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## Beaulieu River Sanitary Survey

Review

February 2015



Cover photo: Looking south from Beaulieu village

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## Statement of use

Under EC Regulation 854/2004 which lays down specific rules for official controls on products of animal origin intended for human consumption, a sanitary survey relevant to bivalve mollusc beds in Beaulieu River was undertaken in 2009. This provided an appropriate hygiene classification zoning and monitoring plan based on the best available information with detailed supporting evidence. The Food Standards Agency (FSA) is committed to reviewing sanitary surveys every six years or sooner if significant changes in pollution sources or the fishery have occurred that may require revision of the sampling plan. This report provides a six year review of information and recommendations for a revised sampling plan. The Centre for Environment, Fisheries & Aquaculture Science (Cefas) undertook this work on behalf of the FSA.

## Revision history

Version	Details	Approved by	Approval date
1	Draft for internal review	David Walker	10/03/2015
2	Draft for external review	Simon Kershaw	23/03/2015
Final	Final report post consultation	Simon Kershaw	17/06/2015

## Consultation

Consultee	Date of consultation	Date of response
New Forest District Council	23/03/2015	26/03/2015
Southern IFCA	23/03/2015	None
Environment Agency	23/03/2015	31/03/2015
Southern Water	23/03/2015	None
Natural England	23/03/2015	23/04/2015

## Dissemination

Food Standards Agency, New Forest District Council. The report is available publicly via the Cefas website.

## Recommended Bibliographic Reference

Cefas, 2015. Review of the Beaulieu River 2009 Sanitary Survey. Cefas report on behalf of the Food Standards Agency, to demonstrate compliance with the requirements for classification of bivalve mollusc production areas in England and Wales under EC Regulation No. 854/2004.

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# 1. Introduction

## 1.1. Background

The Centre for Environment, Fisheries & Aquaculture Science (Cefas) is performing sanitary surveys for new bivalve mollusc production areas (BMPAs) in England and Wales, on behalf of the Food Standards Agency (FSA). The purposes of the sanitary surveys are to demonstrate compliance with the requirements stated in Annex II (Chapter II paragraph 6) of EC Regulation 854/2004, whereby 'if the competent authority decides in principle to classify a production or relay area it must:

- (a) make an inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production areas;
- (b) 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, waste-water treatment, etc.;
- (c) determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal regime in the production area; and
- (d) 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.'

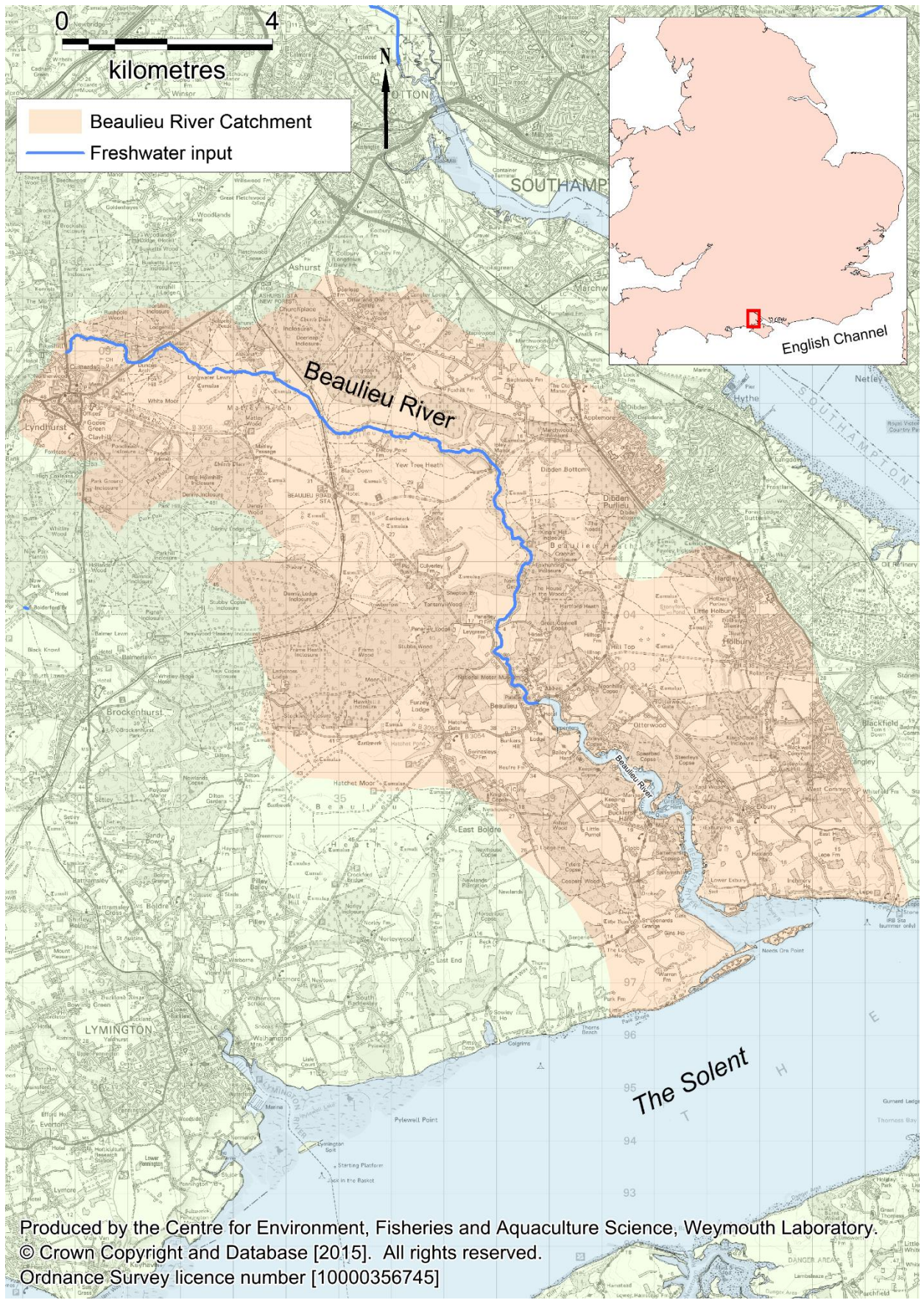
In line with the EU Good Practice Guide Cefas is contracted to undertake reviews of sanitary surveys on behalf of the Food Standards Agency. Reviews are to be undertaken at six yearly intervals after the original sanitary survey or sooner where there are changes to the type and locations of the shellfisheries or significant changes in sources of pollution.

## 1.2. Beaulieu River Review

This report reviews available information and makes recommendations for a revised sampling plan for the existing native oyster and *Tapes* spp. classification zones in the Beaulieu River production area. This review identifies changes to the information presented in the sanitary survey through a desk based study and updates the assessment and sampling plan where necessary.

Specifically, the review will consider:

- (a) changes to the shellfishery
- (b) changes in microbiological monitoring results
- (c) changes in sources of pollution impacting the production area or new evidence relating to the actual or potential impact of sources
- (d) changes in land use in the area
- (e) change in environmental conditions



**Figure 1.1: Location of Beaulieu River**

## 2. Shellfisheries

### 2.1. Description of shellfishery

Harvesting of shellfish in the Beaulieu River is subject to lease from the Beaulieu Estate. At present, while a lease is held, there is no legal harvesting of shellfish taking place in the Beaulieu River. Harvesting of Manila clams is prohibited due to high historical *E. coli* levels. Native oysters are currently not classified due to a lack of a viable stock for harvesting, and as such are subject to a Southern IFCA temporary closure of shellfish beds byelaw (Southern IFCA, 2014).

When in operation, both Manila clams and native oysters are harvested by dredge. According to the lease holder, the highest concentration of Manila clams is between Carpenters Dock and Bailey's Hard (Figure 2.1). The majority of this high density area is upstream of the prohibited Manila clam zone. The lease holder suspects that the Beaulieu Village WwTW is the main source of contamination for Manila clams and plans to take sediment samples at intervals extending away from this discharge. No indication was given of when this may take place. In 2013 an application to change the extent of the Manila clam classification zone was made. Following the 2013 application, a new classification zone was drawn which covers a smaller area of the river than was classified prior to 2013, further downstream, and potentially further away from contamination sources. A total of eight samples were taken from this proposed classification zone in November and December 2013. Not enough samples were taken for a provisional classification to be granted, however, the *E. coli* results from these samples indicated that a C classification would be probable.

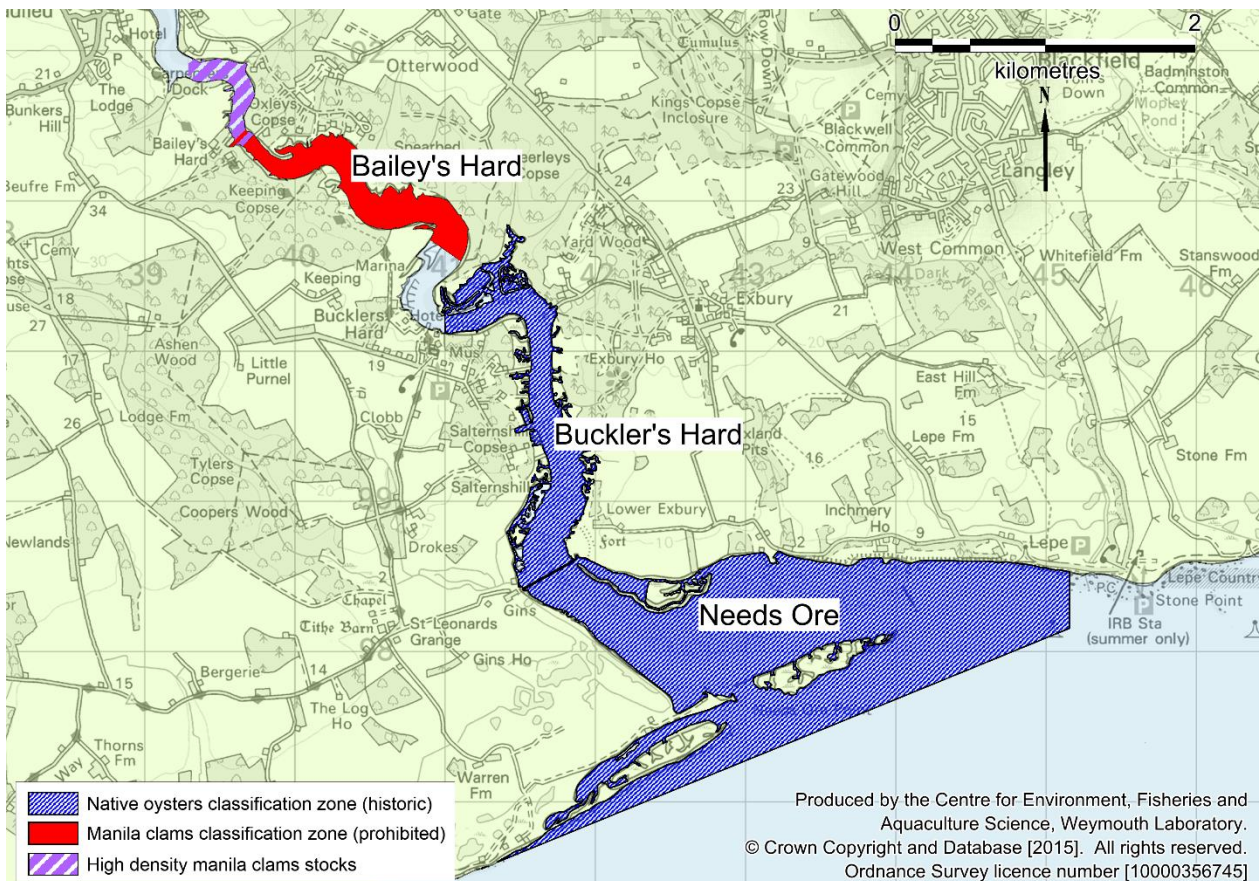
Native oysters were classified in the Beaulieu south of Buckler's Hard until 2011. Since that time oysters have not been classified due to a lack of commercially available stock. The harvester expressed an interest in carrying out their own survey to establish the current distribution of native oysters in the lower Beaulieu and getting the area reclassified.

### 2.2. Classification History

Table 2.1 lists classifications within the Beaulieu River since 2005 and Figure 2.1 shows the locations of classification zones. Bailey's Hard Manila clam classification zone has been prohibited since 2013 due to high *E. coli* results. Following a decline in the native oyster population, sampling for native oysters stopped in 2010, and this species has remained unclassified since.

**Table 2.1: Classification history for the Beaulieu River**

Bed name	Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Buckler's Hard	Native oysters	B	B-LT	B-LT	B-LT	B-LT	B-LT	-	-	-	-
Needs Ore		B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	-	-	-	-
Bailey's Hard	Manila clams	-	-	-	-	-	-	C	C	P	P



**Figure 2.1: Locations of the classification zones for Manila clams and native oysters (historic) in the Beaulieu River. According to the lease holder there are high density stocks of Manila clams between Carpenter's Dock and Bailey's Hard.**



### 3. Overall Assessment

All of the shellfish beds in the Beaulieu River are currently closed due either to prohibitive classification results or low stock numbers. The lease holder would like to be able to harvest Manila clams, and although the clam stocks are denser upstream, it is more desirable to harvest from a lower density stock with lower levels of contamination. For this reason, sampling towards reclassifying a smaller clam classification zone started in 2013, but was never completed. No recent stock surveys have been performed for either Manila clams or native oysters.

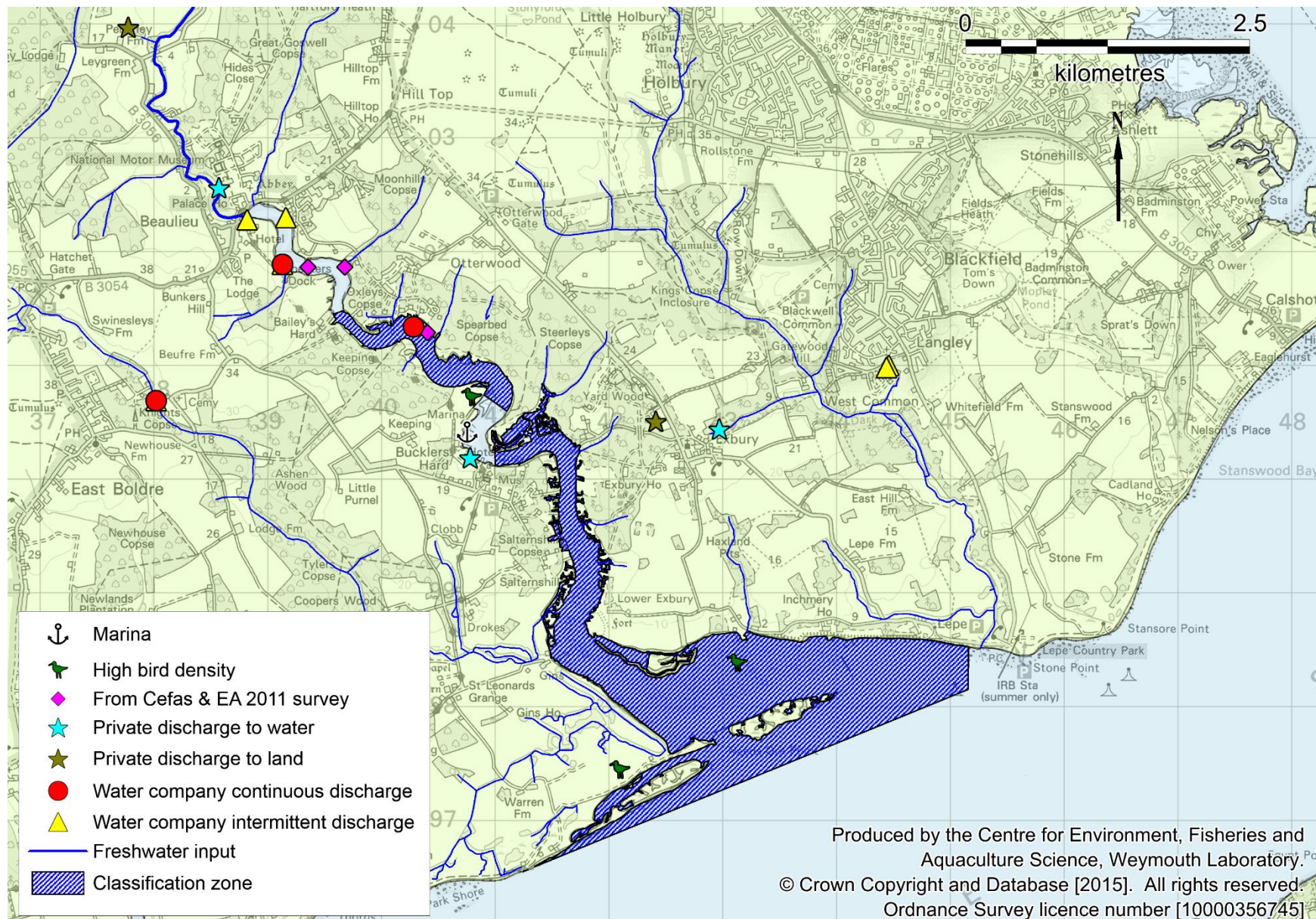
The human population in the catchment rose by 2.2% between the 2001 and 2011 censuses. The majority of this population rise was in the east of the catchment around Dibden Purlieu and Holbury. The volume of sewage discharged may have increased in response.

With the exception of a small increase in permitted dry weather flow at East Boldre sewage treatment work (STW), 2.2%, and some maintenance works to the Beaulieu Village Wastewater Treatment Works (WwTW) there have been no significant reported changes to the three water company owned continuous discharges in the catchment. There are 10 intermittent water company owned discharges in the Beaulieu catchment. The Beaulieu Village WwTW has spilled for approximately 10% of the time since 2009 and is probably a significant source of contamination to shellfish in the river. While the Lyndhurst WwTW overflow also spilled for approximately 10% of the time, it is further up catchment and is less likely to have a large impact on the shellfish. Within the catchment there are 11 private discharges with maximum flows exceeding 5 m<sup>3</sup>/day. The level of treatment for these discharges is not reported and so it is difficult to quantify the impact that they have on shellfish hygiene. However, it is reported by the EA that the discharge from the National Motor Museum has improved since 2009.

There may have been an overall decline in livestock numbers since the 2009 sanitary survey, but no reliable catchment level data were freely available for the current report. Overall bird numbers have fluctuated since 2008, but were at comparable levels to 2008/2009 during the last reported surveying period (2012/2013).

There have been no significant changes to the bathymetry or other hydrographical features in the estuary since 2009.

A survey by Cefas and the Environment Agency (EA) (Cefas and EA, 2011) found three highly contaminated points on the estuary. These were a spring near Carpenters Dock, a spring at Oxleys and a private discharge just to the east of Hummicks WwTW.



**Figure 3.1: Summary of contamination sources to shellfish in the Beaulieu Estuary**

## 4. Sampling Plan

### 4.1. Recommendations

It is recommended that all classification zones and RMPs in the Beaulieu River stay in their current locations. For Manila clams, the reduced classification zone and RMP as set out by the 2013 RMP assessment (Cefas, unpublished) should be used.

#### **Manila clams (*Tapes* spp.)**

Landing Stages – The classification zone for Manila clams should follow the recommendations previously set out by Cefas in the 2013 RMP assessment (Cefas, unpublished). The RMP for this classification zone should be located at the upstream most point of the classification zone in order to account for contamination from the Beaulieu River catchment as well as both the Beaulieu Hummicks and Beaulieu Village WwTWs.

#### **Native Oysters (*O. edulis*)**

Buckler's Hard – This classification zone encompasses the native oysters from just downstream of Buckler's Hard to Gins and the iron-age fort at Lower Exbury. The RMP for this zone should be located at the most upstream point of the classification zone to account for contamination from the Beaulieu River catchment and upstream sewage discharges.

Needs Ore – This classification zone encompasses the native oysters from Gins and the iron-age fort at Lower Exbury to the extent of the Beaulieu River lease. The RMP for this zone should be located to the west of the zone to account for contamination from the bird colony at Needs Ore Point.

## 4.2. General information

### Location Reference

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Production area	Beaulieu Estuary
Cefas main site reference	M023
Ordnance Survey 1:25,000 map	OL22 (New Forest)
Admiralty charts	No. 2021

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### Shellfishery

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Species/culture	Manila clams ( <i>Tapes</i> spp)	Wild
	Native oysters ( <i>Ostrea edulis</i> )	Wild
Seasonality of harvest	Year round	

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### Local Enforcement Authority

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Name	New Forest District Council
Environmental health officer	Dale Bruce
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Email	dale.bruce@nfdc.gov.uk

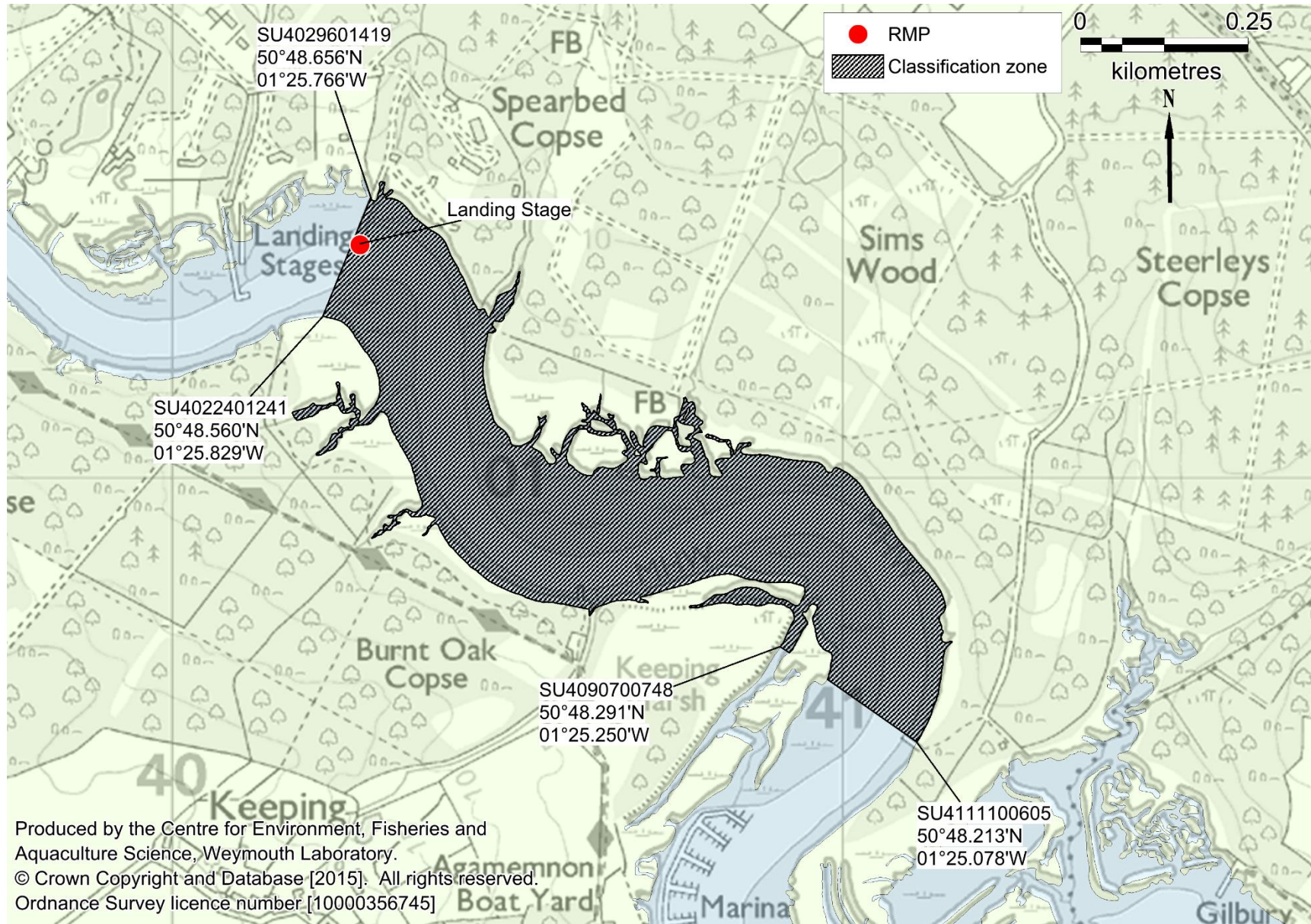
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### Requirement for review

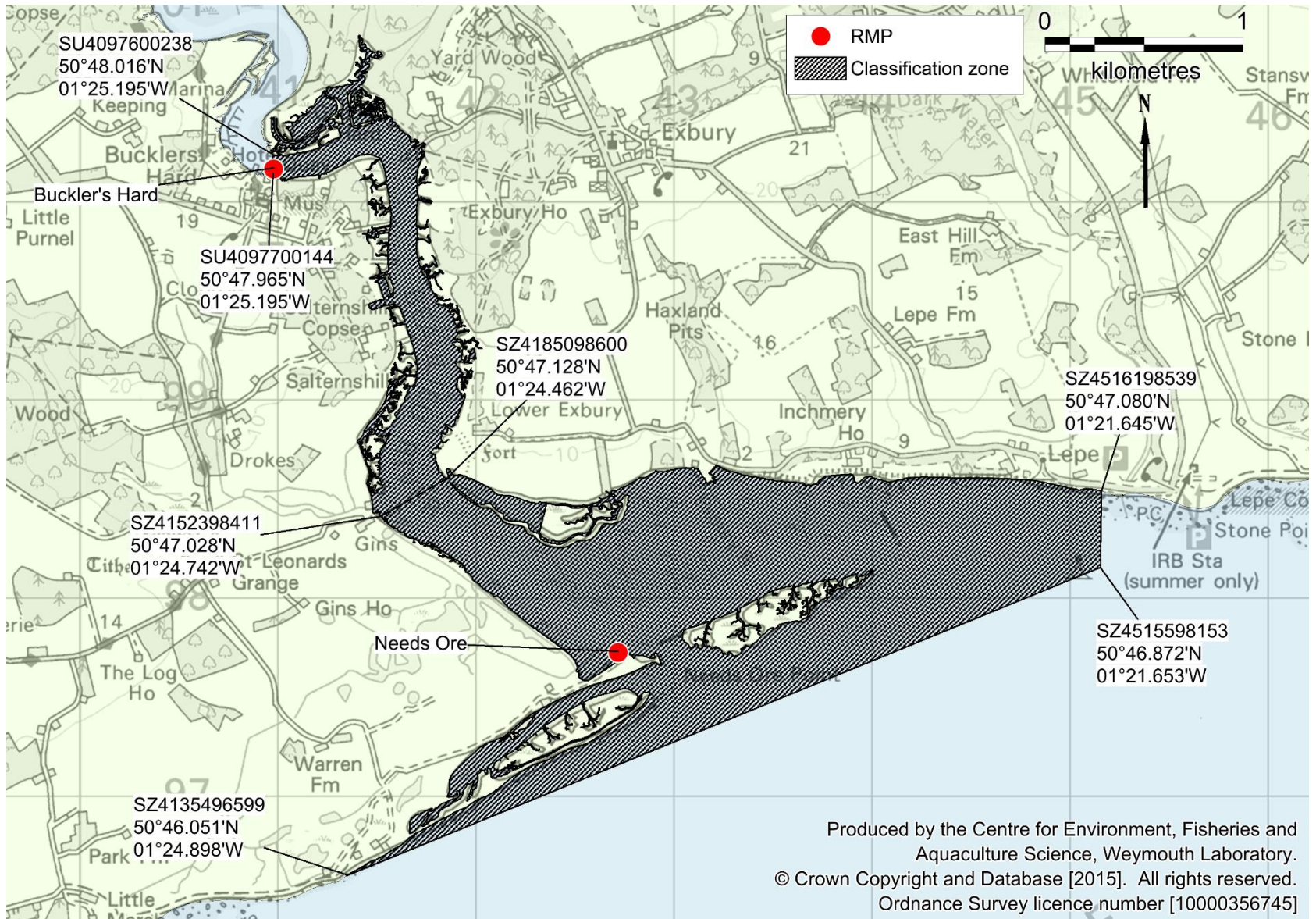
The Guide to Good Practice for the Microbiological Monitoring of Bivalve Mollusc Harvesting Areas (EU Working Group on the Microbiological Monitoring of Bivalve Mollusc Harvesting Areas, 2014) indicates that sanitary assessments should be fully reviewed every six years. This assessment is therefore due for formal review in 2021. The assessment may require review in the interim should any significant changes in sources of contamination come to light.

**Table 4.1: Number and location of representative monitoring points (RMPs) and frequency of sampling for classification within Beaulieu Estuary**

Classification zone	RMP†	RMP name	NGR	Latitude & longitude (WGS84)	Species	Growing method	Harvesting technique	Sampling method	Sampling species	Tolerance	Frequency
Landing Stage	B023I	Landing Stage	SU4028001350	50°48.618'N 01°25.780'W	Manila clams	Wild	Dredge	Dredge	Manila clams	50 m	Monthly
Buckler's Hard	B023A	Buckler's Hard	SU4098000170	50°47.979'N 01°25.192'W	Native oysters	Wild	Dredge	Dredge	Native oysters	50 m	Monthly
Needs Ore	B023B	Needs Ore	SZ4272097730	50°46.655'N 01°23.728'W		Wild	Dredge	Dredge	Native oysters	50 m	Monthly



**Figure 4.1: Recommended zoning and monitoring arrangements (Manila clams)**



**Figure 4.2: Recommended zoning and monitoring arrangements (native oysters)**

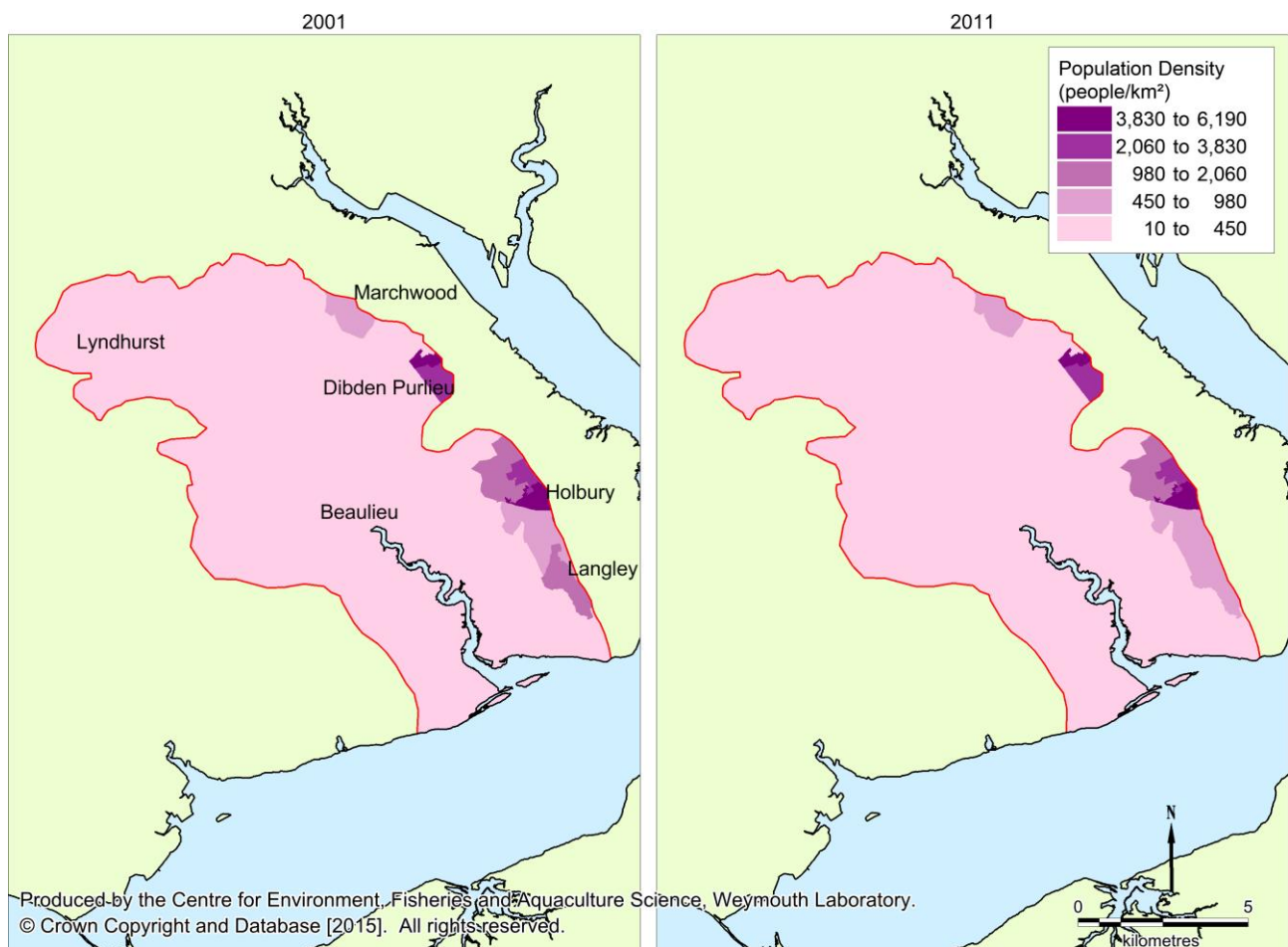
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## 5. Pollution sources

### 5.1. Human Population

In the 2009 Beaulieu River Sanitary Survey Report, the population data presented were collected in the 2001 census. Another census in 2011 was conducted since the report was written, and so changes in the human population in the catchment are discussed here.

Figure 5.1 shows population densities in census Lower Layer Super Output Areas (LSOAs) within or partially within the Beaulieu River catchment area, derived from data collected from the 2001 and 2011 censuses. An overall trend of increased population density is apparent with the average population density across the catchment increasing by 3.6%. Most of this increase has occurred in the east of the catchment around Dibden Purlieu and Holbury.



**Figure 5.1: Human population density in 2001 and 2011 census LSOAs in the Beaulieu River catchment.**

Total resident population within the census areas contained within or partially within the catchment area was approximately 32,273 in 2001 and 32,992 in 2011. This is an increase of around 2.2% at the time of the 2011 census.



## 5.2. Sewage

Figure 5.2 shows the locations of all of the current discharges identified in the Environment Agency (EA) national permit database (July 2014) which fall within the Beaulieu catchment.

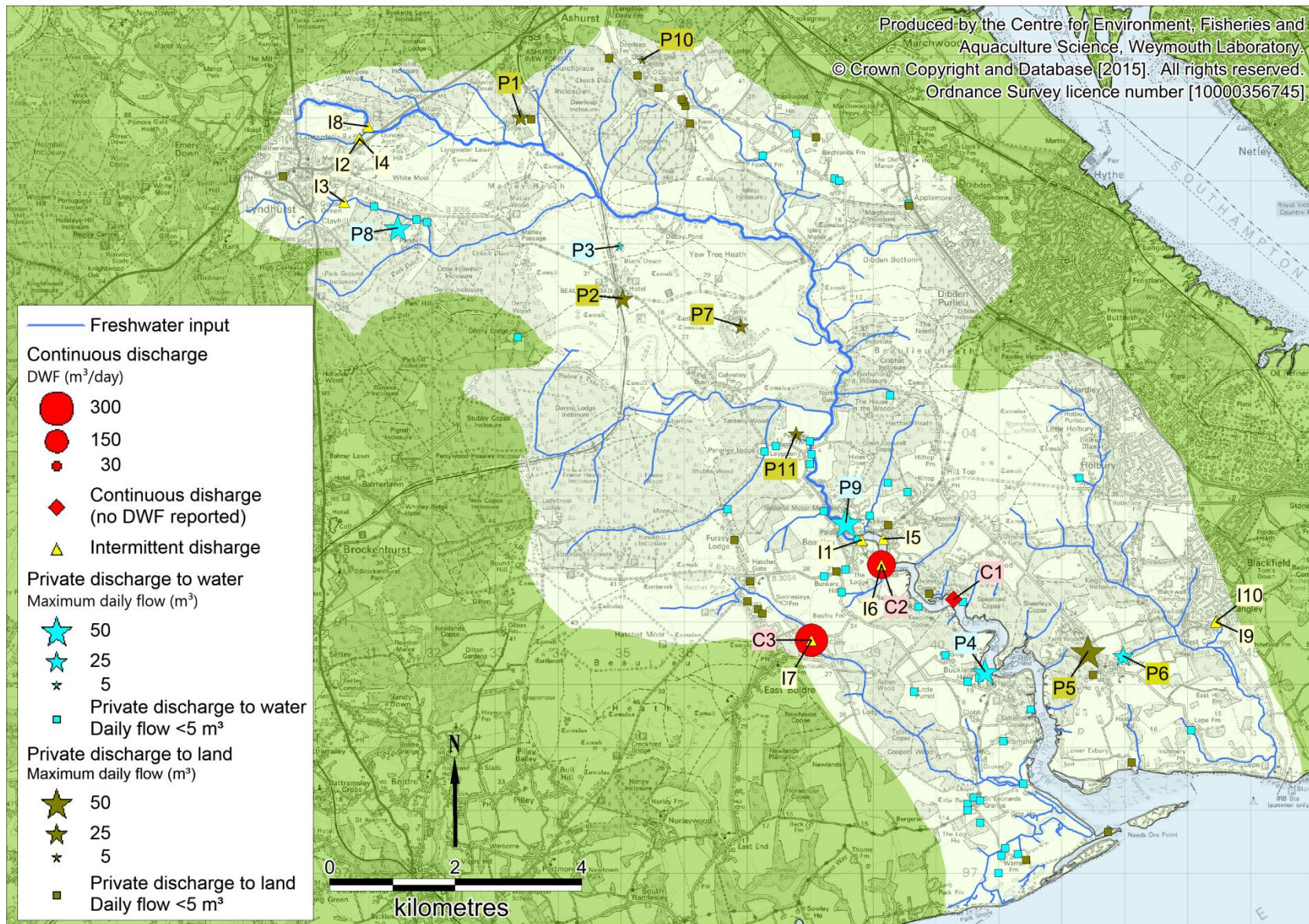
The 2009 sanitary survey only reported a small number of discharges and did not include those in the upper catchment.

There are three water company owned continuous discharges (Table 5.1) within the catchment, all of which were reported in the 2009 sanitary survey report. Two of these discharges had dry weather flows (DWF) reported in the current EA national permit database. East Boldre STW previously had a DWF of 278 m<sup>3</sup>/day, but this has since increased to 284 m<sup>3</sup>/day. The Beaulieu Village WwTW has had no reported change to its DWF and Beaulieu Hummicks WwTW has no reported DWF. Treatment levels for Beaulieu Hummicks WwTW and East Boldre STW are not reported but it is assumed that they remain with a secondary level of treatment as in the 2009 sanitary survey as there have been no changes planned for these discharges (EA, 2009). According to the EA, final effluent monitoring of the Beaulieu Village WwTW between 2013 and 2015 has showed a consistent improvement in water quality (I. Udal, personal communication 10/02/2015).

There are ten water company owned intermittent discharges that are consented within the Beaulieu catchment (Table 5.2). Two of these were reported in the 2009 report. Table 5.4 and Figure 5.3 show the spills from the Beaulieu Village WwTW, East Boldre STW and Lyndhurst WwTW intermittent discharges. The spill data for East Boldre STW and Lyndhurst WwTW were not available between 2006 and 2009 or in 2014 at the time of writing. All of the discharges have spilled for more than 3% of the time in at least one of the years that data were available. Beaulieu Village WwTW and Lyndhurst WwTW discharges spilled very often, with Lyndhurst WwTW spilling for more than 3% of the time in all years where data were available.

There are also 95 private discharges in the catchment, 11 of which have consented maximum daily flows equal to or greater than 5 m<sup>3</sup>/day (Table 5.3). One of these was reported in the 2009 sanitary survey report (National Motor Museum). Improvements to this discharge have resulted in better quality final effluent (I. Udal, personal communication, 10/02/2015). The other private discharge reported in the 2009 sanitary survey, Agamemnon Boatyard, no longer has a reported maximum daily flow consent.

Following Cefas and EA investigations (Cefas and EA, 2012), a small but heavily contaminated private discharge at Burnt Copse just to the east of Beaulieu Hummicks WwTW has been improved (EA, 2014). There have also been improvements to some of the minor discharges from the Beaulieu Estate (I. Udal, personal communication, 10/02/2015).



**Figure 5.2: Discharges in the Beaulieu catchment (Table 5.1, Table 5.2, and Table 5.3 for details)**  
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**Table 5.1: Continuous water company discharges within the Beaulieu catchment.**

Number on map	Name in current database	Name in 2009 report	NGR	Treatment	Dry weather flow (m <sup>3</sup> /day)	Receiving environment	Distance to classification zone (km)	Estimated daily loading <sup>†</sup>
C1	Beaulieu Hummicks WwTW	Beaulieu Hummicks STW	SU4028001350	Unknown*	NR	Saline Estuary	0.0	-
C2	Beaulieu Village WwTW	Beaulieu Village STW	SU3913001900	2° (biological filtration)	216	Saline Estuary	0.9	7.1x10 <sup>11</sup>
C3	East Boldre S.T.W.	East Boldre STW	SU3802000700	Unknown*	284	Freshwater river	4.9	9.4x10 <sup>11</sup>

*Contains Environment Agency information © Environment Agency and database right*

\*Reported as secondary in 2009 sanitary survey, but no information in current database

<sup>†</sup>*E. coli* cfu/day (data from Kay *et al.* 2008),

NR=Not Reported

**Table 5.2: Intermittent water company discharges within the Beaulieu catchment. Grey cells indicate discharges used in Table 5.4 and Figure 5.3.**

Number on map	Name in current database	Name in 2009 report	NGR	Receiving environment	Distance to classification zone (km)
I1	Beaulieu Village PS	Fire Station Lane SPS CSO	SU3882002290	Saline Estuary	1.5
I2	Lyndhurst Pumping Station		SU3085008670	Freshwater river	16.3
I3	Green Lane Lyndhurst CEO		SU3060007660	Freshwater river	16.6
I4	Lyndhurst Golf Club CEO		SU3084008670	Freshwater river	16.3
I5	Palace Lane/Dock Lane CSO		SU3916002310	Saline Estuary	1.2
I6	Beaulieu Village WwTW	Beaulieu Village STW CSO	SU3913001900	Saline Estuary	0.9
I7	East Boldre S.T.W.		SU3802000700	Freshwater river	4.9
I8	Lyndhurst WwTW		SU3098408859	Freshwater river	16.1
I9	West Common road Fawley CEO		SU4444000990	Fresh water river	3.5
I10	West Common PS		SU4446001010	Fresh water river	3.5

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**Table 5.3: Private discharges within the Beaulieu catchment with maximum daily flows above 5 m<sup>3</sup>.**

Number on map	Name in current database	Name in 2009 report	NGR	Maximum daily flow (m <sup>3</sup> )	Receiving environment	Distance to classification zone (km)
P1	Ashurst Lodge		SU3340009010	18	Land	13.4
P2	Beaulieu Road Hotel		SU3502006130	25	Land	9.6
P3	Beaulieu Road Station		SU3497006960	5	Freshwater river	11.1
P4	Bucklers Hard Village STW		SU4078000200	38	Saline Estuary	0.2
P5	Exbury Plant & Garden Centre		SU4241000520	60	Land	0.8
P6	Exbury Sewage Works		SU4297000450	24	Freshwater river	5.0
P7	Ferny Crofts		SU3690005690	15	Land	7.7
P8	Limewood Hotel, Parkhill		SU3145407250	40	Freshwater river	15.5
P9	National Motor Museum	National Motor Museum	SU3857002570	50	Freshwater river	2.1
P10	New Forest Otter Owl & Wildlife Pk		SU3533009920	5	Land	11.2
P11	Seas Worker Accom PENERLY Farm		SU3777503980	15	Land	4.3

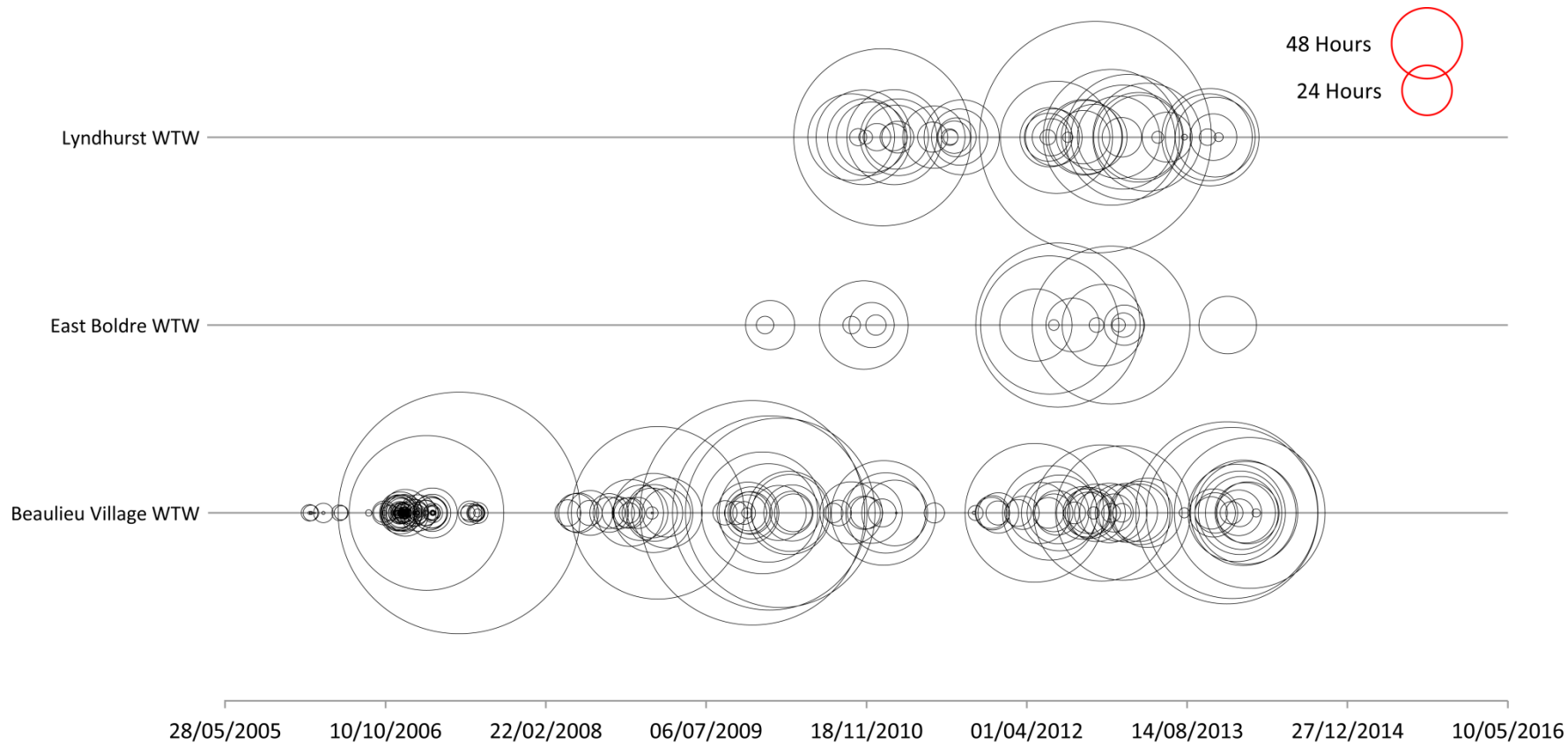
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**Table 5.4: Spills from intermittent discharges in the Beaulieu catchment. Years where a discharge was spilling for 3% or more of the time are highlighted in yellow.**

Discharge	No of spills/ year									% time spilling								
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2006	2007	2008	2009	2010	2011	2012	2013	2014
Beaulieu Village WwTW	31	54	20	65	58	19	60	42	54	2.3	10.8	2.3	14.0	12.8	2.8	9.7	8.3	11.6
East Boldre S.T.W.			NDP		11	NDP	43	6	NDP			NDP		1.5	NDP	9.4	0.6	NDP
Lyndhurst WwTW			NDP		18	41	57	53	NDP			NDP		3.1	7.5	12.5	9.9	NDP

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NDP = No data provided



○ Overflow Duration (hours)

**Figure 5.3: Bubble plot of spills from intermittent discharges in the Beaulieu catchment.**  
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## 5.3. Livestock

Livestock data were not freely available for the same area assessed in the sanitary survey report (Beaulieu River Catchment). However, the livestock numbers for the New Forest district were available for 2007 and 2013 (Defra, 2014). As the Beaulieu River catchment only makes up approximately 15% of the total New Forest District area, the livestock numbers for the Beaulieu River catchment were estimated using the % difference in numbers for the entire district and the 2007 numbers for the catchment presented in the 2009 sanitary survey. These estimates assume that the changes in livestock numbers were uniform across the district, and so may not be a true representation of livestock numbers in the catchment. The reported and estimated livestock numbers are presented in Table 5.5.

There has been an overall decline in livestock numbers across the catchment for all livestock types. The largest decline was for poultry (-63.9%). The decline in livestock may have resulted in a decline of faecal contamination to the Beaulieu River. However, it should be noted that these numbers may not be truly representative.

**Table 5.5: Livestock data for the Beaulieu river catchment in 2007 and 2013\*.**

		<b>New Forest</b>	<b>Beaulieu Catchment</b>
<b>Poultry</b>	<b>2007</b>	617,937	393
	<b>2013</b>	222,997	142*
	<b>% difference</b>	-63.9	
<b>Pigs</b>	<b>2007</b>	19,472	4,923
	<b>2013</b>	11,591	2,930*
	<b>% difference</b>	-40.5	
<b>Cattle</b>	<b>2007</b>	16,591	3,097
	<b>2013</b>	14,377	2,684*
	<b>% difference</b>	-13.3	
<b>Sheep</b>	<b>2007</b>	10,173	270
	<b>2013</b>	9,906	263*
	<b>% difference</b>	-2.6	

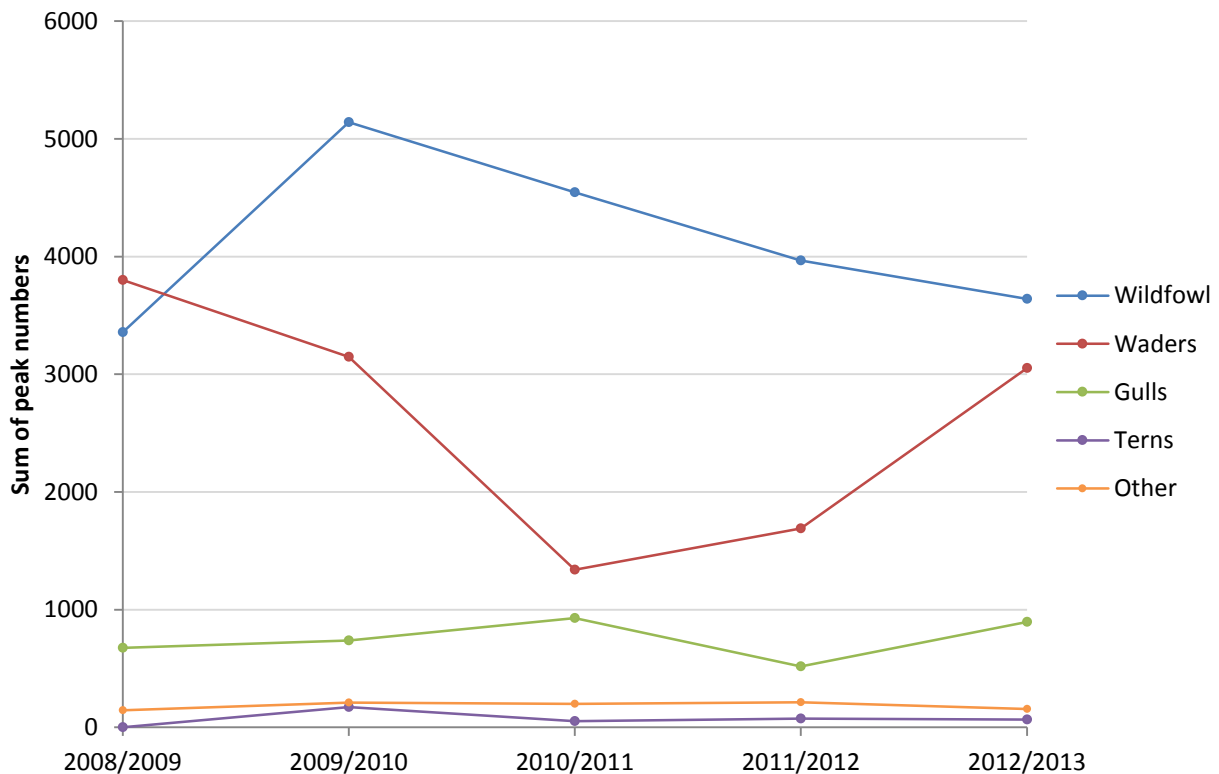
*Data from Defra (2014)*

\*value calculated from % difference

## 5.4. Wildlife

Figure 5.4 shows the peak counts for overwintering birds in the Beaulieu Estuary from 2008 to 2013 (Austin *et al.*, 2014). Bird numbers have varied since 2008, with an increase in wildfowl numbers in 2009/10 and a fall in wader numbers from 2008/09 to 2010/11. However numbers of all of the reported bird groups returned to similar values in 2012/13 to those in 2008/09. The most numerous bird types in the Beaulieu estuary are waders and wildfowl.

Total bird distributions reported by Musgrove *et al.* (2003) showed that there were large concentrations of birds in the north of the estuary from the tidal limit at Beaulieu village, to Bailey's Hard. There were also dense populations on Keeping Marsh, just north of Buckler's Hard. There were also high densities of birds on the marshes in the lower estuary seaward from Lower Exbury/Royal Southampton Yacht club. Much of this information was corroborated by literature and the shoreline survey reported in the 2009 sanitary survey. There is no new information to suggest that the distributions of birds have changed significantly since 2009.



**Figure 5.4: Annual peak bird counts in the Beaulieu Estuary**  
Data from Austin *et al.* (2014)

## 6. Hydrodynamics

Comparisons of the 2006 and 2012 editions of Admiralty Chart 2021 (Harbours and Anchorages in the West Solent Area) show that there have been no major changes to the bathymetry of the Beaulieu Estuary since the 2009 sanitary survey.

No records of developments since 2009 which might affect the hydrography of the estuary could be found.



## 7. Rainfall

There were no freely available rainfall data available that were relevant to the Beaulieu estuary.

# 8. Microbial Monitoring Results

## 8.1. Summary statistics and geographical variation

There are a total of five RMPs in the Beaulieu production area that have been sampled between 2004 and 2014. Two of these RMPs are for native oysters and three are for *Tapes* spp. (Manila clams). Three of these RMPs (Bucklers Hard, Needs Ore and Baileys Hard) have been sampled both before and after the original sanitary survey.

The geometric mean results of shellfish flesh monitoring from all RMPs sampled from 2004 onwards are presented in Figure 8.1 and summary statistics are presented in Table 8.1. Baileys Hard (2004-2008), The Hummicks and Landing Stage *Tapes* spp. RMPs were sampled on fewer than 10 occasions and so will not be considered further. Boxplots for sites with 10 or more samples are shown in Figure 8.2 to Figure 8.3.

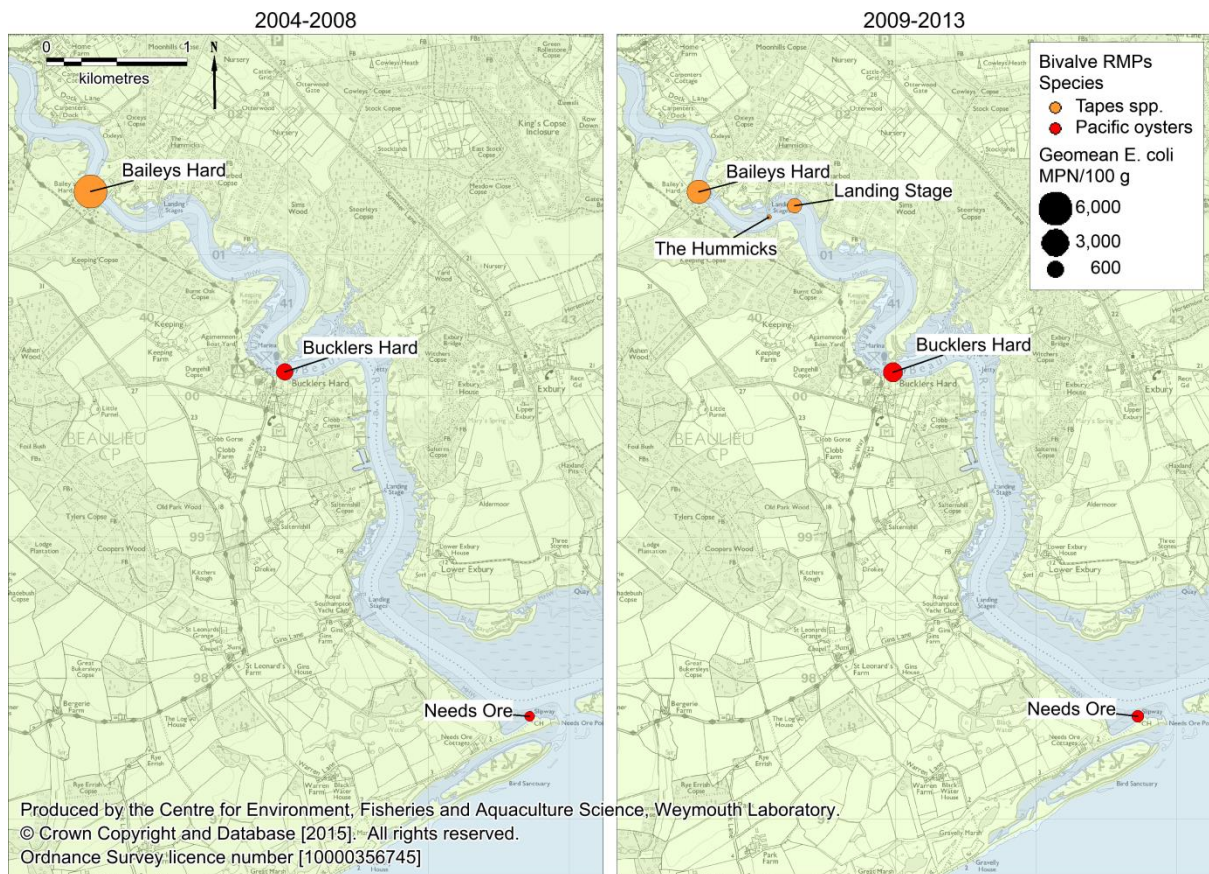
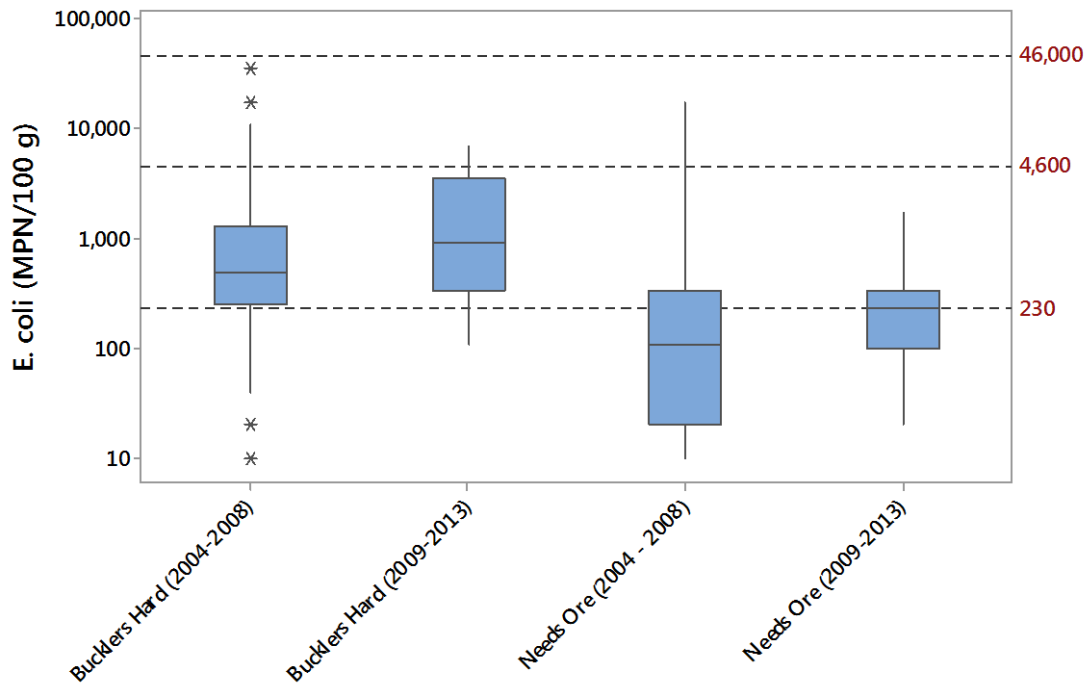


Figure 8.1: Bivalve RMPs active since 2004

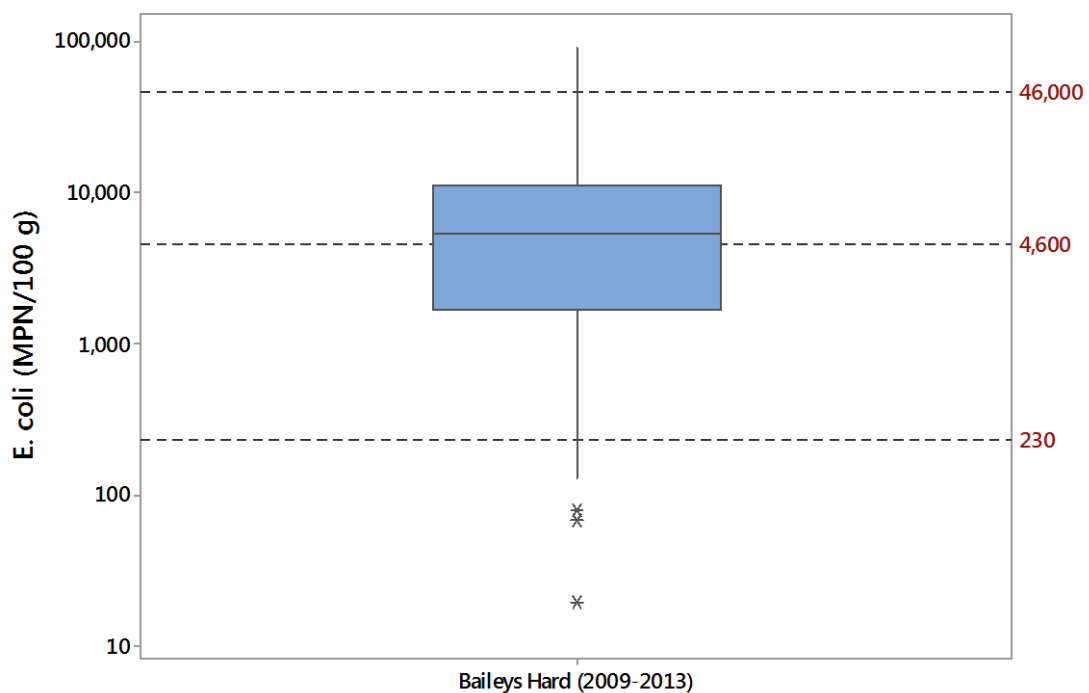
**Table 8.1: Summary statistics of *E. coli* results (MPN/100 g) from RMPs sampled from 2004 onwards**

Sampling Site	Species	No.	Date of first sample	Date of last sample	Geometric mean	Min.	Max.	% over 230	% over 4,600	% over 46,000
Bucklers Hard (2004-2008)		51	26/01/2004	17/12/2008	589.6	<20	35,000	76.5	11.8	0.0
Bucklers Hard (2009-2013)	Native	20	15/01/2009	24/08/2010	1,027.9	110	7,000	80.0	15.0	0.0
Needs Ore (2004-2008)	oyster	47	26/01/2004	17/12/2008	115.0	<20	17,000	29.8	4.3	0.0
Needs Ore (2009-2013)		21	15/01/2009	08/09/2010	196.2	20	1,700	38.1	0.0	0.0
Baileys Hard (2004-2008)		9	09/02/2004	05/05/2004	5,979.0	1,100	54,000	100.0	44.4	11.1
Baileys Hard (2009-2013)	<i>Tapes</i>	35	04/06/2009	31/07/2012	3,426.9	20	92,000	82.9	57.1	5.7
The Hummicks	spp.	1	12/08/2009	12/08/2009	170.0	170	170	0.0	0.0	0.0
Landing Stage		5	07/11/2013	05/12/2013	1,494.7	130	9,200	80.0	40.0	0.0



**Figure 8.2: Boxplots of *E. coli* results from native oyster RMPs.**

*E. coli* levels exceeded 4,600 MPN/100 g at Bucklers Hard in more than 10% of samples both before and after 2008, but never exceeded 46,000 MPN/100 g. One-way ANOVA tests revealed significant differences in *E. coli* levels between the sites ( $p < 0.001$ ). Post ANOVA Tukey tests showed that Buckler's Hard had significantly higher *E. coli* levels than Needs Ore both before and after 2008.



**Figure 8.3: Boxplots of *E. coli* results from *Tapes* spp.**

*E. coli* levels at Baileys Hard exceeded 46,000 MPN/100 g on 5.7% of occasions.

## 8.2. Overall temporal pattern in results

The overall variation in *E. coli* levels found in bivalves is shown in Figure 8.4 and Figure 8.5.

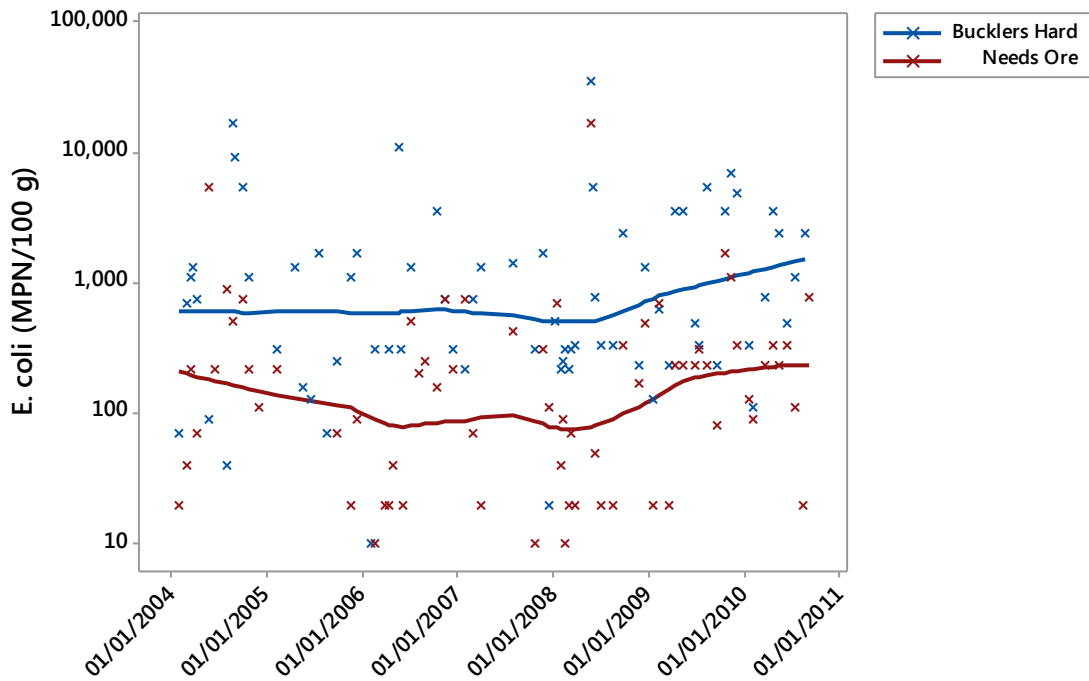


Figure 8.4: Scatterplot of *E. coli* results for native oysters overlaid with loess line.

There have been no overall changes in *E. coli* levels in native oysters since 2004 at either site. Two-sample T-tests revealed that there were no significant differences in *E. coli* levels in samples taken before and after 2008 at either Bucklers Hard or Needs Ore ( $p= 0.146$  and  $0.143$  respectively).

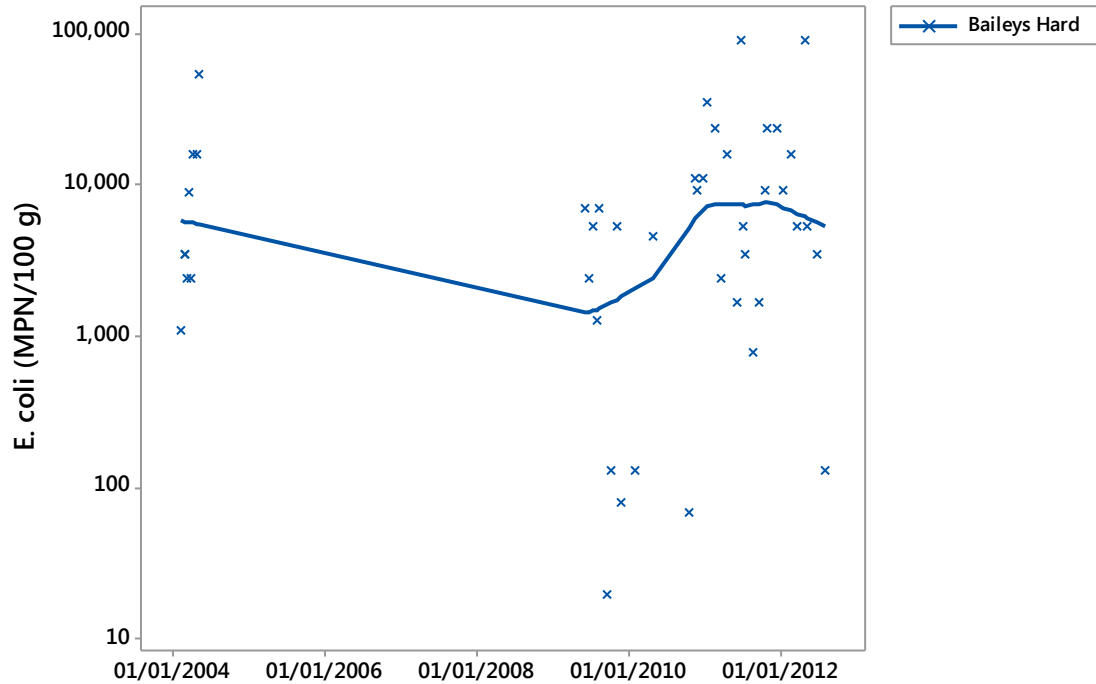
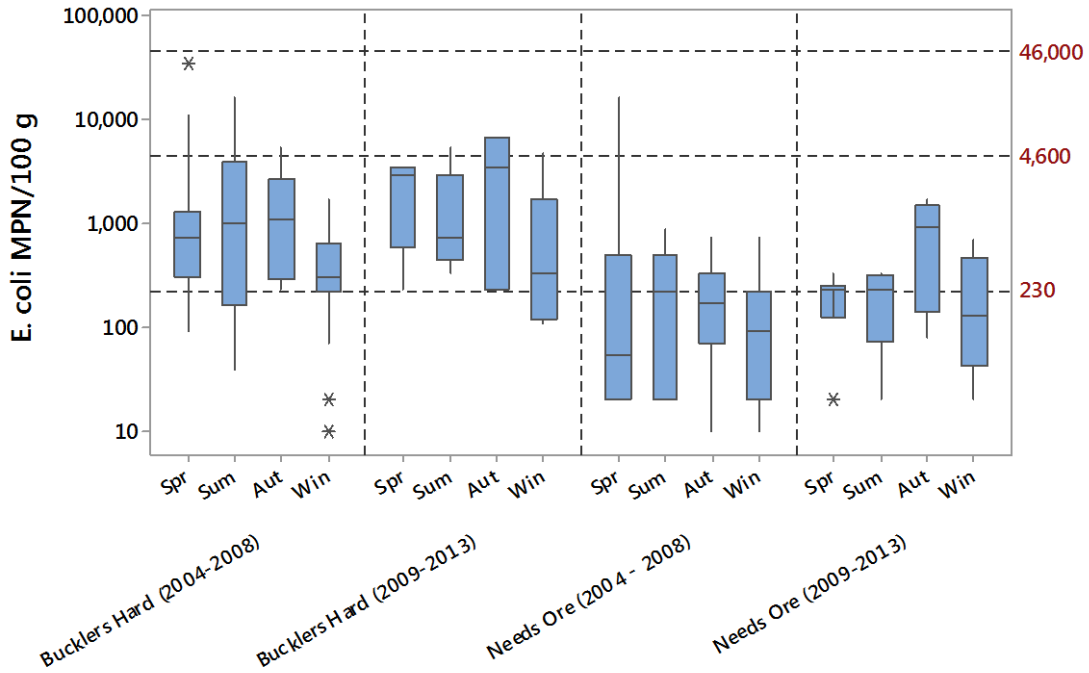


Figure 8.5: Scatterplot of *E. coli* results for *Tapes* spp. overlaid with loess line.

*E. coli* levels have remained fairly stable at the Baileys Hard *Tapes* spp. RMP since 2004. However, there have been several results below 1,000 MPN/100 g since 2008, which had previously not been seen at this RMP.

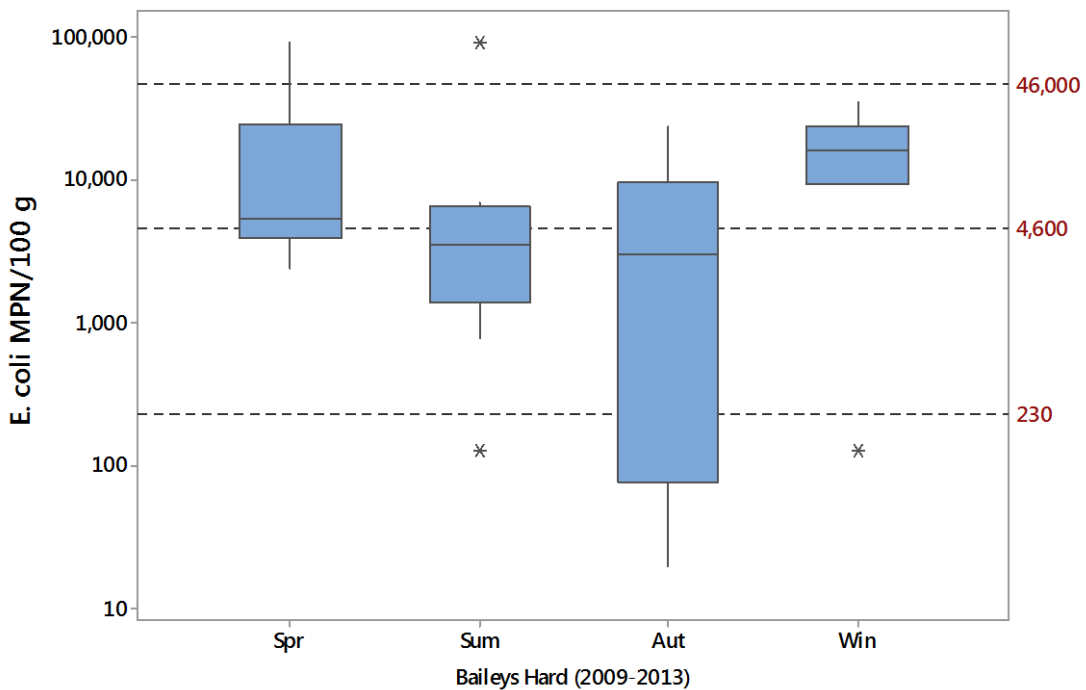
### 8.3. Seasonal patterns of results

The seasonal patterns of results from 2004 to 2013 were investigated by RMP. Figure 8.6 and Figure 8.7 show box plots of *E. coli* levels at each site by season.



**Figure 8.6: Boxplot of *E. coli* results for native oysters by RMP and season**

One-way ANOVAs showed that there were no significant variations in *E. coli* levels between seasons at any of the native oyster RMPs ( $p=0.069$  to  $0.364$ ).



**Figure 8.7: Boxplot of *E. coli* results for *Tapes* spp. by RMP and season**

One-way ANOVAs showed that there were no significant variations in *E. coli* levels between seasons at the Baileys Hard RMP ( $p=0.118$ ).

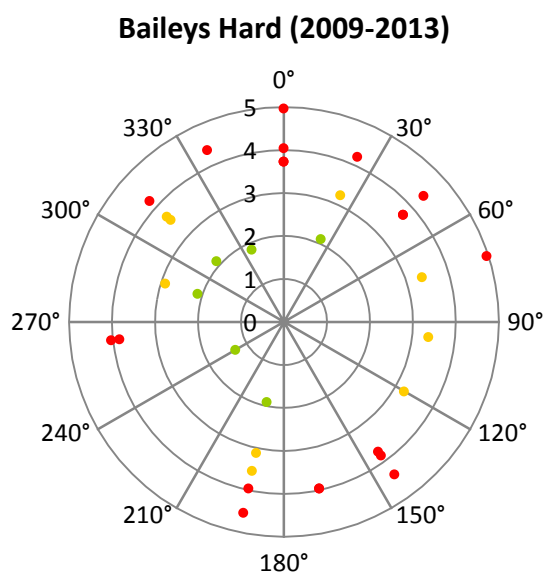
## 8.4. Influence of tide

To investigate the effects of tidal state on *E. coli* results, circular-linear correlations were carried out against the high/low and spring/neap tidal cycles for each RMP where more than 30 samples had been taken. Results of these correlations are summarised in Table 8.2, and significant results are highlighted in yellow.

**Table 8.2: Circular linear correlation coefficients (r) and associated p values for *E. coli* results against the high/low and spring/neap tidal cycles**

Site Name	Species	High/low tides		Spring/neap tides	
		r	p	r	p
Bucklers Hard (2004-2008)	Native oyster	0.201	0.143	0.075	0.762
Needs Ore (2004-2008)		0.252	0.061	0.125	0.503
Baileys Hard (2009-2013)	<i>Tapes</i> spp.	0.235	0.172	0.324	0.034

Figure 8.8 presents a polar plot of log<sub>10</sub> *E. coli* results against the spring neap tidal cycle for the Baileys Hard *Tapes* spp. RMP. Full/new moons occur at 0°, and half moons occur at 180°, and the largest (spring) tides occur about 2 days after the full/new moon, or at about 45°, then decrease to the smallest (neap tides) at about 225°, then increase back to spring tides. Results of 230 *E. coli* MPN/100 g or less are plotted in green, those from 231 to 4,600 are plotted in yellow, and those exceeding 4,600 are plotted in red.



**Figure 8.8: Polar plot of log<sub>10</sub> *E. coli* results (MPN/100 g) at against spring/neap tidal state**

Despite significant correlations calculated between *E. coli* levels and the spring/neap tidal state, there is no pattern distinguishable pattern in Figure 8.8.



## 9. References

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# Acknowledgements

David Mitchell (harvester), Dale Bruce (New Forest District Council).

# Appendices

# Appendix I. Shoreline Survey Report

## Date (time):

23/02/2015 09.30 – 15:00

## Cefas Officers:

Rachel Parks, Alastair Cook and Matthew Green

## Area surveyed:

The Beaulieu estuary, between the Mill Dam sluice gate at Beaulieu village and Gull Island in the outer estuary.

## Weather:

23/02/2015 - overcast with sunny spells and icy showers, 6.4°C, wind bearing/speed 240°/22.2 km/h.

## Tides:

Bucklers Hard. Admiralty TotalTide®.  
Predictions are based on Portsmouth.

### 23/02/2015

High 01:48	3.8 m
High 14:03	3.7 m
Low 07:28	0.3 m
Low 19:48	0.3 m

## Objectives:

The shoreline survey aims to confirm the location of previously identified sources of potential contamination; locate other potential sources of contamination that were previously unknown, obtain samples of freshwater inputs and pipeline discharges to the area for bacteriological testing, find out more information about the fishery and lend context to elements of the desk study. A full list of recorded observations is presented in Table I.1 and the locations of these observations are shown in Figure I.1.

## I.1. Fishery

Currently all of the Beaulieu River production area is closed to harvesting. The whole of the Beaulieu is a private fishery with the current rights for the harvesting of manila clams and native oysters belonging to David Mitchell. In the northern section of the Beaulieu, between Bailey's Hard and north east of Buckler's Hard the classification zone for manila clams is prohibited due to high *E. coli* results. Illegal harvesting of manila clams has been reported by the harvester since the area has become prohibited. The harvester expressed an interest in moving the classification zone for manila clams further down the estuary to see if better hygiene results were observed.

Native oysters were classified in the Beaulieu south of Buckler's Hard until 2011. Declassification occurred due to a lack of commercially available stock. The harvester expressed an interest in undertaking a survey to establish the current distribution of native oysters in the lower Beaulieu and getting the area reclassified.

## **I.2. Sources of contamination**

### **Sewage discharges**

The location of Bucklers Hard STW and Bucklers Hard STW outfall were confirmed and the outfall effluent gave an *E. coli* concentration of 33,000 cfu/100 ml. Beaulieu Village WwTW continuous and intermittent discharge (26) locations were confirmed, however the pipes were submerged at the time of the survey. Spearbed Copse private discharge (21) was located but also submerged. It was therefore difficult to assess whether these discharges were pumping at the time of survey and if so obtain a sample.

A possible septic tank (22) was sighted close to a property on the north eastern shore of the Beaulieu which is not on the EA consents database. No associated pipe was observed.

### **Freshwater inputs**

Small stream inputs were observed at several locations throughout the Beaulieu (5, 15, 19, 24 & 25). For most of these, *E. coli* concentrations ranged between 150 and 800 cfu/100 ml. Observation 5 had relatively high *E. coli* loadings of  $4.45 \times 10^{10}$  cfu/day.

A sluice in Beaulieu village through which the Beaulieu River drains to the Beaulieu estuary (observation 1), and therefore represents all sources above the tidal limit, had a high *E. coli* concentration of 4,000 cfu/100 ml.

Several pipes that were not listed in the EA consents database were observed in the Beaulieu. It is therefore assumed that these are either surface or ground water drainage (2, 3, 4, 11, 12, 13, 16 & 17). At the time of survey six were flowing but only two were sampled as the flow was too small to measure at observation 3, 11, 16 and 17. *E. coli* results of those sampled gave *E. coli* results between 50 and 1,000 cfu/100 ml (4 & 12).

Surface water samples were taken at two locations within the Beaulieu, in the upper (CTD 2, 630 cfu/100 ml) and mid estuary (CTD 3, 140 cfu/100 ml). Samples are referred to as CTD samples as conductivity, temperature and depth measurements were taken at the same location and time as water samples.

### **Livestock**

No livestock was observed on the shoreline survey.

### **Wildlife**

Birds were observed throughout the survey area (7, 10, 18, 20, 23 & 27).

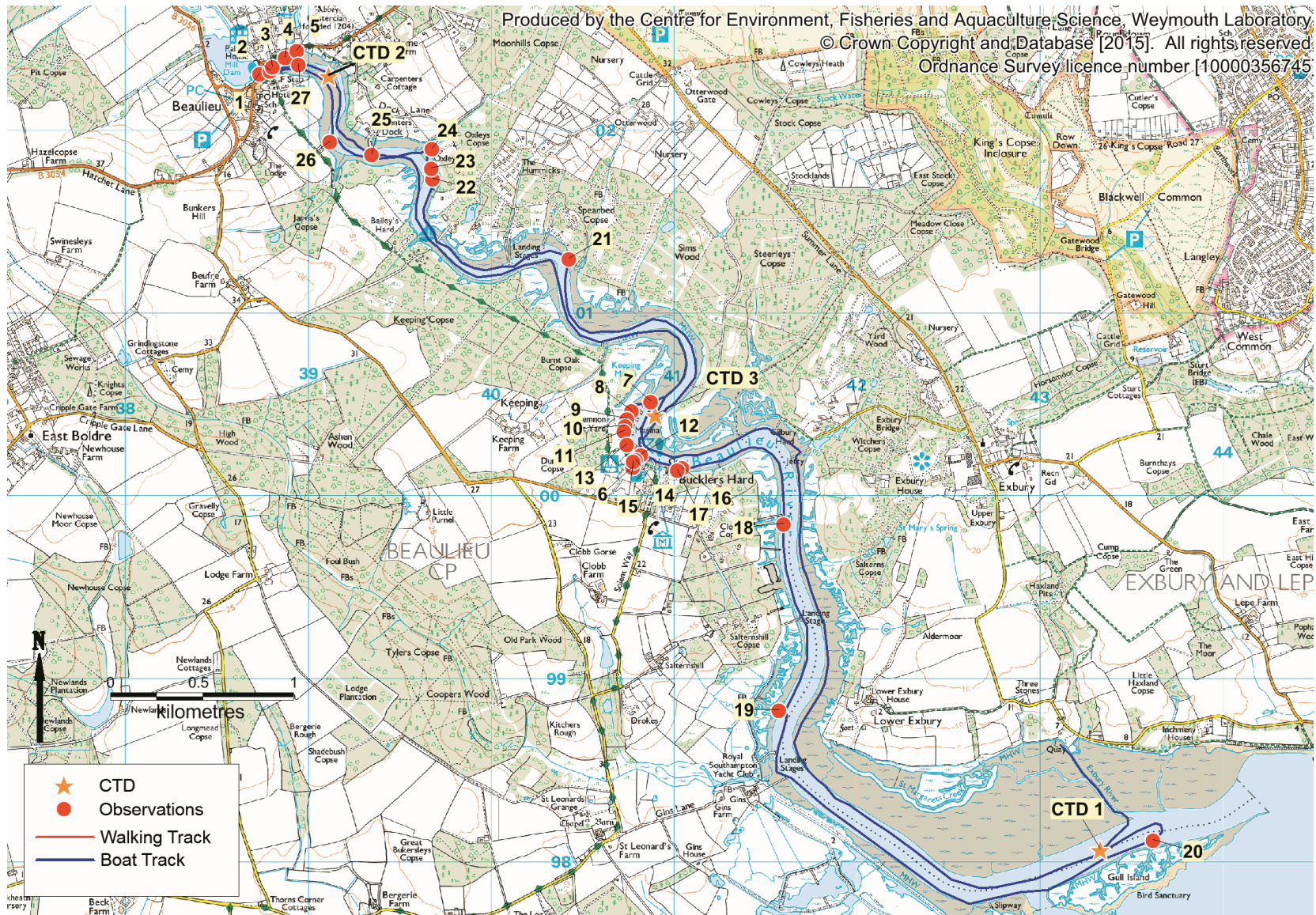


Figure I.1: Locations of shoreline observations (see Table I.1 for details).

**Table I.1: Details of Shoreline Observations**

Observation no.	NGR	Date	Time Description	Photo
1	SU3873402311	23/02/2015	09:00 Sample from above sluice gate, B01	Figure I.6
2	SU3879002327	23/02/2015	09:04 Pipe submerged	Figure I.7
3	SU3880302347	23/02/2015	09:06 Surface drainage pipe, dripping	Figure I.8
4	SU3887202398	23/02/2015	09:07 Pipe with flat valve, flowing (0.17m x 0.02m x 0.184m/s), B02	Figure I.9
5	SU3893502436	23/02/2015	09:12 Stream and pipe, flowing (1.15m x 0.3m x 0.711m/s), B03	Figure I.10
6	SU4077200162	23/02/2015	09:39 Bucklers Hard STW	Figure I.11
7	SU4087000519	23/02/2015	10:50 ~30 ducks on the river	
8	SU4076600469	23/02/2015	10:51 Marsh drainage channel	
9	SU4074200423	23/02/2015	10:52 Marsh drainage channel	
10	SU4073000387	23/02/2015	10:52 ~ 20 ducks	
11	SU4072600357	23/02/2015	10:53 Pipe with flat valve, trickling	Figure I.12
12	SU4081600226	23/02/2015	11:00 Pipe with flat valve, flowing (0.52m x 0.07m x 0.200m/s), B04	
13	SU4074100285	23/02/2015	11:01 Pipe, flowing (0.09m x 0.03m x 0.384 m/s), B05	Figure I.13
14	SU4078900203	23/02/2015	11:08 Bucklers Hard STW outfall (0.43m x 0.01m x 0.058m/s), B06	
15	SU4077700194	23/02/2015	11:09 Culverted stream, flowing	
16	SU4104300159	23/02/2015	11:30 Pipe, dribbling	
17	SU4101500146	23/02/2015	11:32 Pipe in quay, dribbling	
18	SZ4159899850	23/02/2015	11:40 ~ 30 ducks	
19	SZ4157098832	23/02/2015	12:11 Stream, flowing, B07	
20	SZ4361698122	23/02/2015	13:30 ~ 40 gulls	
21	SU4042201299	23/02/2015	13:30 Spearbed Copse Private discharge submerged	Figure I.14
22	SU3967801738	23/02/2015	13:41 Possible septic tank	
23	SU3967301795	23/02/2015	13:43 ~ 30 gulls	
24	SU3967601901	23/02/2015	13:45 Unnamed stream culverted, flowing, B08	
25	SU3934601870	23/02/2015	13:52 Submerged culvert	Figure I.15
26	SU3911601939	23/02/2015	13:55 Beaulieu Village WwTW continuous and intermittent discharge	
27	SU3894502361	23/02/2015	14:03 ~40 gulls	
CTD 1	SZ4332998071	23/02/2015	12:27 CTD measurement	
CTD 2	SU4089500447	23/02/2015	14:00 CTD measurement and water sample	
CTD 3	SU3911002302	23/02/2015	14:29 CTD measurement and water sample	

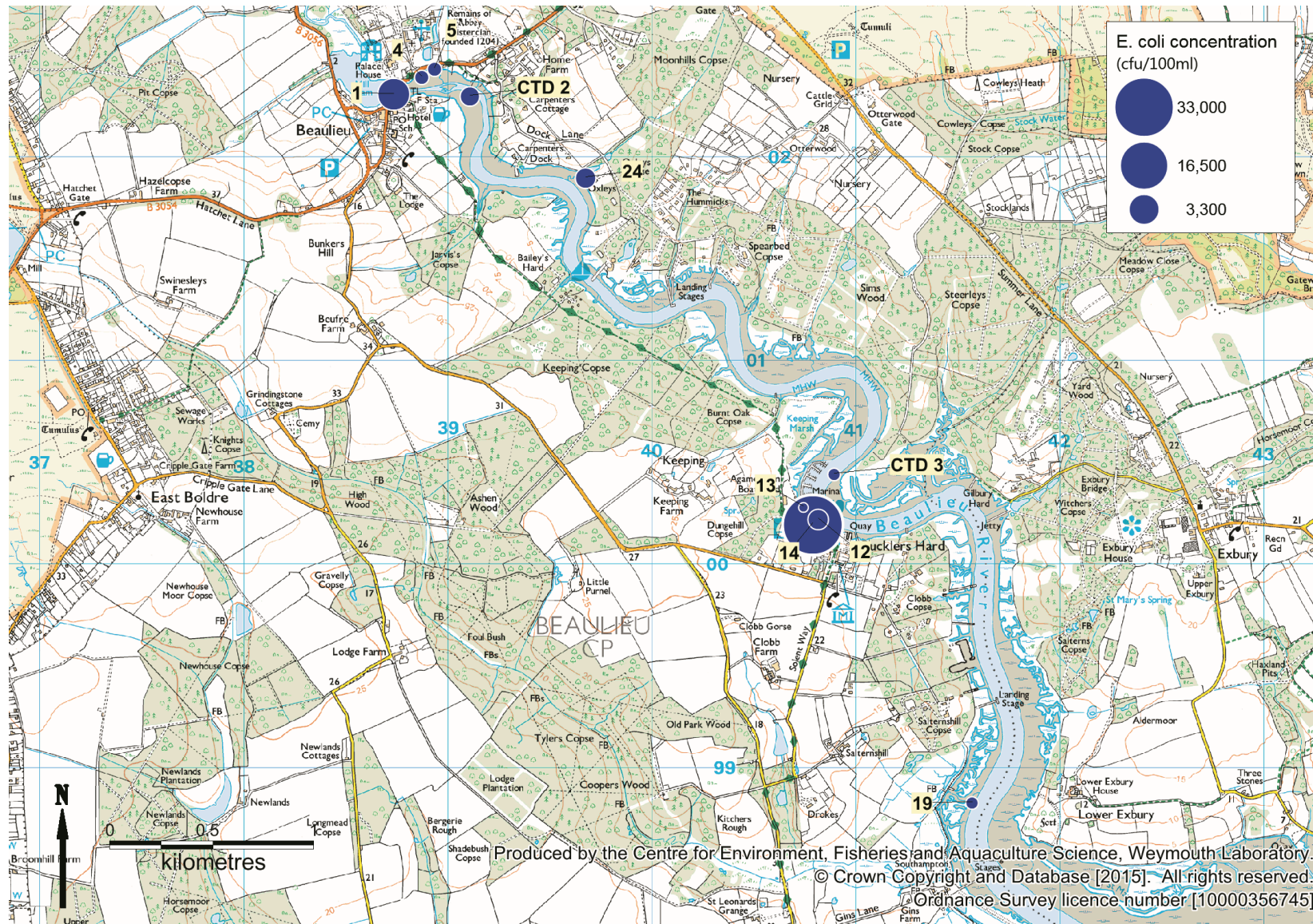


Figure I.2: Water sample results (Table I.2 for details).



**Table I.2: Water sample *E. coli* results, spot flow gauging results and estimated loadings.**

Sample ID	Observation number	Date and time	Description	Flow (m/s)	<i>E. coli</i>		NGR
					concentration (cfu/100 ml)	<i>E. coli</i> loading (cfu/day)	
B01	1	23/02/2015 09:00	Sample from above sluice gate	Too large to measure	4,000	-	SU3873402311
B02	4	23/02/2015 09:08	Pipe with flat valve	0.001	230	1.24x10 <sup>8</sup>	SU3887202398
B03	5	23/02/2015 09:12	Stream and pipe	0.245	210	4.45x10 <sup>10</sup>	SU3893502436
B04	12	23/02/2015 11:00	Pipe with flat valve	0.007	963	6.06x10 <sup>9</sup>	SU4081600226
B05	13	23/02/2015 11:02	Pipe	0.001	50	4.48x10 <sup>7</sup>	SU4074100285
B06	14	23/02/2015 11:09	Bucklers Hard STW Outfall	<0.001	33,000	7.11x10 <sup>9</sup>	SU4078900203
B07	19	23/02/2015 12:11	Stream	Not accessible	150	-	SZ4361698122
B08	24	23/02/2015 13:46	Unnamed stream culverted	Not accessible	800	-	SU3967601901
B09	CTD 2	23/02/2015 14:00	CTD deployment	-	140	-	SU4089500447
B10	CTD 3	23/02/2015 14:30	CTD deployment	-	630	-	SU3911002302

### I.3. Conductivity, temperature and depth (CTD) measurements

Conductivity on the practical salinity scale (PSS), temperature in °C and depth in metres [CTD] measurements were taken at three locations within the Beaulieu River shown in Figure I.1. Temperature and salinity profiles for these locations are shown in Figure I.3 to Figure I.5.

CTD measurements were taken in the upper, middle and lower Beaulieu estuary. CTD 1 was taken 1.5 hours before high water and CTD 2 and 3 measurements were taken on the ebb tide. In the lower estuary CTD 1 the salinity and temperature measurements were fairly constant (31.5 – 32.4 PSS and 6.3°C) throughout the water column showing that there is limited variation in salinity and therefore minimal freshwater inputs.

In the upper estuary (CTD 2) there was a large freshwater influence, as demonstrated by the salinity ranges recorded, from 0 PSS at the surface increasing to 7.7 PSS at 2.9 metres. The temperature is fairly constant between 5.9 and 6.1 °C.

In the mid estuary (CTD 3) there is incomplete mixing with lower salinities being recorded in the surface waters and higher salinities at depth.

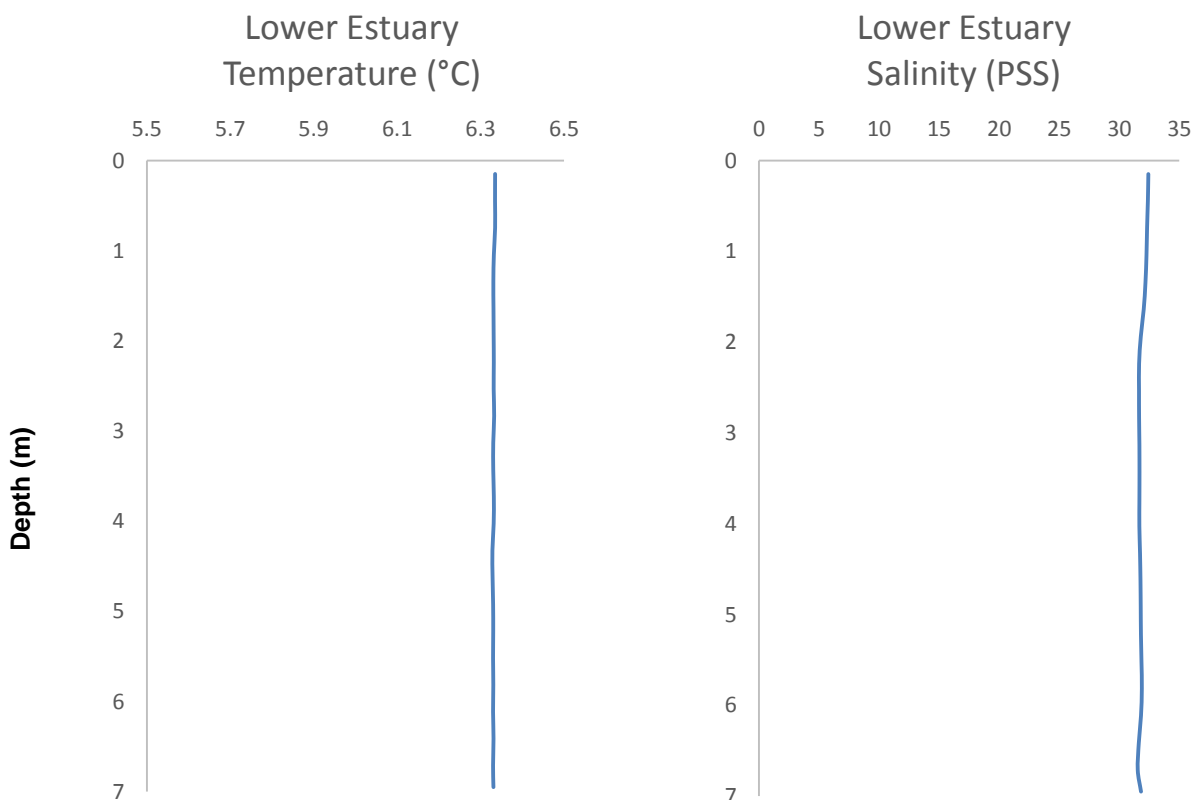
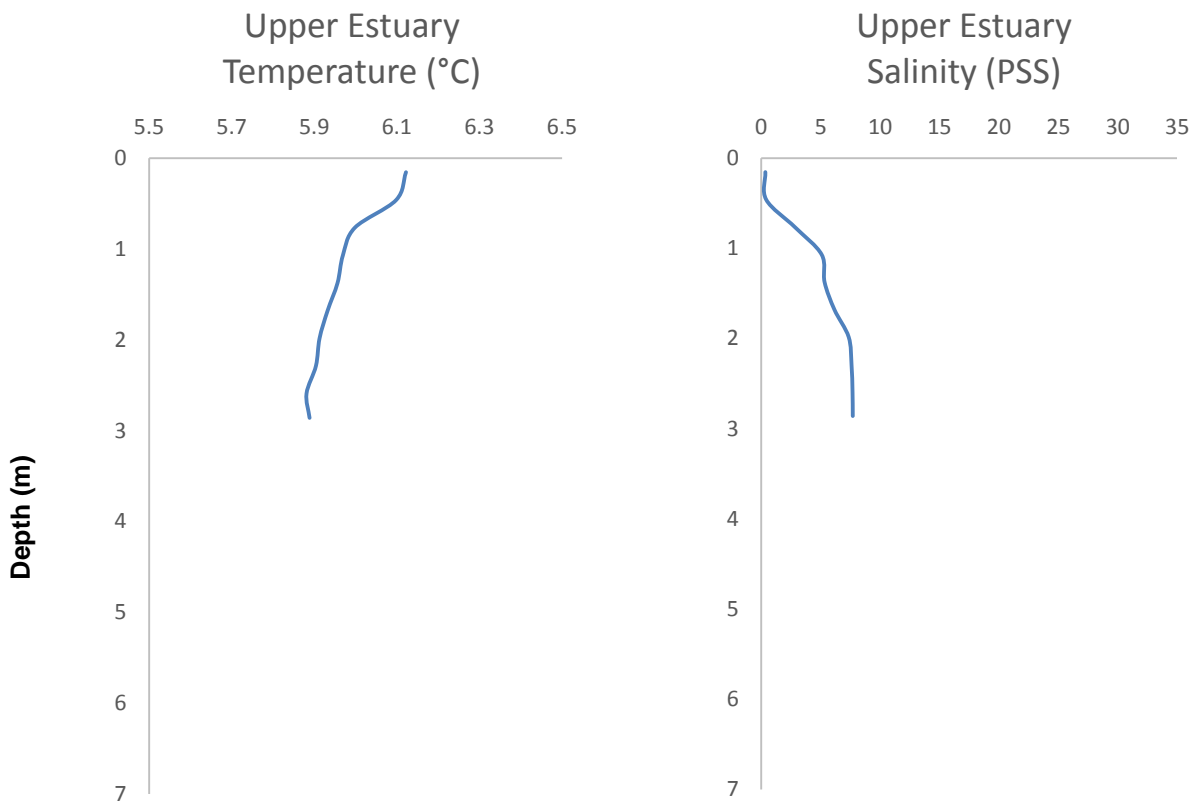
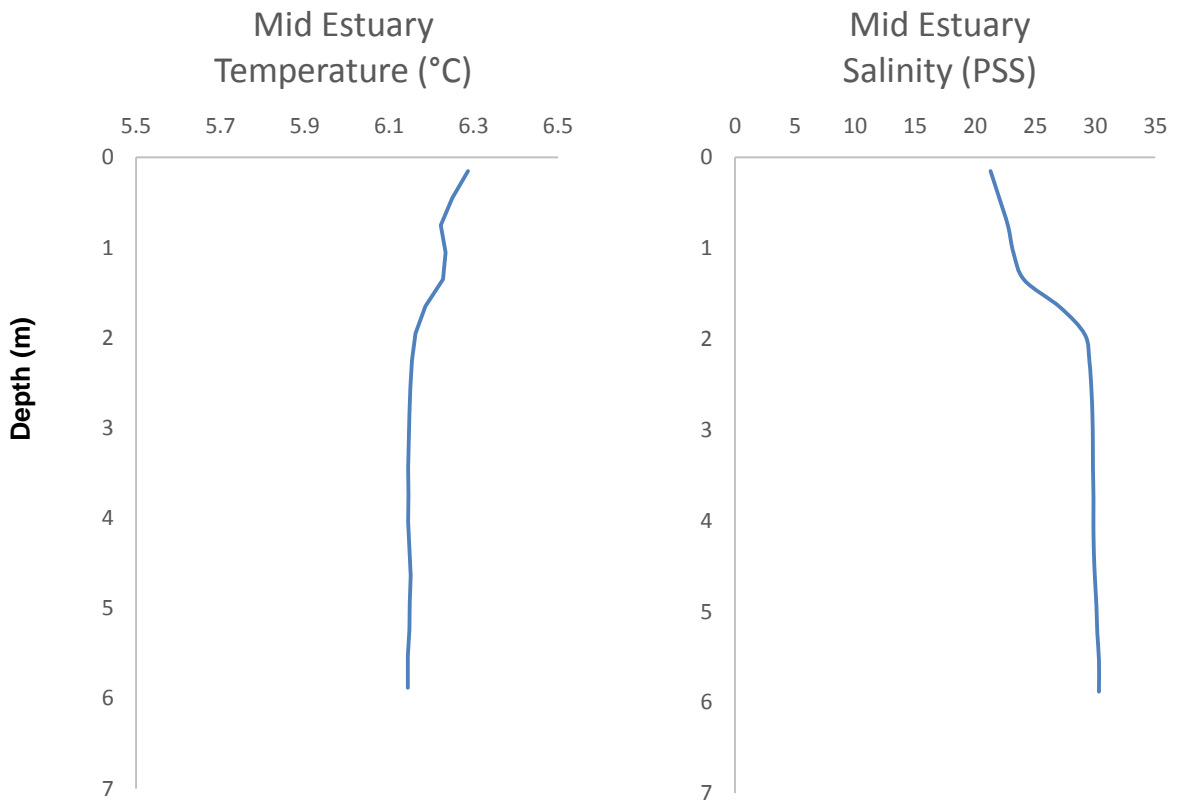


Figure I.3 CTD 1



**Figure I.4 CTD 2**



**Figure I.5 CTD 3**



**Figure I.6**



**Figure I.7**



**Figure I.8**



**Figure I.9**



**Figure I.10**



**Figure I.11**



**Figure I.12**



**Figure I.13**



**Figure I.14**



**Figure I.15**



# **Appendix II. Beaulieu River Sanitary Survey Report 2009**