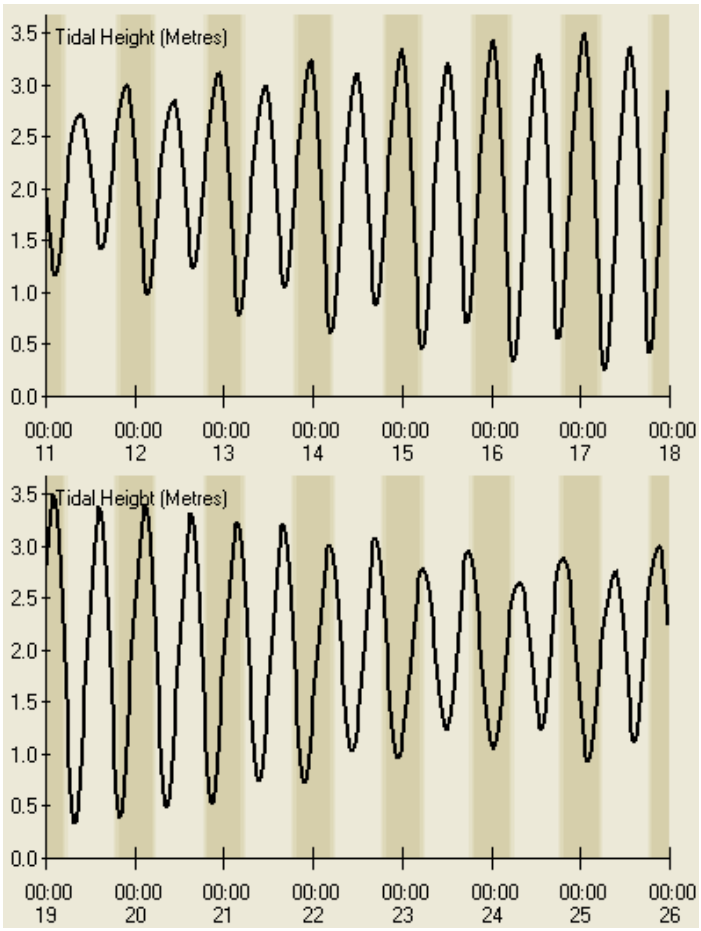

Figure 8.4 Tidal curves for Millport

The following is the UKHO summary description for Millport:
The tide type is Semi-Diurnal.

MHWS	3.4 m
MHWN	2.7 m
MLWN	1.0 m
MLWS	0.4 m

Predicted heights are in metres above chart datum. The tidal range at spring tide is therefore approximately 3 m and at neap tide 2.3 m.

8.2 Tidal stream information

The nearest tidal stream information comes from Inchmarnock Water, approximately 12km southwest of Ettrick Bay (Admiralty chart 2131, Tidal Diamond G). The chart information states that the tidal stream in this area is weak and irregular, with flows of 0.25 knots (0.13 m/s) or less.

All of Ettrick Bay is designated a Foul Area on the chart. According to the Admiralty Chart notes, anchoring and fishing are to be avoided in this area due to the presence of underwater obstructions.

8.3 Conclusions regarding affect on impacting sources

The nearest tidal stream information is from a location over 10 km away from the fishery and so will not be an accurate reflection of flows in and near the fishery itself. Flows may be slightly higher off Ettrick Bay as tidal waters from the West Kyle flow past and join Inchmarnock Water on the outgoing tide.

Tidal flows into and out of the bay are likely to be relatively weak. Wind and density driven flows may have a greater impact on the movement of contaminants within and out of the bay. South-westerly winds predominate along the west coast of Scotland. These would blow directly into Ettrick Bay, potentially mixing and entraining contaminants within the bay.

Strong winds will create a surface current that moves in the same general direction as the wind. These wind driven currents can sometimes create currents moving in different directions to the wind at the seabed.

Currents within the bay are likely to run parallel to shore and move contaminants along the shoreline. Contaminants entering the bay from St. Colmac's Burn are likely to be transported along the shoreline as well as across the shellfish bed on the tide. Without further measurement or modelling, it is not possible to say whether one part of the bay will be more affected than another.

9. Shoreline Survey Overview

A map is presented in Figure 9.1 showing the relative locations of the most significant findings of the shoreline survey. Where the bacterial concentration is labelled, 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 1×10^3, in this case it would be written as 1E+3.

In summary, identified sources of potentially significant contamination are:

- Heavily contaminated freshwater input from streams running through grazed land.
- Inputs from livestock grazing on the shoreline.
- Slurry tanks and dung heap near shoreline.
- The septic tank for the café and public toilets at the southeastern end of the shoreline discharging onto the beach.

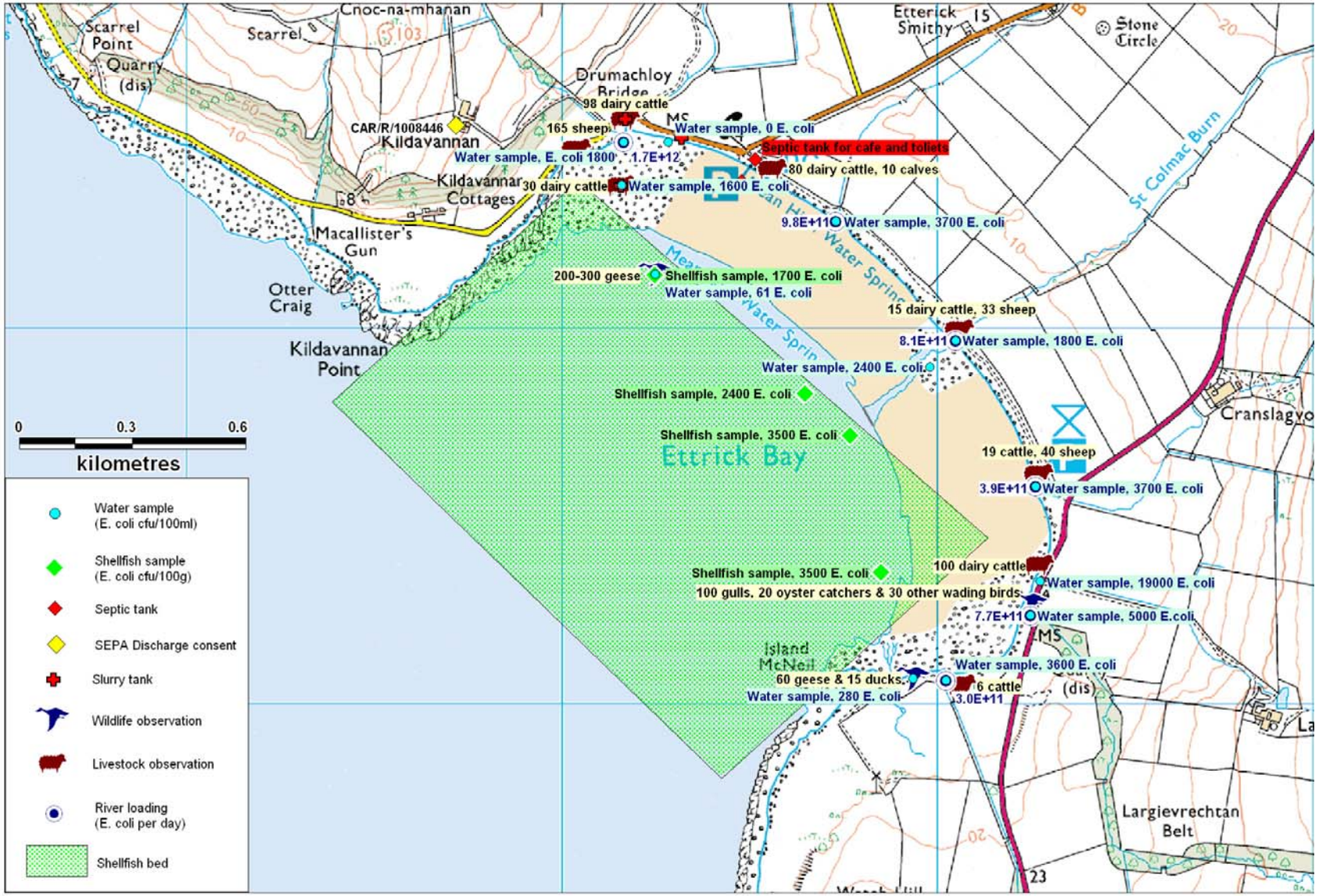

Figure 9.1 Summary of shoreline observations

10. Overall Assessment

Human sewage inputs

With a neighbouring human population at the 2001 census of 298 and with no settlements being in the immediate vicinity of Ettrick Bay, the overall loading of sewage to Ettrick Bay is low. The area is not connected to any mains sewerage. A septic tank was identified during the shoreline survey at the eastern end of the bay near the café and toliets. The outfall pipe for the septic tank was found but this continued into the sea and so could not be directly sampled.

Agricultural inputs

Livestock density in the immediate vicinity of Ettrick Bay was relatively high. During the shoreline survey approximately 350 cattle and 205 sheep were observed grazing in the fields surrounding the bay. This should be considered as a significant source of faecal contamination to the fishery. The location and timing of these said inputs would be unpredictable. Slurry is both collected and spread in the field next to the St Colmac Burn. Slurry spreading can occur at any point throughout the year. A dung heap was observed in a field near the shore.

Wildlife inputs

Wildlife such as seals and waterbirds are likely to be resident in or visit the area. Overall, the wildlife impacts to the fishery at Ettrick Bay are likely to be localised, minor and unpredictable and will therefore not be explicitly taken into account in determining the sampling plan, although impacts from wildlife may sometimes contribute to the bacterial contamination of shellfish. Ducks, geese and gulls were observed in significant numbers and is therefore thought that this would contribute to bacterial contamination of the shellfish at Ettrick Bay.

Seasonal variation

There are no historical *E. coli* monitoring results for Ettrick Bay to establish any patterns of seasonal variation. Livestock numbers in the area as a whole are likely to be at their highest during the summer months when lambs and calves are present. During warmer months the livestock may access the streams discharging into Ettrick Bay to drink and cool off more frequently, which may lead to higher levels of faecal contamination in the water. There is likely to be a slight increase in population during the summer months, but the population will remain at a relatively low level density nevertheless.

Rivers and streams

In total six fresh water streams discharge into Ettrick Bay. Water samples were taken from all six streams and *E. coli* results were high varying from 1800 to 5000 *E. coli* cfu/100ml. The river loading results indicated that the streams discharging into the eastern end of the bay, including St Colmac Burn had higher loadings than the streams at the western end of the bay. It is therefore likely that the freshwater

inputs into Ettrick Bay at the eastern end will have a relatively high effect on the bacterial contamination of shellfish.

Rainfall

Rainfall patterns at Bute, Rothesay (the nearest rainfall station) show rainfall is highest from August to January. An increase in rainfall in August after the drier summer months may be expected to wash a flush of bacteria from the surrounding land into the production area.

Analysis of results

Seawater samples were taken from four points in the bay ranged from 61 to 2400 *E. coli* cfu/100ml. The first sample was taken at the western end of the bay and had a result of 280 *E. coli* cfu/100ml . The sample with the highest result of 2400 *E. coli* cfu/100ml was taken just below the mouth of the St Colmac Burn. The remaining two samples were taken close to the mouth of the stream at the far eastern end of the bay and had results of 1600 and 1800 *E. coli* cfu/100ml.

Shellfish samples were taken from four points along the Razor bed during the shoreline survey. The sample taken from the far eastern side of the bay had a result of 1700 *E. coli*/100g and the sample taken from the far western end of the bay had a result of 3500 *E. coli*/100g. Two samples were taken close to the discharge point of the St Colmac Burn and provided results of 2400 and 3500 *E. coli*/100g. Shellfish samples were taken toward the end of an outgoing spring tide.

As noted in the previous section the level of contamination and calculated bacterial loading for the streams entering Ettrick Bay is relatively high.

Summary

Factors of particular relevance to the sampling plan are as follows:

- Location of septic tank and outfall pipe (for the café and toilets) at the south eastern end of the bay.
- Location of all the streams that discharge into the bay, especially St Colmac Burn.
- Location of dung heap south of St. Colmac Burn.
- Higher levels of contamination found in shellfish samples collected from the south-eastern side of the fishery.

11. Recommendations

It is recommended that the boundaries of the new Ettrick Bay razor fish production area be set as the area bounded by lines drawn between NS 03522 64480, NS 02211 65774, NS 02596 66048 and then extended to MHWS.

The RMP should be placed close to St Colmac Burn at NS 03746 65598 (see Figure 11.1) with a 150 m tolerance.

Sampling frequency should be monthly as there is inadequate monitoring history on which to base less frequent sampling.

Figure 11.1 illustrates the recommended RMP and new production area boundaries for Ettrick Bay.

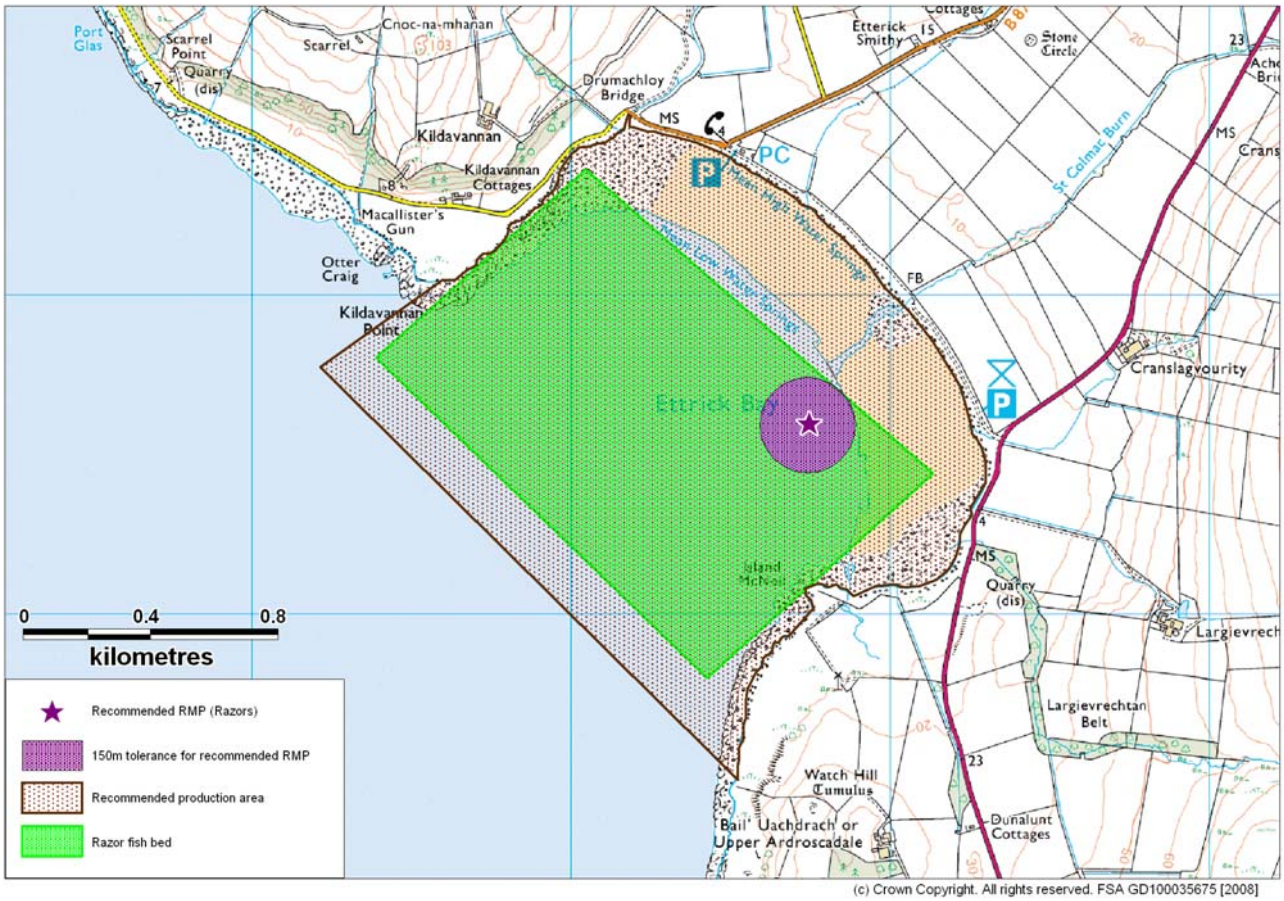

Figure 11.1 Recommendations for Ettrick Bay

Note: Sample submission for the bacteriological monitoring program was reviewed on 17/12/2009. All samples were found to have come from well within the boundary of the tolerance zone described above. Therefore, the tolerance zone applied above has so far been adequate to allow for collection of sufficient samples to satisfy bacteriological monitoring requirements and no further changes to either RMP or zone are recommended at this time.

12. References

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13. List of Figures and Tables

Figures

Tables

Appendices

1. **Summary Sampling Plan**
2. **Shoreline Survey Report**
3. **Statistical Data**

Sampling Plan for Ettrick Bay

PRODUC-TION AREA	SITE NAME	SIN	SPECIES	TYPE OF FISHERY	NGR OF RMP	EAST	NORTH	TOLER-ANCE (M)	DEPTH (M)	METHOD OF SAMPLING	FREQ OF SAMPLING	LOCAL AUTHORITY	AUTHORISED SAMPLER(S)	LOCAL AUTHORITY LIAISON OFFICER
Ettrick Bay	Ettrick Bay	AB 389	Razors	Wild harvest	NS 03746 65598	203746	665598	150	NA	Hand	Monthly	Argyll & Bute	Christine McLachlan William MacQuarrie Ewan McDougall Donald Campbell	Christine McLachlan

Shoreline Survey Report

Ettrick Bay
AB 389

Restricted Scottish Sanitary Survey Project

Shoreline Survey Report

Production area:	Ettrick Bay
Site name:	Ettrick Bay
Species:	Razor fish
Harvester:	Hector Stewart
Local Authority:	Argyll and Bute Council
Status:	New site
Date Surveyed:	11/09/08 and 17/09/08
Surveyed by:	Christine McLachlan (11/09/08) and William MacQuarrie (11/09/08 & 17/09/08)
Existing RMP:	N/A
Area Surveyed:	See Figure 1

Weather observations

11/09/08 – Cloudy, dry with sunny spells. Previous rain, some heavy. Wind S, Force 6, Seas choppy
17/09/08 – Cloudy, dry, Wind SE Force 1. Heavy rain previous 2 days.

Site Observations

Fishery

This site is a wild shellfishery. Razor fish are found scattered throughout the bay however the part of the bay harvested by harvester is the area bounded by lines drawn between NS 02387 65803, NS 03043 66394, NS 04134 65441 and NS 03425 64800. Stock of sufficient size and quantity was present for sampling.

Sewage/Faecal Sources

The Ettrick Bay public toilets septic tank is located at NS 03514 66450. The outfall of this septic tank was located at NS 03479 66393 and runs into the bay, however the end of the pipe could not be located as it continues far into the bay. There were also several slurry tanks and two cast iron pipes visible close to the shoreline.

Seasonal Population

The Isle of Bute is traditionally a summer holiday destination however there are no campsites near Ettrick Bay. The beach is expected to have an increase in visitors over summer months, however exact figures are not known.

Boats/Shipping

There were no boats visiting the area on the day of the shoreline survey.

Land Use

The land use surrounding Ettrick Bay was primarily used for agricultural purposes, mainly dairy and sheep farming.

Wildlife/Birds

During the survey roughly 350 geese were spotted on the shoreline and water. There were also 15 ducks, 100 gulls, 20 oyster catchers and 30 other wading birds spotted along the shoreline.

Observations can be found in Table 1.

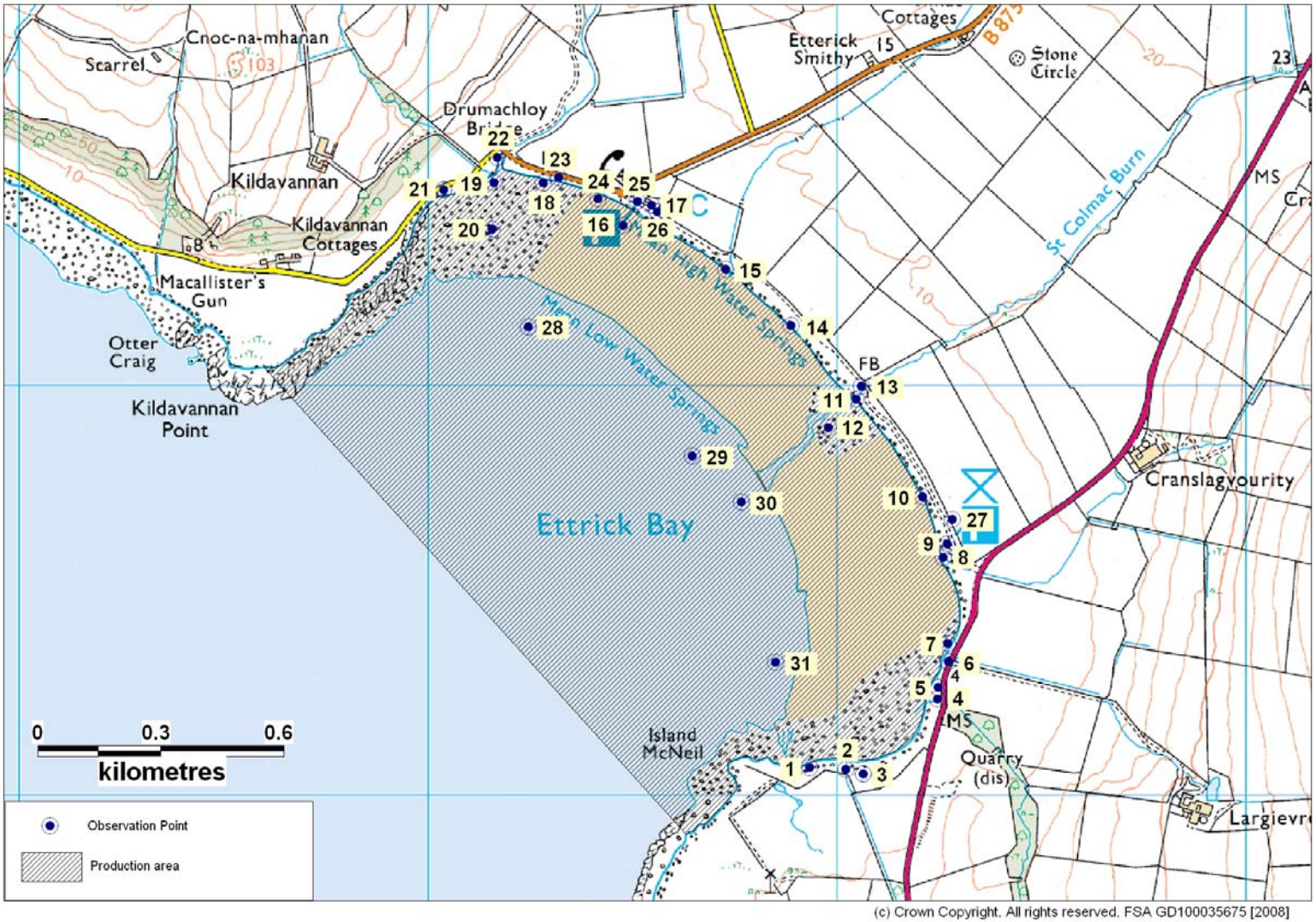

Figure 1 Shoreline observations

Table 1. Shoreline observations

No.	Date	Time	NGR	East	North	Associated photograph	Description
1	11.09.08	13:22	NS 03935 65067	203935	665067	Figure 5	Seawater 1, salinity 34 ppt, 60 geese and 15 ducks on water,
2	11.09.08	13:36	NS 04024 65063	204024	665063		Stream – 115cm x 15cm x 0.562, Freshwater sample 2
3	11.09.08	13:38	NS 04066 65052	204066	665052		Farmhouse, 6 cows in field
4	11.09.08	13:45	NS 04248 65235	204248	665235	Figure 6	Stream – 330cm x 10cm x 0.543, Fresh water sample 3
5	11.09.08	13:48	NS 04249 65264	204249	665264		Birds on shore; .100 gulls, 20 oyster catchers and 30 other wading birds. Significant number of cockle shells and some mussels shells
6	11.09.08	13:52	NS 04275 65326	204275	665326	Figure 7	Stream under road, pipe 45cm diameter. Freshwater sample 4.
7	11.09.08	13:53	NS 04274 65371	204274	665371	Figure 8	Dairy farm & house. ~ 100 dairy cattle
8	11.09.08	14:00	NS 04262 65580	204262	665580		Stream – 120cm x 50cm x 0.202, Freshwater sample 5.
9	11.09.08	14:02	NS 04272 65614	204272	665614		Farmhouse, 9 cows & 40 sheep plus additional 10 cows on horizon
10	11.09.08	14:04	NS 04212 65729	204212	665729		Sanitary debris in high tide mark
11	11.09.08	14:10	NS 04049 65968	204049	665968	Figure 10	St Colmac Burn – 760cm x 20cm x 0.343. Freshwater sample 6
12	11.09.08	14:15	NS 03981 65898	203981	665898		Seawater sample 7, Salinity=10ppt
13	11.09.08	14:19	NS 04062 65999	204062	665999	Figure 9	15 dairy cows & 33 sheep. Slurry spreading in field to right.
14	11.09.08	14:21	NS 03890 66147	203890	666147		Sanitary debris in the high tide mark
15	11.09.08	14:22	NS 03730 66285	203730	666285	Figure 11	Stream – 210cm x 50cm x 0.291, Freshwater sample 8, brown scum visible at side of stream
16	11.09.08	14:35	NS 03479 66393	203479	666393	Figure 12	Outflow pipe (could not see end of pipe), café and toilets in background.
17	11.09.08	1438	NS 03548 66441	203548	666441		Public Toilets and cafe
18	11.09.08	14:45	NS 03283 66497	203283	666497		Plastic onto cast iron water pipe, flowing, 20cm diameter, Freshwater 9.
19	11.09.08	14:50	NS 03164 66497	203164	666497		Burn – 740cm x 22.5cm x 0.645, Freshwater sample 10
20	11.09.08	14:55	NS 03159 66382	203159	666382	Figures 13 & 14	Seawater sample 11, salinity=25ppt. Farm, house and slurry tank to the north plus 30 daily cattle.
21	11.09.08	14:59	NS 03041 66479	203041	666479		125 sheep in field, 40 in field behind
22	11.09.08	15:02	NS 03171 66558	203171	666558		Farm, house and slurry tank, 98 dairy cows
23	11.09.08	15:04	NS 03321 66509	203321	666509		Farm, house and slurry tank. Cattle and sheep in distance (too far to count)
24	11.09.08	15:08	NS 03418 66457	203418	666457		Cast iron pipe, not flowing, may be broken.

No.	Date	Time	NGR	East	North	Associated photograph	Description
25	11.09.08	15:10	NS 03514 66450	203514	666450		Septic tank for café & public toilets
26	11.09.08	15:12	NS 03563 66426	203563	666426		10 calves and 80 dairy cattle in field behind
27	11.09.08	15:29	NS 04285 65674	204285	665674	Figure 16	Dung heap in field.
28	17.09.08	08:35	NS 03248 66144	203248	666144		Ettrick Razor sample 1, Seawater sample 5, 200 – 300 Geese on Ettrick Beach. Strong smell of slurry in the wind
29	17.09.08	08:45	NS 03648 65828	203648	665828		Ettrick Razor sample 2
30	17.09.08	08:55	NS 03769 65717	203769	665717		Ettrick Razor sample 3
31	17.09.08	09:10	NS 03852 65325	203852	665325		Ettrick Razor sample 4

Photographs referenced in the table can be found attached as Figures 4 - 16.

Sampling

Water and shellfish samples were collected at sites marked on the map. Bacteriology results follow in Tables 2 and 3.

Four Razor samples were taken during the shoreline survey. The first sample was taken at the western end of the bay. The second and third samples were taken close to the mouth of the St Colmac burn and the fourth sample was taken at the eastern end of the bay (see Figure 3). In total, twelve water samples were taken. Two were taken from the mouth of the St Colmac Burn along the shellfish samples and a further nine were taken from streams discharging into the bay.

Seawater samples were tested for salinity using a hand held refractometer. These recordings are recorded in Table 1 as salinity in parts per thousand (ppt).

Samples were also tested for salinity by the laboratory using a salinity meter under more controlled conditions. These results are shown in Table 2, given in units of grams of salt per litre of water. This is the same as ppt.

Table 2. Water sample results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100 ml)	Salinity (g/L)
1	11.09.08	FW1	NS 03935 65067	Seawater	280	30.0
2	11.09.08	FW2	NS 04024 65063	Freshwater	3600	
3	11.09.08	FW3	NS 04248 65235	Freshwater	5000	
4	11.09.08	FW4	NS 04275 65326	Freshwater	19000	
5	11.09.08	FW5	NS 04262 65580	Freshwater	3700	
6	11.09.08	FW6	NS 04049 65968	Freshwater	1800	
7	11.09.08	FW7	NS 03981 65898	Seawater	2400	9.5
8	11.09.08	FW8	NS 03730 66285	Freshwater	3700	
9	11.09.08	FW9	NS 03283 66497	Freshwater	0	
10	11.09.08	FW10	NS 03164 66497	Freshwater	1800	
11	11.09.08	FW11	NS 03159 66382	Seawater	1600	22.1
12	17.09.08	Ettrick Bay 5	NS 03248 66144	Seawater	61	29.3

Table 3. Shellfish sample results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100g)
1	17.09.08	Ettrick Razor sample 1	NS 03248 66144	Razor clam	1700
2	17.09.08	Ettrick Razor sample 2	NS 03648 65828	Razor clam	2400
3	17.09.08	Ettrick Razor sample 3	NS 03769 65717	Razor clam	3500
4	17.09.08	Ettrick Razor sample 4	NS 03852 65325	Razor clam	3500

Figure 2 Water sample results

Figure 3 Shellfish sample results

Photographs

Figure 4 Ettrick Bay

Figure 5 Collection point of seawater sample 1

Figure 6 Collection point of freshwater sample 3

Figure 7 Collection point of freshwater sample 4

Figure 8 Dairy house and farm on the hill

Figure 9 Slurry spreading on adjacent field

Figure 10 St Colmac Burn, collection point of freshwater sample 6

Figure 11 Collection point of freshwater sample 8, brown scum at the side of stream

Figure 12 Outflow pipe, end not visible

Figure 13 Collection point of seawater sample 11

Figure 14 Farm house and slurry tank to the north plus 30 dairy cattle

Figure 15 Ettrick Bay

Figure 16 Dung heap in field

Statistical Data

Minitab Output:

Regression Analysis: LogResult FC versus Prev 2 days

```
The regression equation is
LogResult FC = 1.86 + 0.0529 Prev 2 days


Predictor        Coef   SE Coef      T      P
Constant      1.85603   0.07462  24.87  0.000
Prev 2 days  0.052913  0.007525   7.03  0.000


S = 0.772107   R-Sq = 23.0%   R-Sq(adj) = 22.5%


Analysis of Variance

Source           DF       SS      MS      F      P
Regression        1   29.478  29.478  49.45  0.000
Residual Error  166   98.961   0.596
Total           167  128.439


Unusual Observations

     Prev 2  LogResult
Obs    days         FC     Fit  SE Fit  Residual  St Resid
  1     3.1     3.6902  2.0201  0.0634    1.6701      2.17R
 71    13.0     0.6990  2.5439  0.0797   -1.8449     -2.40R
 98     1.5     3.6990  1.9354  0.0684    1.7636      2.29R
 99    40.0     3.6812  3.9725  0.2629   -0.2913     -0.40 X
100    55.1     2.8261  4.7715  0.3744   -1.9455     -2.88RX
108    25.0     3.6990  3.1789  0.1551    0.5201      0.69 X
128    26.3     3.2041  3.2476  0.1642   -0.0435     -0.06 X
138    11.5     0.6990  2.4645  0.0727   -1.7656     -2.30R
146    27.0     3.7324  3.2847  0.1691    0.4477      0.59 X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
```

Regression Analysis: LogResult FS versus Prev 2 days

```
The regression equation is
LogResult FS = 1.54 + 0.0274 Prev 2 days


Predictor        Coef   SE Coef      T      P
Constant      1.53736   0.06828  22.51  0.000
Prev 2 days  0.027389  0.006886   3.98  0.000


S = 0.706596   R-Sq = 8.7%   R-Sq(adj) = 8.2%


Analysis of Variance

Source           DF       SS      MS      F      P
Regression        1   7.8983  7.8983  15.82  0.000
Residual Error  166  82.8800  0.4993
Total           167  90.7784
```

Unusual Observations

Obs	Prev 2 days	LogResult FS	Fit	SE Fit	Residual	St Resid
6	0.2	0.0000	1.5428	0.0675	-1.5428	-2.19R
37	1.0	3.2041	1.5647	0.0644	1.6394	2.33R
51	2.4	0.0000	1.6031	0.0598	-1.6031	-2.28R
98	1.5	3.1584	1.5784	0.0626	1.5799	2.24R
99	40.0	3.0492	2.6329	0.2406	0.4163	0.63 X
100	55.1	1.3010	3.0465	0.3427	-1.7455	-2.82RX
108	25.0	2.4150	2.2221	0.1419	0.1929	0.28 X
123	2.8	3.2577	1.6140	0.0587	1.6436	2.33R
128	26.3	2.1461	2.2577	0.1502	-0.1116	-0.16 X
139	0.0	3.3010	1.5374	0.0683	1.7637	2.51R
146	27.0	2.6902	2.2769	0.1547	0.4133	0.60 X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

Regression Analysis: LogResult TC versus Prev 2 days

The regression equation is
LogResult TC = 2.22 + 0.0443 Prev 2 days

Predictor	Coef	SE Coef	T	P
Constant	2.22340	0.06510	34.15	0.000
Prev 2 days	0.044336	0.006754	6.56	0.000

S = 0.661674 R-Sq = 21.2% R-Sq(adj) = 20.7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	18.864	18.864	43.09	0.000
Residual Error	160	70.050	0.438		
Total	161	88.914			

Unusual Observations

Obs	Prev 2 days	LogResult TC	Fit	SE Fit	Residual	St Resid
1	3.1	3.6990	2.3608	0.0551	1.3381	2.03R
6	0.2	0.6990	2.2323	0.0643	-1.5333	-2.33R
12	0.0	3.6628	2.2234	0.0651	1.4394	2.19R
95	1.5	3.8976	2.2899	0.0596	1.6077	2.44R
96	40.0	3.7853	3.9968	0.2368	-0.2115	-0.34 X
97	55.1	2.8451	4.6663	0.3370	-1.8212	-3.20RX
105	25.0	3.7634	3.3318	0.1397	0.4316	0.67 X
134	11.5	1.3010	2.7333	0.0647	-1.4322	-2.17R
146	23.1	2.9956	3.2475	0.1279	-0.2519	-0.39 X
148	0.0	0.6990	2.2234	0.0651	-1.5244	-2.32R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.