

Shellfish Water Quality Investigation Report

Beaulieu River



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1 Background

Beaulieu River (Figure 1) has shown poor compliance with the faecal coliform guideline standard of the Shellfish Waters Directive (SWD; 300 faecal coliforms/100g shellfish flesh) since its designation in 1999 (Table 1). Median levels of faecal coliforms in the water column were however low (median <10) during the period 2001–2008 (Acornley et al., 2010).

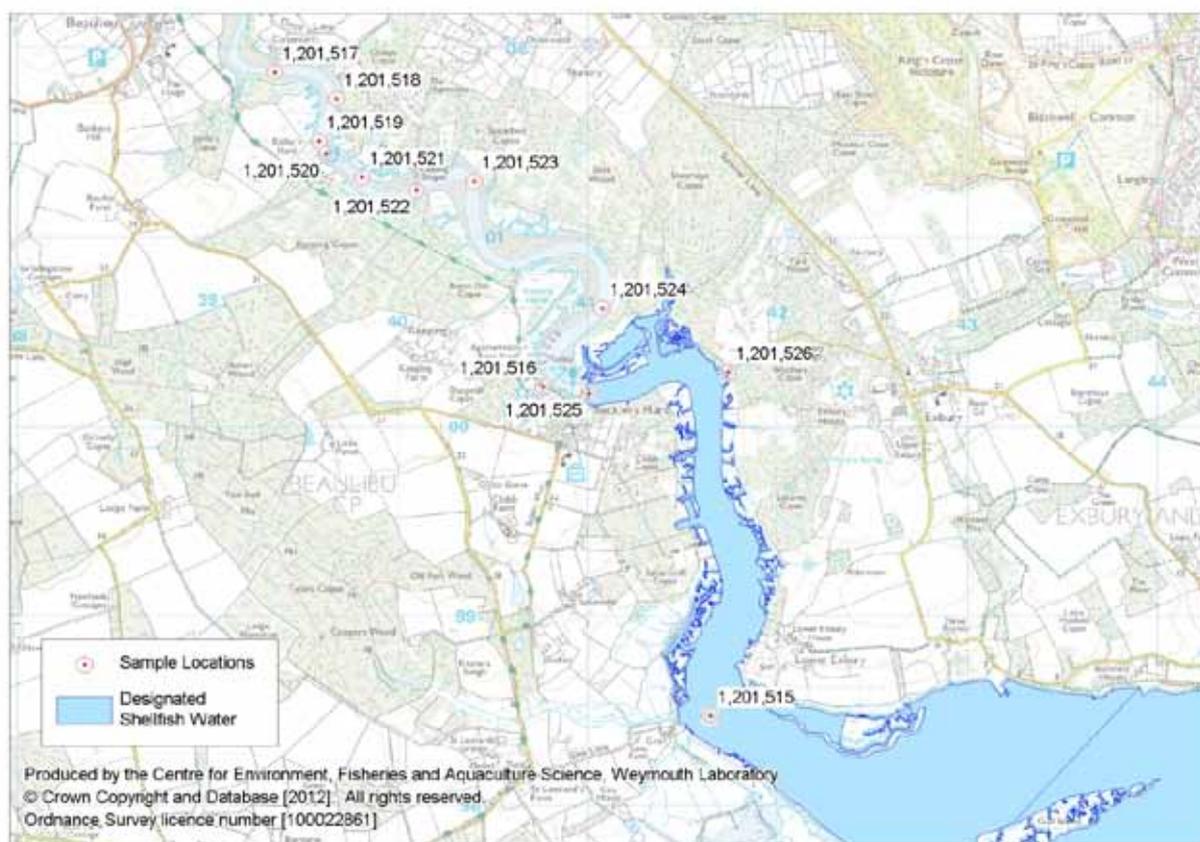


Figure 1. Beaulieu River shellfish water showing locations of sites sampled for the purposes of this investigation. Legends of sampling points represent sites listed in Table 5.

Median levels of faecal coliforms in the water column showed an increasing trend during the period 2001–2008 (Acornley et al., 2010).

Table 1. Historical compliance of Beaulieu shellfish water with the guideline faecal coliform standard of the Shellfish Waters Directive, 2000–2011.

Year of designation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1999	Fail	Pass	Fail	Fail	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Fail*

Source: Environment Agency. * indicates shortfall in compliance data.

Native oysters in Bucklers Hard and Needs Ore were declassified under Regulation (EC) No 854/2004 in 2011 due to insufficient harvestable stocks (Cefas, 2011). As of February 2012, the production area for Manila clams in Baileys Hard had achieved class C (Table 2).

The Environment Agency (EA) Pollution Reduction Plan refers that the most significant sources of faecal contamination impacting upon the shellfish water are discharges from sewerage infrastructure and diffuse pollution from agricultural land (Environment Agency, 2009). Additional, less significant, potential sources of contamination include large breeding and wintering bird populations and sewage inputs from boats (Cefas, 2009).

This report summarises the main results of desk-based and field investigations carried out by the EA and Cefas in 2011 aimed to quantify the contribution of point and diffuse sources of pollution affecting the microbiological quality of the shellfish water. The specific objectives of these investigations were to:

- § Determine the impact of sewage discharges upon the quality of the shellfish water.
- § Obtain information on the location and extent of shellfish beds.
- § Recommend measures to help ensure that faecal coliform concentrations meet the guideline standard of the SWD.

Table 2. Classifications of shellfish harvesting areas under Regulation (EC) No 854/2004.

Bed name	Bed ID	Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bucklers Hard	B023A	<i>O. edulis</i>	C ¹	C	B	B	B	B ^{1&2}	B-LT	B-LT	B-LT	B-LT	B-LT	DC
Needs ore	B023B	<i>O. edulis</i>	C ¹	B ¹	B	B	B	B-LT	B-LT ¹	B-LT ¹	B-LT ¹	B-LT ²	B-LT	DC
Bailey's Hard	B023E	<i>Tapes</i> spp.	-	-	-	-	-	-	-	-	-	-	-	C ¹

* Seasonal classification applied. A 'seasonal classification' is normally considered when sampling results indicate a clear and consistent period when the shellfish are of a quality to be harvested compared to the rest of the year.

1 – Classification was provisional due to insufficient sample results, either in number or period of time covered.

2 – Production area was classified at higher level due to results close to the tolerance limit.

DC – declassified.

B-LT – long-term class B. The long-term classification system was introduced in England and Wales alongside the annual classification system and applies to class b areas only. New class b areas will initially be given annual classification until they meet the criteria for a long-term classification.

2 Sources of microbiological pollution

2.1 Sewage discharges

Waste-water treatment facilities in the Beaulieu River catchment are provided by Southern Water Services Ltd. (SWS), although there are also a number of private discharges to the estuary. The water company operates four sewage treatment works [Bucklers Hard STW (approximately 250m from the shellfish water boundary); Beaulieu Village STW (approximately 4km from the shellfish water), Beaulieu Hummicks STW (approximately 2km from the shellfish water) and East Boldre STW (approximately 5km from the shellfish water)] which discharge secondary treated sewage effluent (Table 3; Figure 2). There are two other private discharges (National Motor Museum and Agamemnon Boatyard) which also discharge secondary treated effluent into the river. Typical levels of faecal coliforms in secondary treated sewage effluent under base and high flow conditions as observed in a range of effluents by Kay *et al.* (2008) are 3.3×10^5 and 5×10^5 cfu 100ml⁻¹ (geometric mean).

In addition to these continuous discharges, there are three intermittent discharges (IDs) [including combined sewer overflows (CSOs) and pumping station overflows], which discharge directly to the shellfish water. The typical geometric mean faecal coliform concentrations in storm sewage overflows is 2.5×10^6 cfu 100ml⁻¹ (Kay *et al.*, 2008).

Event/duration monitoring is currently in place in Palace Lane CSO and Beaulieu Village STW CSO (Environment Agency, 2009). Event/duration monitoring was also installed at Fire Station Lane CSO in 2010. The sanitary survey assessment of shellfish production areas in the Beaulieu River undertaken by Cefas refers that there would be other small (<5m³/day) consented discharges from domestic properties (septic tanks and package treatment plants) and unconsented discharges from domestic properties that are not connected to the sewerage network (Cefas, 2009).

The monitoring data supplied by SWS has been reviewed by the EA to assess if further improvements are required such as increasing the volume of storage to limit the spill frequency for unsatisfactory CSOs¹. An inspection of event monitoring data for Beaulieu Village STW undertaken

¹ The Government (Urban Waste Water Treatment (England and Wales) Regulations Guidance Note, July 1997 states that a CSO is “unsatisfactory” if it:

§ Causes significant visual or aesthetic impact due to solids, fungus and has a history of justified public complaint;

by Cefas for the period 2006–2008 revealed that this asset frequently discharges storm water in excess of 10 spills per annum on average (Cefas, 2009), which is the maximum determined under the EA discharge consenting guidance for discharges impacting upon shellfish waters.

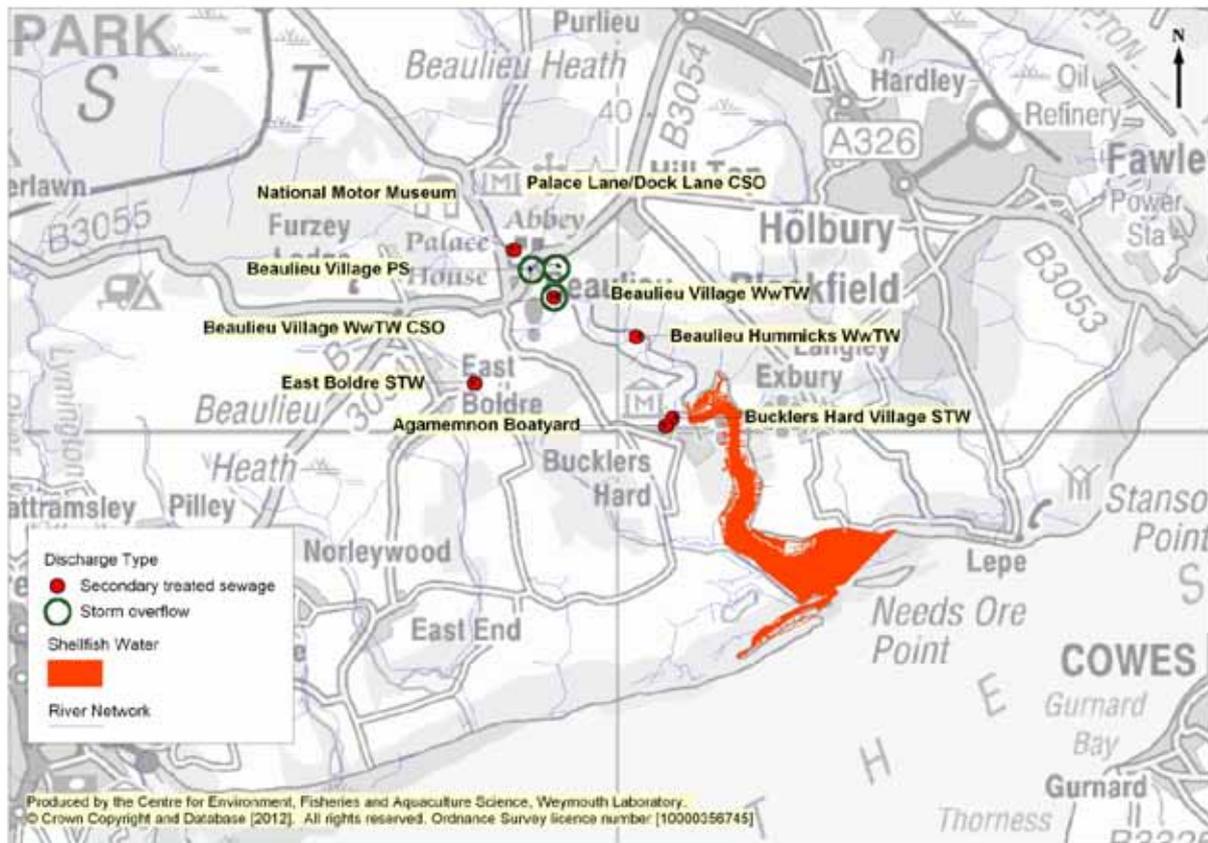


Figure 2. Significant continuous and intermittent sewage discharges to Beaulieu shellfish water.

- § Causes or makes a significant contribution to a deterioration in river chemical or biological class;
- § Causes or makes a significant contribution to a failure to comply with Bathing Water Quality Standards for identified bathing waters;
- § Operates in dry weather conditions;
- § Operates in breach of consent conditions provided that they are still appropriate;
- § Causes a breach of water quality standards (EQS) and other EC Directives.

Table 3. Significant continuous and intermittent discharges to Beaulieu shellfish water.

Discharge name	Receiving water	NGR (outlet)	DWF (m ³ /day)	Maximum flow rate (m ³ /day)	Discharge type
East Boldre STW	Beaulieu River	SU 37862 00706	278	13.0	Secondary treated sewage
Beaulieu Village WwTW	Beaulieu River	SU 39130 01900	216	7.5	Secondary treated sewage
National Motor Museum	Beaulieu River	SU 38570 02570	50	N/A	Secondary treated sewage
Bucklers Hard Village STW	Beaulieu River	SU 40780 00200	38	N/A	Secondary treated sewage
Agamemnon Boatyard	Beaulieu River	SU 40690 00100	10	N/A	Secondary treated sewage
Beaulieu Hummicks WwTW	Beaulieu River	SU 40093 01265	Descriptive	N/A	Secondary treated sewage
Beaulieu Village PS	Beaulieu River	SU 38824 02286	N/a	N/A	Storm overflow
Beaulieu Village WwTW CSO	Beaulieu River	SU 39130 01900	N/a	N/A	Storm overflow
Palace Lane/Dock Lane CSO	Beaulieu River	SU 39160 02310	N/a	N/A	Storm overflow

CSO – combined sewer overflow; SPS – sewage pumping station; WwTW – waste-water treatment works; STW – sewage treatment works; NGR – national grid reference; DWF – dry weather flow. N/a – not applicable. N/A – not available.

3 Diffuse agricultural pollution

Effluent discharges from livestock holdings and dirty water runoff from farm yards in the catchment are potential sources of microbiological contamination of shellfisheries in the estuary. Effluent discharges from the majority of farms in the catchment would ultimately be transported to the tidal limit at Beaulieu and shellfisheries at greatest risk of contamination from this source are expected to be those in the upper reaches of the estuary. Discharges from farms to the west of the estuary may also be of significance due to their proximity to the estuary (Cefas, 2009).

4 Coastal survey

4.1 Aim

The aim of the coastal survey was to confirm the presence of potentially contaminating sources to Beaulieu River shellfish water identified during the desk-based study and confirm the existence of harvestable shellfish stocks to help identify appropriate locations for sampling under the shellfish waters monitoring programme.

3.2 Results

The estuary was surveyed by boat during the ebb tide, under dry weather on the 3 October 2011. Water samples from watercourses and discharges of known/unknown type/origin (Table 4) were collected during the survey for enumeration of faecal indicator organisms.

Table 4. Summary of observations made during the coastal survey in Beaulieu River on 3 October 2011.

Production area	Beaulieu	
Shellfish hygiene bed names	Baileys Hard	
Area of shellfish beds	Baileys Hard: 0.3574km ² (<i>Tapes</i> spp.)	
Shellfish water	Beaulieu River (1.988km ²)	
EA Officers	Hana Abdul-Wahab Mark Davison	
Cefas Officers	Simon Kershaw Carlos Campos	
Date/time of survey	3 October 2011 (08:00–13:00)	

Extent of survey Area	Carpenters Dock to Gins Landing Stage	
Map/Chart References	OS Explorer OL22; Imray Chart No. 2.200/7	
Predicted tides at Bucklers Hard	High Water (time/height)	14:59 (3.7m)
	Low Water (time/height)	08:38 (0.7m)
Weather forecast	Met Office Inshore Waters: <u>Solent West/Lymington</u> Wind: SW Sea state: smooth or slight Weather: dry Visibility: good	
Air temperature	Increasing from 15°C at 07:00 to 20°C at 13:00	
Wind	Increasing from 7knots at 07:00 to 11 knots at 13:00	
Precipitation	None at time of survey	
Cloud cover	5% (07:00)	
Rivers/streams/springs	Springs at Jarvis Copse Springs at Oxleys Springs at Bailey's Hard Springs at Spearbed Copse St. Mary's Spring (Salterns Copse)	
Key discharges identified (Cefas database)	Beaulieu Hummicks WwTW	
Other discharges	Burnt Copse outfall	
Boats/ports	Bucklers Hard marina Pontoon moorings between Needs Hore and Carpenters Dock	
Animals observed	Relatively few woodland birds in the upper reaches of the estuary	
Sewage related debris	None observed	
Samples taken	See Figure 3 and Table 5 below	
Water appearance	Turbid/sediment resuspension in the upper estuary Clear in the lower estuary	
Bivalve harvesting activity	None at time of survey	
Land use adjacent to shellfish water	Interspersed areas of marshland fringing the estuary. Woodland Urban in Beaulieu	
Topography in the lower catchment	Flat land (<20m OD) at Bucklers Hard	

Shellfisheries	<p>Manila clam beds have been restocked - 30 tonnes seed in the upper reaches of the river between Bailey's Hard and Carpenters Dock and at the mouth of the estuary at Needs Ore.</p> <p>Other seeded areas within the currently classified Manila clam bed include Spearbed Copse in the vicinity of Beaulieu Hummicks STW discharge and at Simms Wood.</p> <p>Commercially sized American clams along the eastern shores between Witchers Copse and Salterns Copse.</p> <p>Native oyster harvesting activity relatively low in recent years due to <i>Bonamia</i>. Bed within shellfish waters boundary presently restricted to mudflat at the river mouth (St Margarets Creek–Exbury River) (probably ½ tonne harvested latest season).</p>
Other comments	<p>Notes from meeting with Mr. David Mitchell (S&J Shellfish) (12:10): Mr Mitchell expressed concern that discharges from Beaulieu Hummicks WwTW and Beaulieu Village STW had affected river water quality. Point source and diffuse pollution from agricultural land at Hartford Bridge were also highlighted.</p>

The results of the coastal survey are given in Table 5 below.

A



B, C



D



E



F



G



Figure 3. Sites where surface water samples were collected during the coastal survey. A: River Beaulieu near Southampton Yacht Club; **B, C:** shellfish water surface water at Gins landing stages; **D:** Bucklers Hard outfall near Jetty; **E:** Burnt Copse outfall; **F:** marina near Bucklers Hard. **G:** Beaulieu upstream shellfish water.

Table 5. Bacteriological concentrations in surface water and shellfish samples collected during the boat survey on 3 September 2011.

Figure 1 ID	Time	Sampling location	NGR Easting	Northing	Salinity	Total coliforms (presumptive) ^b (No 100ml ⁻¹)	Faecal coliforms (presumptive) ^b (No 100ml ⁻¹)	Faecal streptococci (presumptive) ^b (No 100ml ⁻¹)	MST filtration (code)
1201513	11:00	Royal Southampton Yacht Club Shellfish water surface water	441645	98473	31.76	27	10	10	2
1201514	11:04	sample at Gins landing stages Shellfish water 6m depth sample	441648	98476	32.18	27	10	10	2
1201515	11:05	at Gins landing stages	441648	98476	N/r	10	27	10	2
1201516	11:41	Bucklers Hard outfall near jetty	440767	100217	6.75	5,200	4,200	36,000	2
1201517	08:53	Spring near Carpenters Dock	439357	101874	15.16	5,200	2,900	580	2
1201518	09:34	Spring at Oxleys	439678	101733	14.76	5,300	3,200	650	2
1201519	09:39	Spring near Baileys Hard	439586	101511	20.43	901	460	99	2
1201520	09:43	Estuarine water at Bailey's Hard	439625	101445	15.4	4,200	2,500	430	2
1201521	09:49	Rivers House	439812	101322	11.57	63	18	10	2
1201522	09:56	Tarks Reach	440102	101251	27.04	200	99	45	2
1201523	10:00	Burnt Copse outfall	440406	101299	0.45	1,000,000	1,000,000	39,000	2
1201524	10:18	Marina near Bucklers Hard	441077	100628	28.68	545	636	18	2
1201525	10:23	Beaulieu upstream shellfish water	441007	100179	30.13	99	63	10	2
1201526	10:36	Beaulieu outfall	441742	100292	32.37	99	63	27	2

a – enumerated using the Most Probable Number method.

b – enumerated using the Membrane filtration method.

MST code 2 – sample collected and stored. Analysis not undertaken.

N/r – not recorded.

5 Conclusions

- § The most significant sources of microbiological contamination to the shellfish water at the time of the survey were the outfall near Burnt Copse and streams in Oxleys and Carpenters Dock. The extremely high concentrations of coliform bacteria from Burnt Copse outfall are consistent with crude or primary treated effluent and therefore require improvement.

- § Water samples collected in the upper reaches of the shellfish water were found to be considerably more contaminated than those from the lower reaches. This indicates a decreasing gradient of water contamination towards the mouth of the estuary which is consistent with the differences in average levels of *E. coli* between shellfish beds.

- § According to information provided by S&J Shellfish (the leaseholder), at the time of the survey there were harvestable stocks of Manila clams within the boundaries of the designated shellfish water which can be used for the purposes of the shellfish waters' monitoring programme.

- § Sampling for the purposes of the above programme using natural Manila clams or American clams or, alternatively, bagged mussels as sentinel species could be facilitated by the leaseholder should this be required.

6 Shellfish hygiene monitoring

Native oysters have been sampled on a monthly basis from designated monitoring points in the Beaulieu River for the purposes of classifying shellfish production areas since the implementation of hygiene controls in 1991. Clams (*Tapes* spp.) in Bailey's Hard were given provisional classification in 2011. Monthly *E. coli* results monitored in oysters from Bucklers Hard and Needs Ore and in clams from Bailey's Hard over the last 7 years were used for the purposes of this assessment. Summary statistics indicate that there are substantial differences between the three beds (Table 6).

Table 6. Summary statistics of levels of *E. coli* in shellfish from Beaulieu River.

Bed name	Species	Total number of samples	MPN <i>E. coli</i> /100g					
			Number of samples >230	Number of samples >4,600	Minimum	Maximum	Median	Geometric mean
Bucklers Hard	<i>O. edulis</i>	57	47	5	<20	35,000	490	646
Needs Ore	<i>O. edulis</i>	57	24	1	<20	17,000	160	122
Bailey's Hard	<i>Tapes</i> spp.	27	22	15	20	92,000	5,400	2,803

Data periods: Bucklers Hard: February 2005–July 2009. Needs Ore: February 2005–September 2010. Bailey's Hard: June 2009–November 2011.

These results confirm the findings from the sanitary survey in that Bailey's Hard is the most contaminated bed and there is a gradient of microbiological contamination from the upper to the lower estuary (Cefas, 2009).

An analysis of variance was also undertaken to study any seasonal variation in *E. coli* levels in shellfish from the three beds. Results showed no significant (<1 log₁₀ between most contaminated and least contaminated months) differences in the levels of contamination between months/seasons.

7 Shellfish waters investigation monitoring

The EA have undertaken investigative monthly catchment monitoring which commenced in November 2010 and finished in March 2012. Samples were collected at 6 sites from Hartford Bridge in the river down to the shellfish water point in the south of the estuary. The analysis of these data is not yet complete but should further inform the findings of this report.

8 Relationships between *E. coli* levels in oysters and rainfall

The dependence between the levels of *E. coli* in shellfish and rainfall were studied using the non-parametric Spearman's rank correlation coefficient. Statistically significant positive correlations were obtained between daily rainfall (3 days prior to sampling) and *E. coli* levels in oysters from Bucklers Hard and Needs Ore (Table 7). Significant correlations were also obtained between total rainfall (6–7 days prior to sampling) and *E. coli* levels in oysters from both of these beds. No significant

correlations were detected between rainfall and *E. coli* in clams. Positive correlations were also found in oysters from Bucklers Hard with daily rainfall on the 7th day prior to sampling.

Table 7. Results of correlation analysis (Spearman's *rho*) between *E. coli* levels in shellfish flesh and daily/cumulative rainfall (Brockenhurst; SU31060281).

	Shellfish bed name (species)		
	Bucklers Hard (<i>O. edulis</i>) - B023A n=55; $p \geq 0.266$	Needs Ore (<i>O. edulis</i>) - B023B n=56; $p \geq 0.264$	Bayley's Hard (<i>Tapes</i> spp.) - B023E n=25; $p \geq 0.398$
Total daily rainfall			
1 day	0.060	-0.044	-0.174
2 days	0.080	0.038	-0.117
3 days	0.267*	0.371*	0.149
4 days	-0.003	0.177	-0.079
5 days	0.232	0.008	0.209
6 days	0.212	0.131	0.201
7 days	0.297*	0.208	0.336
Cumulative rainfall			
2 days	0.130	0.017	-0.146
3 days	0.231	0.239	-0.033
4 days	0.163	0.231	-0.037
5 days	0.209	0.212	0.020
6 days	0.289*	0.270*	0.014
7 days	0.336*	0.313*	0.027

* Significant at 95% confidence level. n=number of paired results. *E. coli* values <20 *E. coli*/100g were assigned values of 10 *E. coli*/100g. Data periods: Bucklers Hard: February 2005–July 2009. Needs Ore: February 2005–September 2010. Bailey's Hard: June 2009–November 2011.

The strongest association between variables was obtained when rainfall fell 3 days before oyster sampling at Needs Ore. However, overall the correlation coefficients obtained are not strong indicating that other environmental factors are likely to explain the variation in *E. coli* content in shellfish.

Figure 4 shows that although there is a general increasing trend in *E. coli* levels in oysters from Needs Ore with rainfall. A proportion of class B (230<MPN *E. coli*<4,600) results were detected under dry weather or levels of rainfall below the average for the catchment (2.1mm).

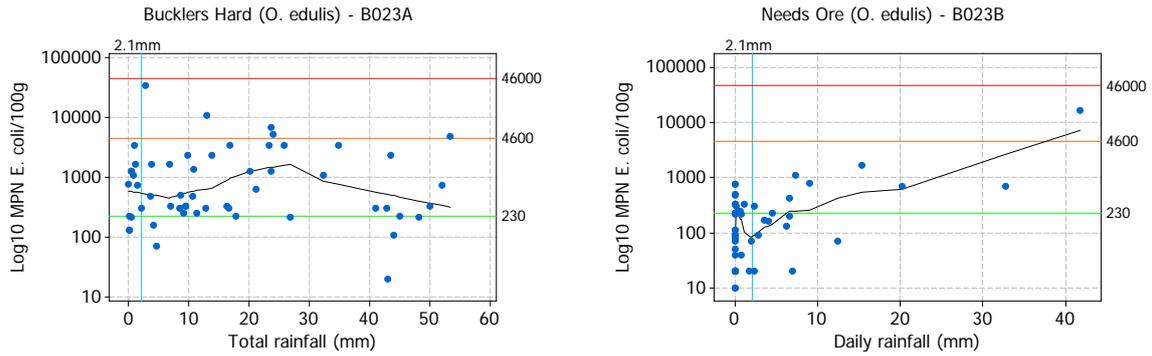


Figure 4. Scatterplot of *E. coli* levels in native oysters from Bucklers Hard and total rainfall (7 days before sampling) and Needs Ore (3 days before sampling). Blue reference line indicates average rainfall for the monitored period. Green, orange and red lines indicate shellfish hygiene classification thresholds.

These results indicate that the microbial quality of oysters in Needs Ore is governed by rainfall events. Such impacts would be associated with the discharge of freshwater and direct land runoff into the river in the proximity of the sampling point. In contrast, the magnitude of *E. coli* contamination in oysters from Bucklers Hard is not proportional to the levels of rainfall, with a few class A results (MPN *E.coli*<230) detected under wet weather.

9 Recommendations

- § The sanitary survey for shellfish production areas in the Beaulieu undertaken by Cefas in 2009 highlights that the most significant sources of microbiological contamination to the fishery are the water company and private continuous and intermittent discharges sewage discharges, freshwater inputs from the river itself, intermittent discharges of waste from boats and birds. The results from this investigation highlighted the outfall near Burnt Copse as a very significant source of contamination to the shellfish water. The EA is investigating whether there is inaccuracy in the geographical grid reference as this discharge is close to Hummicks WwTW and will make recommendations for improvement in due course.

- § Streams at Oxleys and Carpenters Dock were found to be contaminated with faecal coliform bacteria at levels of 5×10^3 CFU 100ml⁻¹. The surface estuarine water in the vicinity of Bailey's Hard upstream the designated shellfish water was also contaminated with coliform levels of similar magnitude. This suggests that there is a potentially significant contribution of diffuse pollution from this area of the catchment which could be exacerbated during wet weather conditions.

- § Consideration could be given to extending the boundaries of the designated shellfish water to encompass existing stocks of Manila clams in the upper reaches of the estuary.

- § Relocation of the shellfish waters' sampling point towards the upper reaches of the which would be more representative of the significant pollution sources identified above.

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