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Camel Sanitary Survey

Review

March 2015

Food Standards Agency

Cover photo: Floating cages of juvenile Pacific oysters up-estuary of Pinkson Creek

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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 Camel 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.

Report prepared by

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Revision history

Version	Details	Approved by	Approval date
1	Draft for internal review	Rachel Parks	09/03/2015
2	Draft for external review	Simon Kershaw	24/03/2015
Final	Final report post consultation	Simon Kershaw	18/06/2015

Consultation

Consultee	Date of consultation	Date of response
Cornwall Port Health Authority	25/03/2015	26/03/2015
Environment Agency	25/03/2015	01/05/2015
Cornwall Inshore Fisheries & Conservation Authority	25/03/2015	None
South West Water	25/03/2015	None
Natural England	25/03/2015	23/04/2015
Shellfish Association of Great Britain	25/03/2015	01/05/2015
Defra	25/03/2015	None

Dissemination

Food Standards Agency, Cornwall Port Health Authority. The report is available publicly via the Cefas website.

Recommended Bibliographic Reference

Cefas, 2015. Review of the Camel 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.

Contents

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. Camel Review

This report reviews information and makes recommendations for a revised sampling plan for existing mussel, Pacific oyster and peppery furrow shell classification zones in the Camel Estuary (Figure 1.1). This review identifies changes to information presented in the sanitary survey through a desk based study, and shoreline survey and updates the assessment and sampling plan as necessary.

Specifically, the review considers:

(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

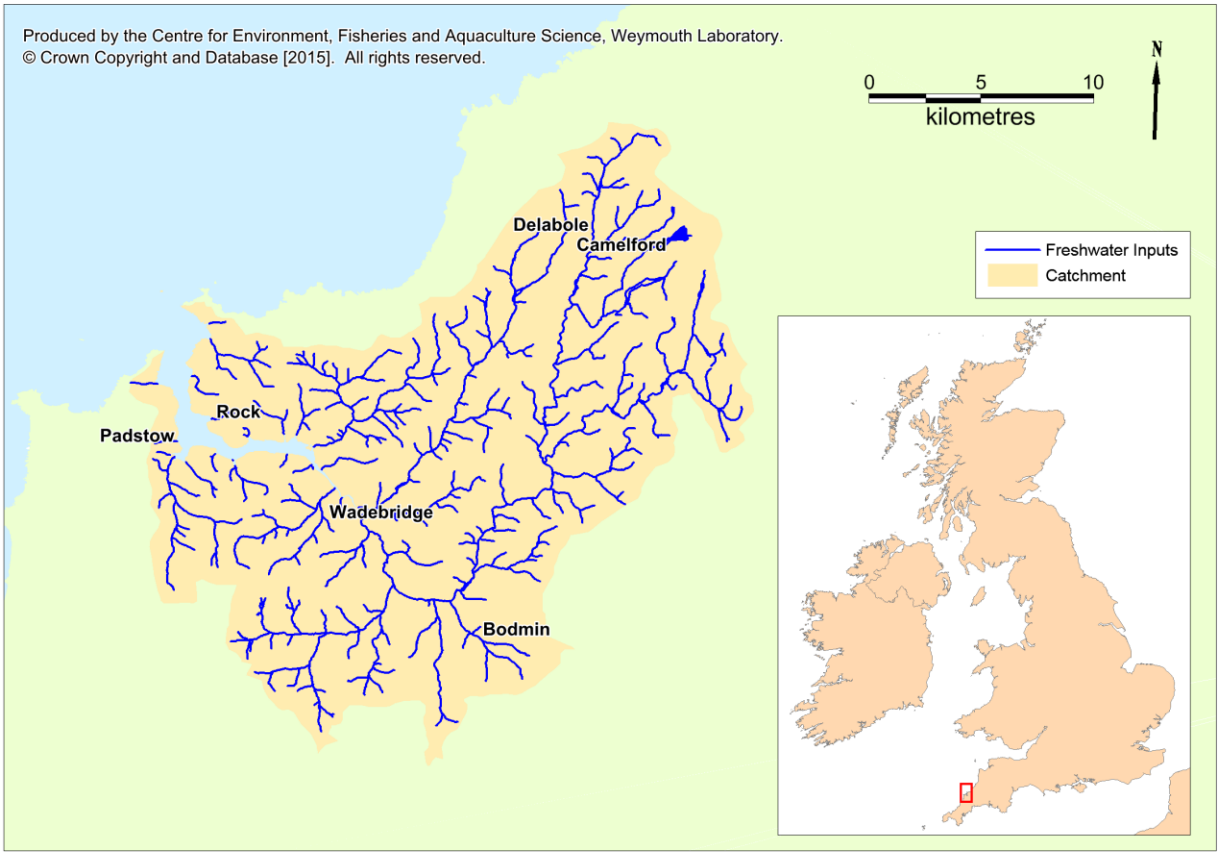


Figure 1.1: Location of the Camel Estuary

1.3. Landcover

Figure 1.2 and Figure 1.3 illustrate landcover within the Camel catchment before and after the 2009 sanitary survey. The urban:rural land ratio within the catchment has remained largely unchanged. The catchment is predominantly covered by rural land with smaller areas of urbanised land, surrounding the estuary representing the towns and villages of Padstow, Wadebridge, Rock, Trebetherick and Polzeath. Before the sanitary survey a large proportion of the rural catchment was covered by pasture land but since then a high proportion of this pasture land (particularly in the lower catchment) has been converted to non-irrigated arable land. This change in land use, with less livestock being situated in fields in the lower catchment, could reduce the amount of microbiological pollution being transported to the shellfish beds via surface run off.

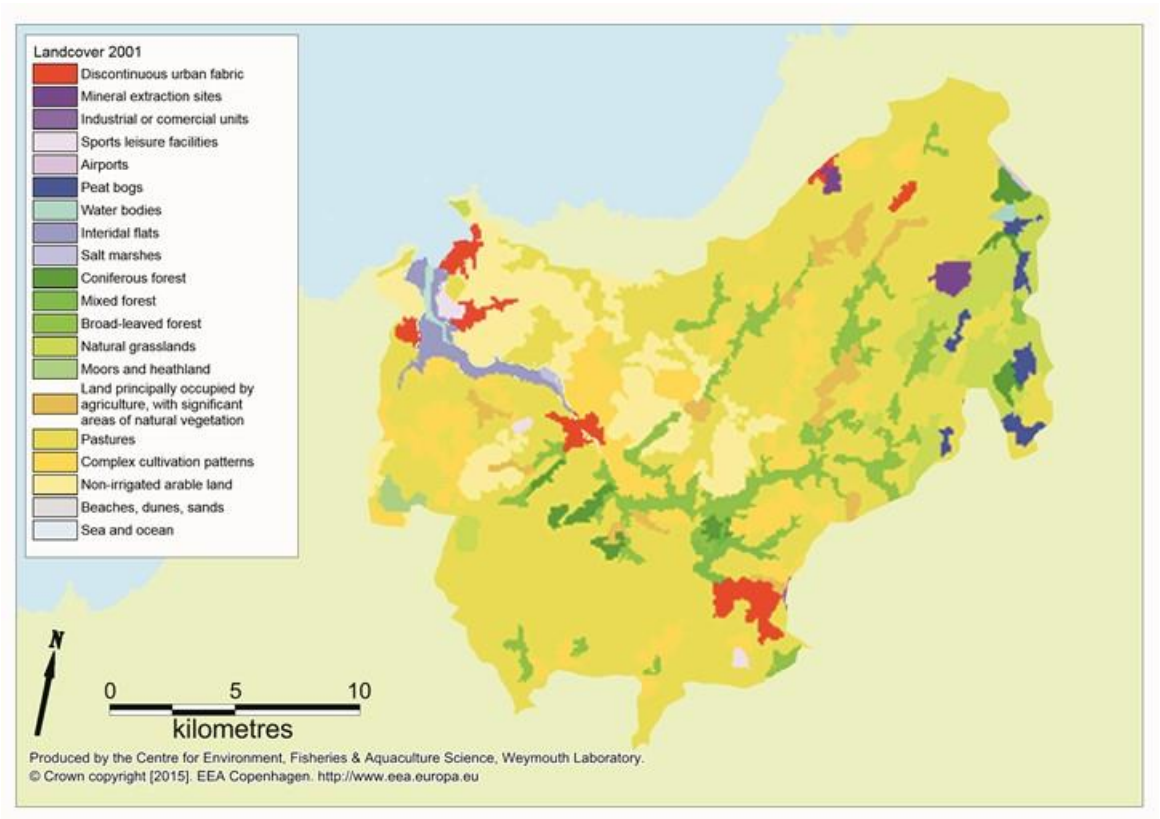


Figure 1.2: Landcover in the Camel Estuary (2001 data)

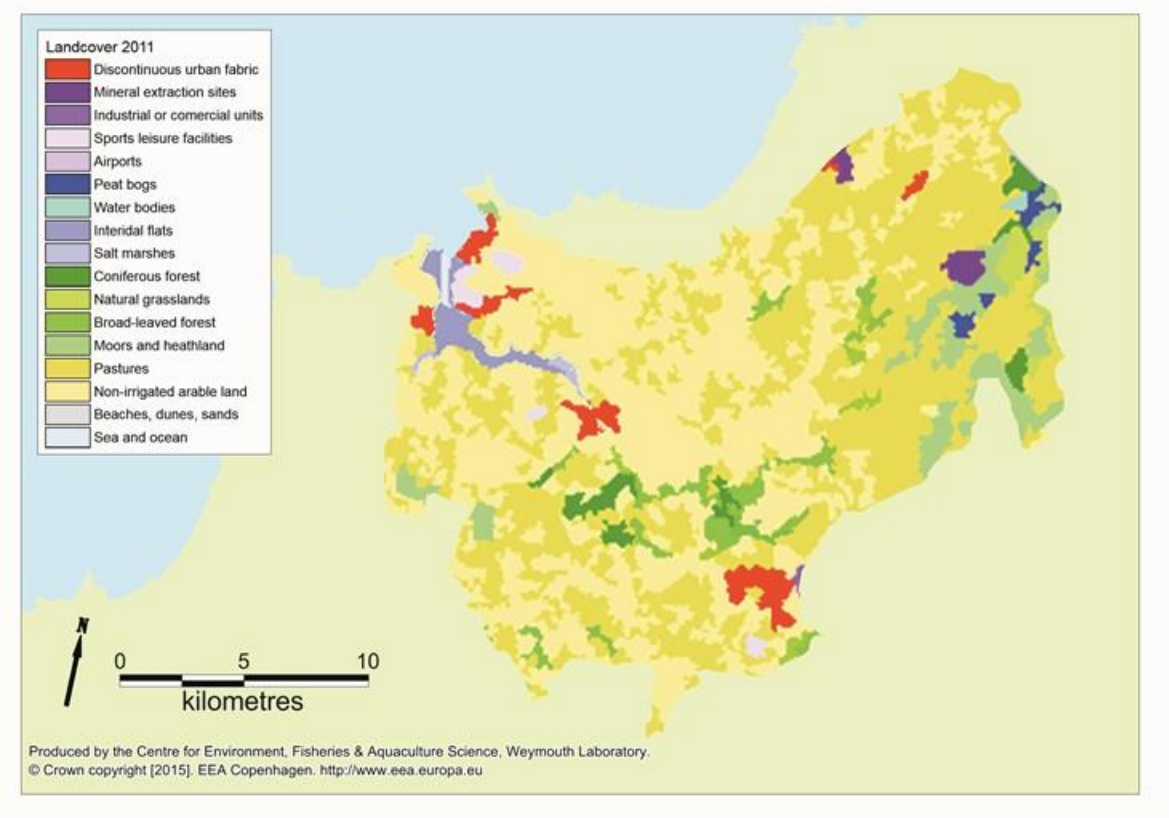


Figure 1.3: Landcover in the Camel Estuary (2011 data)

2. Shellfisheries

2.1. Description of shellfishery

The locations and extents of the mussel (*Mytilus* spp.), Pacific oyster (*Crassostrea gigas*) and peppery furrow clam (*Scrobicularia plana*) beds are shown in Figure 2.1.

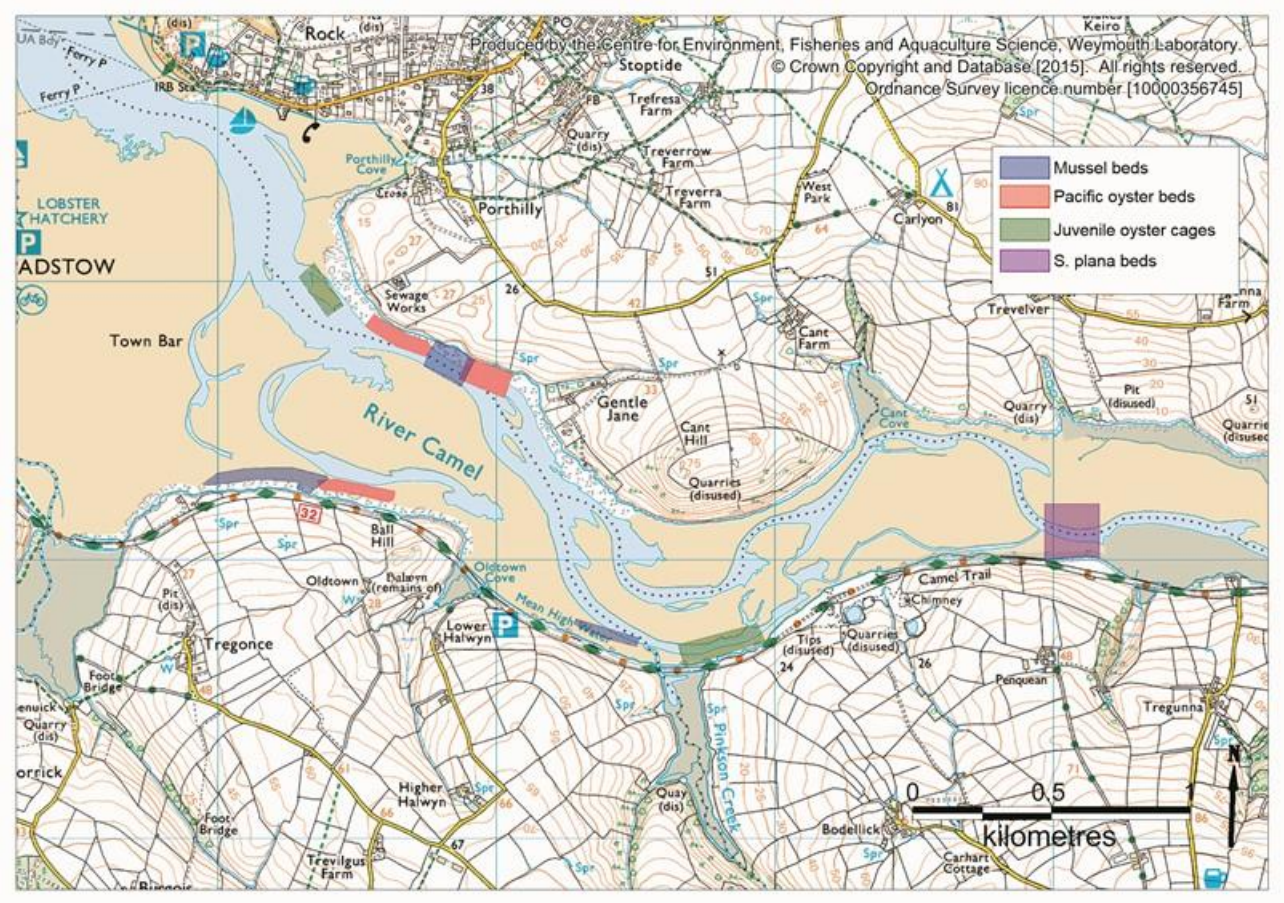


Figure 2.1: Locations of mussel, Pacific oyster and clams beds in the Camel production area.

The River Camel mussel and oyster Fishery Order 2013 states that I. Marshall and Sons LLP has “a right of Several Fishery for Pacific Oysters (*Crassostrea gigas*) and Mussels (*Mytilus edulis*) in the River Camel (Cornwall) for a period of 15 years”. The locations of the Camel mussel and oyster Fishery Order is presented in Figure 2.2.

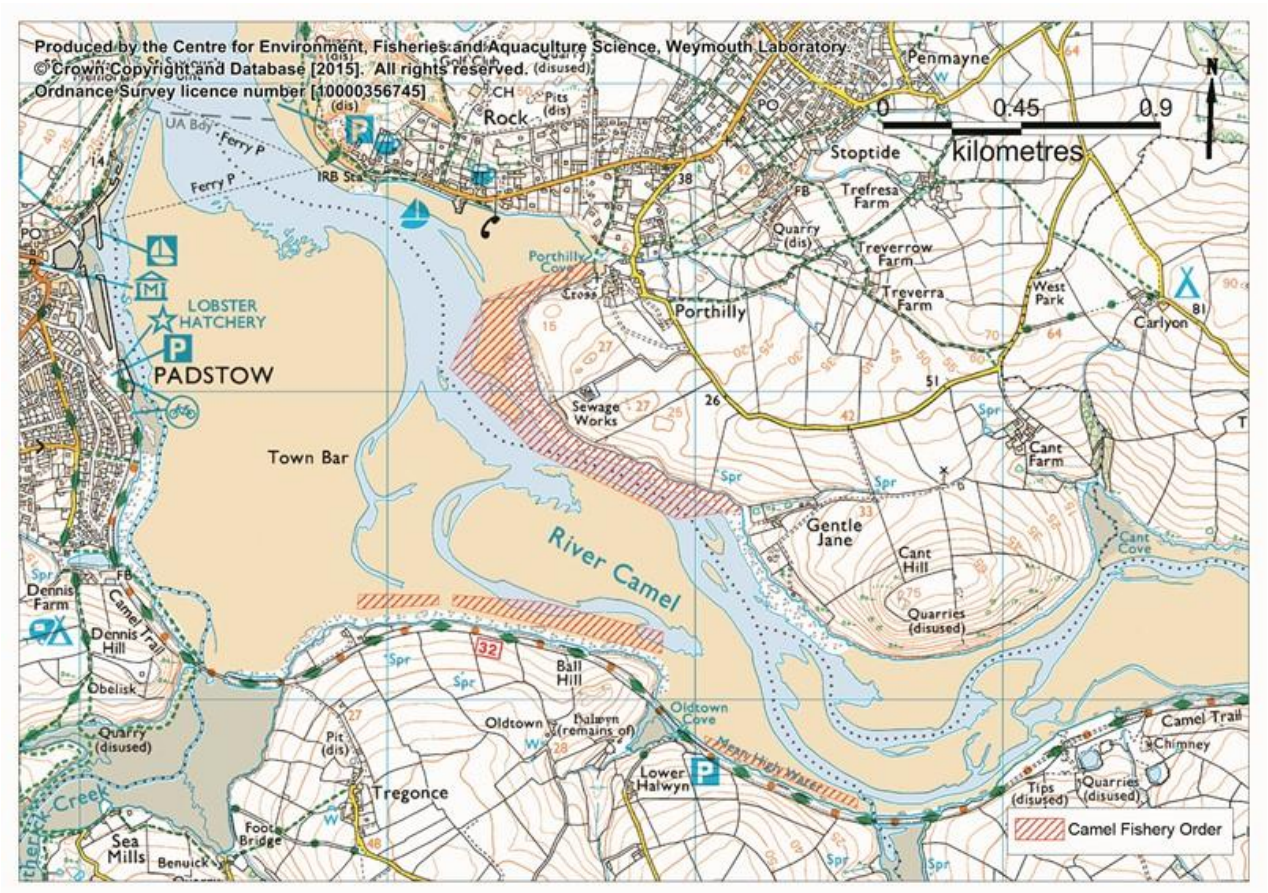


Figure 2.2: Locations of the Camel mussel and oyster Fishery Order

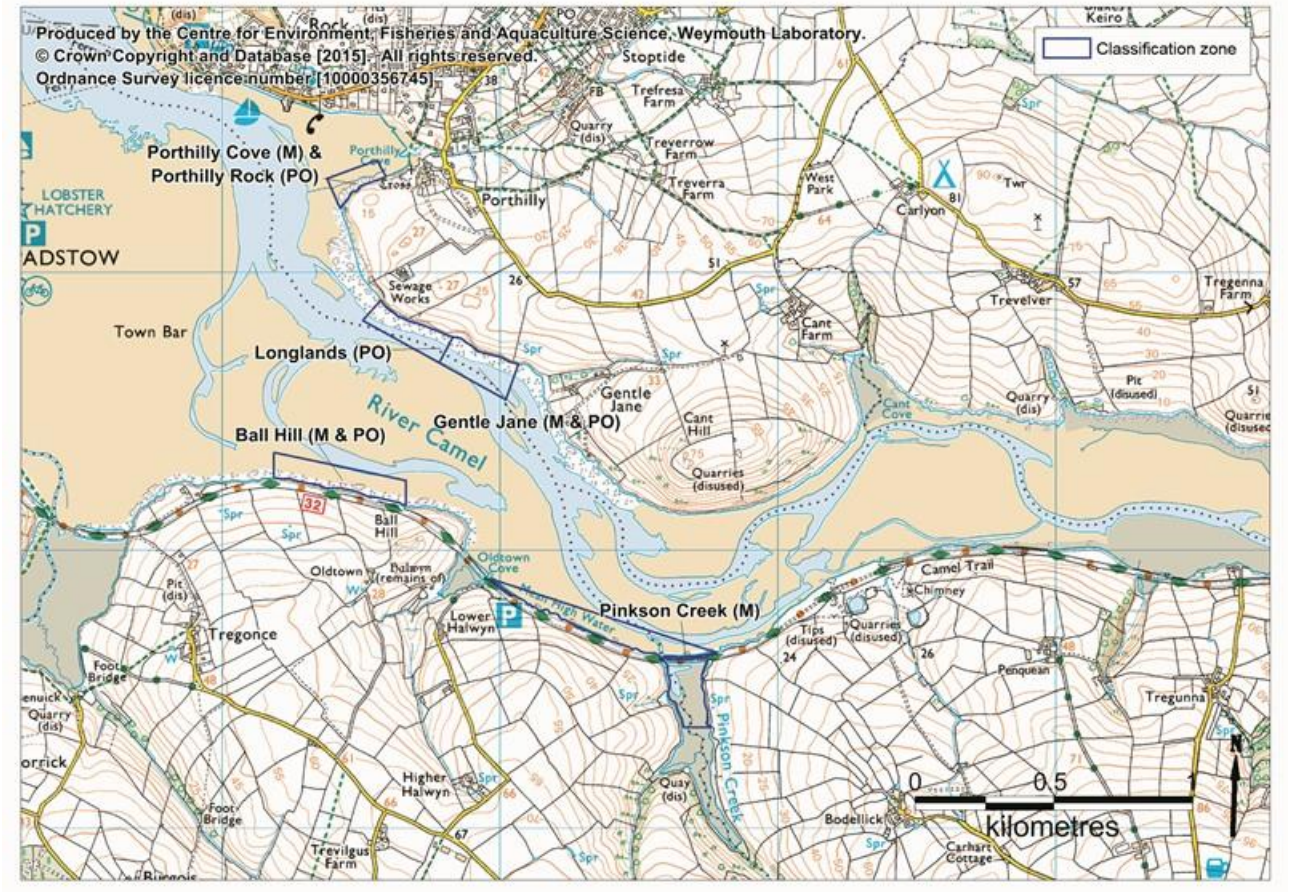


Figure 2.3: Locations and names of current shellfish classification zones within the Camel Production Area (PO: Pacific oyster zone and M: mussel zone)

The locations and names of current classification zones within the Camel estuary are presented in Figure 2.3. Farmed mussel beds are commercially harvested from the foreshore of the Camel estuary. At Gentle Jane mussels are cultivated on the muddy foreshore they currently receive a seasonal 'B' classification between 1st September and 31st May reverting back to a 'C' classification at all other times. At Pinkson Creek and Ball Hill mussels are grown in bags on trestles. All mussel beds within the Camel production area are harvested by hand, year round. In the 2009 sanitary survey mussels were also harvested from the rocky shore at Trebetherick Rocks, in the mouth of the estuary; however numbers of mussels in this region were not high enough to sustain commercial harvesting.

Pacific oyster seed from Barrow-in-Furness, Morecambe Bay are kept in floating racks at Longlands and east of Pinkson Creek which are 220 m and 400 m long respectively. They are left there for 12 months before being transferred to the classified intertidal racks at Gentle Jane, Longlands and Ball Hill beds. They are then left on these racks for 2 to 3 years to reach maturity before being harvested.

Porthilley Rock oyster and Porthilley Cove mussel classification zones act as holding bays for mussel and oysters relocated from zones of the same classification, elsewhere in the estuary during stormy weather conditions.

The oysters and mussels are depurated in the harvester's own depuration tanks before being sold to wholesalers in the south of England. Pacific oyster and mussel production within the Camel equates to approximately 87.5 tonnes and 122 tonnes per annum respectively.

Peppery furrow clams grow on the intertidal mudflats in the upper estuary. Since 2014 these have not been harvested or classified within the Camel estuary. There has been some new commercial interest in harvesting this species which therefore is considered in the sampling plan recommendations.

Cockles have not been harvested in the Camel estuary since 2009 due to a lack of commercial interest. They were harvested from four locations in the outer Camel estuary.

2.2. Classification History

Table 2.1 lists all of the classifications within the Camel Estuary since 2003. Figure 2.4 and Figure 2.5 shows the locations of the current classification zones.

Table 2.1 Historical hygiene classifications, 2003 to present

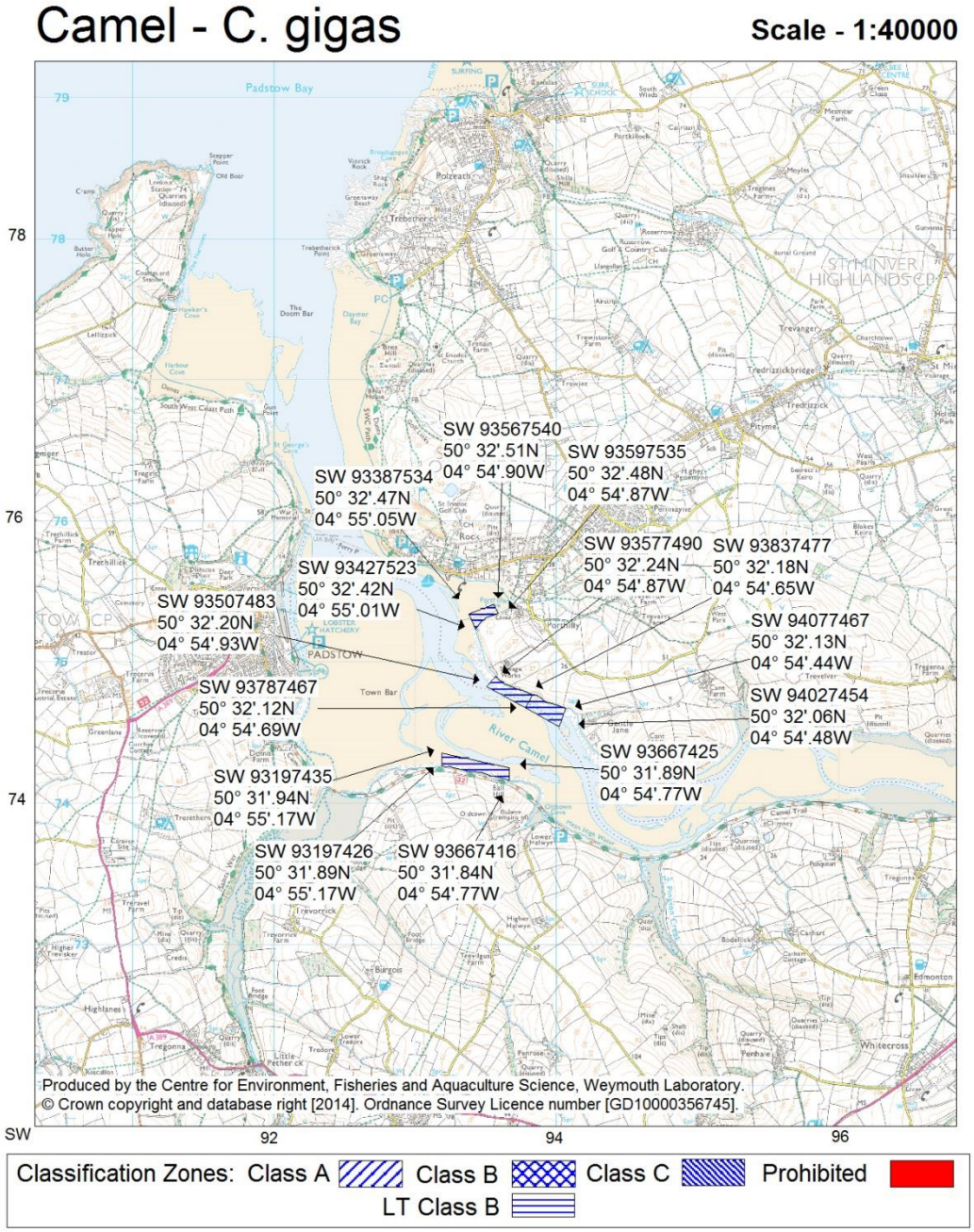
Bed name	Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Port Arthur (Town Bar)	Cockles	B											
Lower Town Bar	Cockles		B	B-LT	B-LT	B-LT	B-LT	B-LT					
Upper Town Bar	Cockles		B	B-LT	B-LT	B-LT	B-LT	B-LT					
Little Petherick Creek	Cockles	B	B	B-LT	B-LT	B-LT	B-LT				DC	DC	
Porthilley Cove	Mussels							B	B	B	B	B	B-LT
Gentle Jane	Mussels	B	C	C	C	B	B	B	B-LT	B-LT	B-LT	B-LT	B-LT
Pinkson Creek	Mussels	DC				C	C	C	B	B	B	B	B-LT
Trebetherick Rocks	Mussels	C	B	B-LT	B	B	B	B	B-LT	DC	DC	DC	
Ball Hill	Mussels							B	B	B	B	B	B-LT
Porthilley	*C. gigas*	B	B	B-LT	B-LT	B-LT	DC						
Gentle Jane	*C. gigas*	B	B	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT
Longlands	*C. gigas*	B	B	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT
Pinkson Creek	*C. gigas*						B	B	B	B	B	B	DC
Porthilley Rock	*C. gigas*	B	B	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT
Ball Hill	*C. gigas*					B	B	B	B-LT	B-LT	B-LT	B-LT	B-LT
Tregunna	Clams							B	C	C	B	B	B

Cockles have not been classified within the Camel production area since 2009 due to low population numbers and a lack of commercial interest. All mussel classification areas within the Camel have received B or long term B classifications since 2009 with the exception of Trebetherick Rocks which has not been classified since 2011 due a lack of commercial interest. Gentle Jane mussel bed receives a seasonal B classification from 1st September to 31st May inclusive and reverts back to a C classification at all other times. Pacific oyster beds at Gentle Jane, Longlands and Porthilley Rock have all received long term B classifications since 2005 as have those at Ball Hill, since 2010. A lack of commercial activity at Pinkson Creek Pacific oyster bed led to it being declassified and removed from the classification list in 2013. The clam bed at Tregunna was declassified in 2014 due to a lack of commercial interest, sampling being reduced to quarterly monitoring to enable an immediate re-classification if required. Since declassification further some discussion between the harvester and the local authority regarding potentially re-classifying the area resulted in the decision not to reclassify the bed at present. However if reclassified in the future, the results (>4,600 *E. coli* MPN/100 g) returned in June and October 2014, indicate a need for review of data to ensure an appropriate level of re-classification.

Table 2.2: Criteria for classification of bivalve mollusc production areas.

Class	Microbiological standard[1]	Post-harvest treatment required
A[2]	Live bivalve molluscs from these areas must not exceed 230 Most Probable Number (MPN) of *E. coli* $100g^{-1}$ Fluid and Intravalvular Liquid (FIL)	None
B[3]	Live bivalve molluscs from these areas must not exceed the limits of a five-tube, three dilution MPN test of 4,600 *E. coli* $100g^{-1}$ FIL in more than 10% of samples. No sample may exceed an upper limit of 46,000 *E. coli* $100g^{-1}$ FIL	Purification, relaying or cooking by an approved method
C[4]	Live bivalve molluscs from these areas must not exceed the limits of a five-tube, three dilution Most Probable Number (MPN) test of 46,000 *E. coli* $100g^{-1}$ FIL	Relaying for, at least, two months in an approved relaying area or cooking by an approved method
Prohibited[6]	>46,000 *E. coli* $100g^{-1}$ FIL[5]	Harvesting not permitted

[1] The reference method is given as ISO 16649-3.
[2] By cross-reference from EC Regulation 854/2004, via EC Regulation 853/2004, to EC Regulation 2073/2005.
[3] From EC Regulation 1021/2008.
[4] From EC Regulation 854/2004.
[5] This level is not specifically given in the Regulation but does not comply with classes A, B or C. The competent authority has the power to prohibit any production and harvesting of bivalve molluscs in areas considered unsuitable for health reasons.
[6] Areas which are not classified and therefore commercial harvesting of LBMs cannot take place. This also includes areas which are unfit for commercial harvesting for health reasons e.g. areas consistently returning prohibited level results in routine monitoring and these are included in the FSA list of designated prohibited beds



Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2014

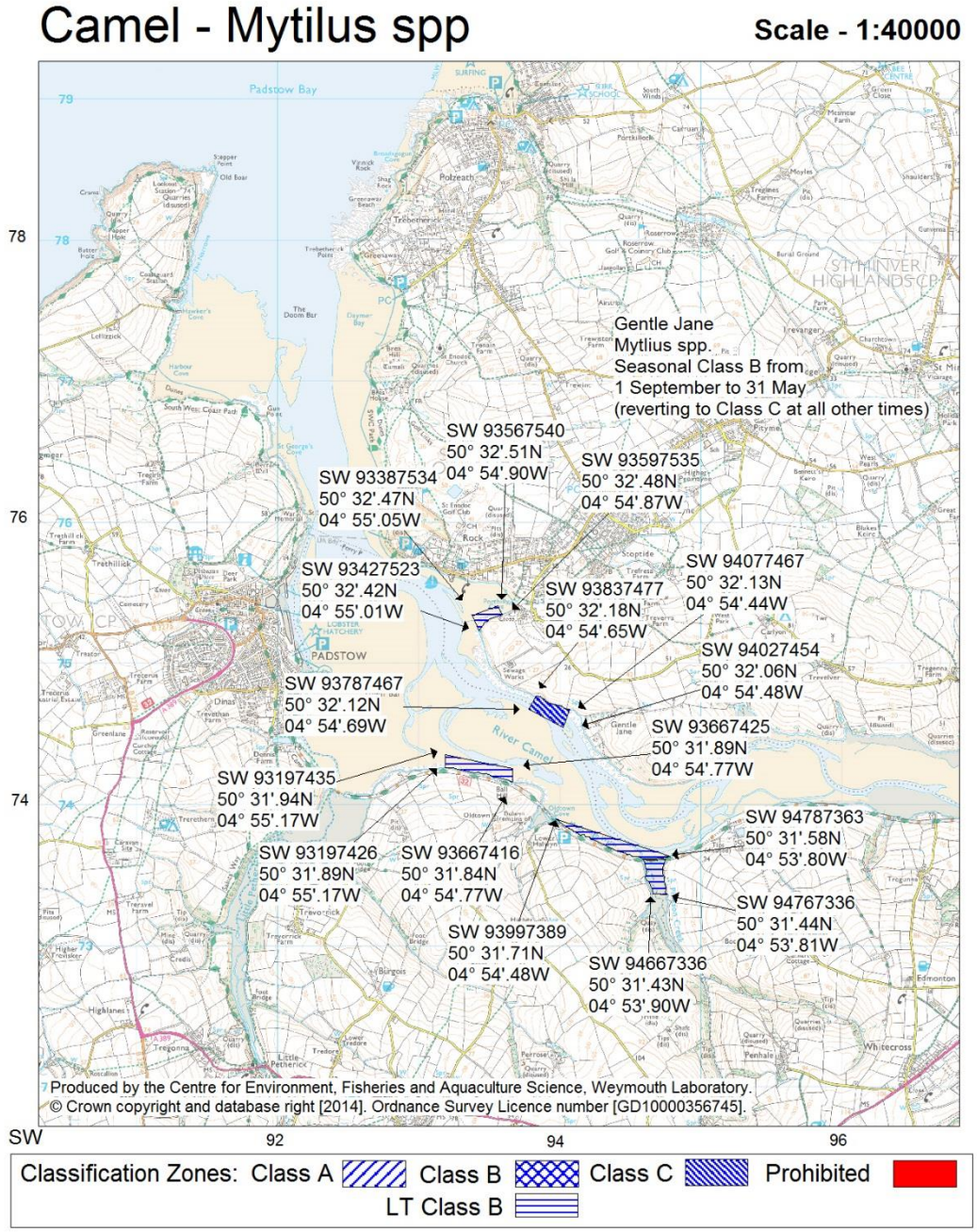
The areas delineated above are those classified as bivalve mollusc production areas under EU Regulation 854/2004.

Further details on the classified species and the areas may be obtained from the responsible Food Authority. Enquiries regarding the maps should be directed to: Shellfish Microbiology, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB.
(Tel: 01305 206600 Fax: 01305 206601)

N.B. Lat/Longs quoted are WGS 84
Separate map available for Mytilus spp. at Camel

Food Authority: North Cornwall District Council

Figure 2.4: Current Pacific oyster classification zones in the Camel production area



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N.B. Lat/Longs quoted are WGS 84
Separate map available for C. gigas at Camel

Food Authority: North Cornwall District Council

Figure 2.5: Current mussel classification zones in the Camel production area

3. Overall Assessment

Shellfishery

Since the 2009 sanitary survey, the fishery within the Camel estuary has declined. Cockles are no longer harvested from within the estuary due to a lack of commercially available stock. Pacific oysters are no longer harvested from Pinkson Creek but beds remain at Porthilley, Longlands, Gentle Jane and Ball Hill. The Trebetherick Rocks mussel bed is no longer harvested due to a lack of commercially available stock, however harvesting of mussels is still active at Gentle Jane and Pinkson Creek. The 2009 sanitary survey resulted in the classification of new mussel beds at Porthilley Cove and Ball Hill both of which are still commercially active. At present there are no peppery furrow clams classified within the Camel although there is some commercial interest in this species for the future.

Population

The overall human population within the catchment has decreased by around 1% between the 2001 and 2011 census data reports. However, population densities within the main towns, such as Padstow and Wadebridge which are situated adjacent to the shore of the Camel estuary, have increased since the last census. This overall population decrease is unlikely to have made a considerable difference to the amount of sewage being discharged to the estuary. Seasonal fluctuations to the population and thus the volume of sewage discharges are still expected to increase during the spring and summer months.

Sewage discharges

Since the 2009 survey improvements have been made to the following continuous discharges; Bodmin (Nanstallon) STW, Little Petherick STW and Bodmin Scarletts Well STW, which have all been upgraded from secondary treatment to UV tertiary treatment and Chapel Amble WwTW which has been upgraded to a secondary reedbed system. Improvements to these discharges were made to improve water quality in the vicinity of the shellfish beds. However not enough data were available to carry out a detailed comparison of water quality before and after these improvements. Little Petherick STW discharges to a stream and is located 2.8 km down estuary from Ball Hill classification zone and has potentially decreased the microbiological loading to this shellfish bed on a flood tide.

Porthilley STW continuous discharge is a source of microbiological contamination to Longlands Pacific oyster bed and Gentle Jane mussel and Pacific oyster bed with it being situated approximately 25 m and 325 m north east of the beds. The discharge is UV treated and if operating effectively is expected to discharge low concentrations of faecal contamination to the shellfish beds.

On the shoreline survey, a sample taken from Wadebridge STW continuous discharge gave an *E. coli* concentration of 1,000 cfu/100 ml, indicating that the UV treatment is working

efficiently. It is situated 3.7 km from the closest shellfish bed and is therefore unlikely to be a considerable source of contamination.

A cluster of permitted intermittent discharges (sewer overflows) at Porthilley Cove and at Padstow have been identified as an occasional source of contamination to the mussel and oyster beds in the mid estuary. Porthilley STW intermittent discharge is located 25 m northwest of Longlands classification zone and is a possible source of contamination at both Longlands and Gentle Jane beds on a flood tide. Porthilley Cove PS, Porthilley Cove CSO and Harbour Lights CSO all discharge 40 m west of Porthilley Cove mussel bed and will be an irregular source of contamination on a flood tide. Up-estuary there are a cluster of intermittent discharges which may contribute to the microbiological contamination to the shellfish beds. Since the 2009 sanitary survey improvements to these intermittent discharges have been made to reduce the number of spills per year. The closest is 4.7 km upstream of the Tregunna clam bed so these should receive substantial dilution between their points of discharge and the clam bed. The majority of intermittent discharges (with spill data) spilled <1 % of the time since 2012 so will be of minor influence. Exceptions to this include Padstow Foreshore Pumping Station, Porthilley Sewage Treatment Works, Rock Pumping Station and Little Petherick STW which all spilled for between 3 and 6% of the time and Nanstallon STW CSO which spilled for 12% of the time. Nanstallon STW is situated >13 km from the closest shellfish bed and is therefore likely to be subject to a high level of dilution before reaching the beds.

Private discharges were considered in this review and it was concluded that the majority are unlikely to contribute significantly to the microbiological loading to the shellfish beds as are located >5 km away from the shellfish beds and have low daily loadings, they will therefore be subject to significant dilution before arriving at the shellfish beds and are therefore unlikely to cause significant contamination to the shellfish.

Five private's discharges situated <5 km from the closest shellfish beds discharge to soakaways. Although these are close to shellfish beds they are considered to have little to no impact to the microbiological contamination of the shellfish bed's considering that they are operating appropriately.

Agriculture

Landcover maps confirm that there has been a decline in pasture land between 2001 and 2011, being replaced with arable land particularly in the lower catchment adjacent to the estuary. This decline of livestock within the lower catchment could cause a decrease in faecal contamination to the shellfish beds. However, this decline in livestock is unlikely to influence the position of the RMP as the data provided does not give detailed information on the distribution of livestock. Overall numbers of livestock reported in the Camel catchment have decreased between 2007 and 2013. Freely available data were not available after 2013, therefore it is difficult to assess changes in livestock numbers since then. The livestock data may not be fully representative of livestock within the Camel catchment as it covers the wider area of North Cornwall district, Caradon district and Restormel district.

Wildlife

Bird populations within the Camel estuary have remained fairly constant since the sanitary survey. Overwintering birds are likely to aggregate on the saltmarsh and intertidal flats, particularly in the upper estuary, however no particular location has been identified as holding large aggregations of birds. It is therefore difficult to select specific RMP locations to capture contamination from birds, which is both diffuse and spatially unpredictable. This review has also identified seals as an occasional source of contamination to shellfish beds in the Camel estuary. However, due to their low numbers and large spatial and temporal variability their presence will not influence the sampling plan.

Hydrography

There have been no significant changes in bathymetry of the estuary since the sanitary survey, consequently it is expected that there won't have been any major changes to contamination circulation within the Camel estuary. The tide will flood up-estuary following the main channels and will carry shoreline sources of contamination along the shore with the opposite occurring on the ebb.

Microbial Monitoring Results

Since 2003, 21 representative monitoring points (RMPs) have been sampled in the Camel estuary. Nine of these RMPs were sampled both before and after the sanitary survey. There were significant changes in *E. coli* levels at Ball Hill Pacific oysters and Pinkson Creek mussels with higher *E. coli* levels recorded before the 2009 sanitary survey.

Pacific oyster and mussel hygiene results have indicated an overall spatial trend of higher *E. coli* towards the head of the estuary suggesting that sources of contamination are likely to have come from up-estuary where there is a higher population and more sources of contamination. Pacific oyster flesh results also gave higher *E. coli* levels from the northern shore compared to the southern shore, possibly owing to the main low water channel being situated closer to the shellfish beds on the northern shore.

There was a seasonal effect on *E. coli* levels in shellfish flesh throughout the Camel estuary. The greatest seasonal effect on *E. coli* levels was that significantly lower *E. coli* levels in shellfish were observed in the spring compared to the summer and autumn months at several Pacific oyster, mussel and clam beds. A seasonal classification is already in place at Gentle Jane mussel beds between September 1st and May 31st to take into account the higher *E. coli* results in the summer and autumn months. All other beds have been classified as B/long term B and none have returned low enough *E. coli* results to qualify for a class 'A' classification (either seasonal or year-round).

Some minor influence of tide on *E. coli* levels in mussel flesh has been observed, with shellfish collected closer to low water showing higher levels of contamination than those taken at other states of tide. This possibly indicates that the contamination sources are subjected to less dilution when the quantity of water within the estuary is reduced. However,

Pacific oysters, peppery furrow clams and cockles did not show this trend. Significant differences in *E. coli* levels between spring and neap tides were present in Pinkson Creek mussels, Gentle Jane and Ball Hill Pacific oyster zones, however there were no obvious trends to suggest whether *E. coli* levels were higher or lower on particular tidal states.

4. Sampling Plan

4.1. Recommendations

Pacific oysters (*Crassostrea gigas*)

Porthilley Rock

It is recommended that the RMP for Porthilley Rock oysters is situated south west of the current RMP so that it is positioned on the western extremity of the classification zone. This will more adequately capture contamination from up-estuary sources including Porthilley CSO and Harbour Lights CSO intermittent discharges which are located 40 m upstream from the classification zone and are likely to present irregular sources of contamination. The RMP is also positioned to capture contamination carried by Porthilley stream.

Longlands

The classification zone is located on the northern shore of the Camel estuary at Porthilley, opposite Ball Hill. The current RMP for this zone will be maintained and is situated on the western extremity of the classification zone to best capture contamination from Porthilley STW continuous discharge (located 25 m away from the Longlands zone) and to capture intermittent discharges from the sewage overflows in Porthilley Cove. It is also situated adjacent to the main low water channel to capture any up-estuary sources of contamination.

Gentle Jane

It is recommended that a new RMP is established on the eastern extremity of the classification zone adjacent to the main low water channel to capture up-estuary sources of contamination. Up-estuary sources are the most likely cause of contamination to the shellfish bed as shown in hygiene data for both Pacific oysters and mussels from here, with an increasing *E. coli* concentration towards the upper the estuary.

Ball Hill

The location of the RMP at Ball Hill has been readjusted to better represent up-estuary sources of contamination. The new RMP is positioned adjacent to the main channel to capture up-estuary sources of contamination. As mentioned above, hygiene results revealed an increasing *E. coli* concentration towards the upper the estuary. With it being located adjacent to the main channel it may also receive contamination from several

intermittent discharges located at Padstow on a flood tide, however discharges from these will be irregular and are likely to follow heavy rainfall events.

Mussels (*Mytilus spp.*)

Porthilley Cove

It is recommended that the RMP for Porthilley Cove mussels is situated south west of the current RMP so that it is positioned on the western extremity of the classification zone. This will adequately reflect contamination from up-estuary sources including Porthilley CSO and Harbour Lights CSO intermittent discharges which are located 40 m from the classification zone and are likely to present irregular sources of contamination. The RMP is also positioned to capture any contamination carried by Porthilley stream.

Gentle Jane

The classification zone has been moved to represent a shift in the mussel bed to the west of the current bed. The existing RMP adequately reflects the principal sources of contamination as it is situated up-estuary and close to the main low water channel. It will capture up-estuary sources of contamination on an ebb tide and potential contamination from the discharges located at Porthilley Cove on a flood tide.

Ball Hill

The classification zone has been shifted to represent a change in the distributions of mussels to the west of the current bed. The existing RMP adequately reflects the principal sources of contamination from up-estuary as it is both on the eastern extremity of the zone and close to the main low water channel. Its location will also capture possible contamination from intermittent discharges at Padstow and from Petherick Creek on a flood tide.

Pinkson Creek

The classification zone has been modified to better represent the extent of the existing mussel beds within this area of the Camel. A new RMP is situated up estuary, close to the main low water channel and is positioned to adequately reflect diffuse sources of contamination from Pinkson Creek and from the main Camel estuary.

Peppery furrow shell (*Scrobicularia plana*)

Peppery furrow shell clams are not currently classified within the Camel estuary however there was some recent interest in resuming harvesting from this bed. Following discussions between the FSA, LA and potential harvester, it was decided that this bed should remain declassified. However, should this bed be reclassified in the future, the following recommendations for classification apply.

Tregunna

The RMP for Tregunna was previously positioned towards to the western extent of the classification zone. The recommended new RMP is situated on the eastern extremity of the classification zone adjacent to the main channel to best capture up-estuary sources of contamination. Both Pacific oyster and mussel RMPs showed an increasing *E. coli* concentration towards the upper end of the estuary suggesting the main sources of contamination are from up-estuary sources.

4.2. General information

Location Reference

Production area	Camel Estuary
Cefas main site reference	M035
Ordnance survey 1:25,000 map	Explorer 106 (Newquay & Padstow)
Admiralty chart	No 1168

Shellfishery

Species/culture	Pacific oysters (*Crassostrea gigas*) Mussels (*Mytilus* spp.) Peppery furrow shells (*Scrobicularia plana*)	Farmed Farmed/Wild Wild
Seasonality of harvest	Year round	

Local Enforcement Authority

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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 2020. The assessment may require review in the interim should any significant changes in sources of contamination or changes in the shellfishery come to light.

Table 4.1 Number and location of representative points (RMPs) and frequency of sampling for classification zones within the Camel estuary

Classification zone	RMP	RMP name	NGR	Latitude & Longitude (WGS84)	Species	Growing method	Harvesting technique	Sampling method	Tolerance	Frequency	Comments
Porthilley Rock	B35AC	Porthilley Rock B	SW 93407530	50°32.453'N 04°55.028'W	*C. gigas*	Bags on trestles	Hand-picked from bags	Hand-picked	10	Monthly	n/a
Longlands	B035I	Longlands	SW 93547483	50°32.203'N 04°54.894'W	*C. gigas*	Bags on trestles	Hand-picked from bags	Hand-picked	10	Monthly	n/a
Gentle Jane	B35AD	Gentle Jane B	SW 94047463	50°32.104'N 04°54.462'W	*C. gigas*	Bags on trestles	Hand-picked from bags	Hand-picked	10	Monthly	n/a
Ball Hill	B035Q	Ball Hill Oyster B	SW 93577428	50°31.901'N 04°54.850'W	*C. gigas*	Bags on trestles	Hand-picked from bags	Hand-picked	10	Monthly	n/a
Porthilley Cove	B35AE	Porthilley Rock B	SW 93407530	50°32.453'N 04°55.028'W	*Mytilus* spp.	Wild	Hand-picked from rocky shore	Hand-picked	10	Monthly	n/a
Gentle Jane	B035B	Gentle Jane	SW 93907468	50°32.130'N 04°54.584'W	*Mytilus* spp.	Seeded mussels on foreshore	Hand-picked from foreshore	Hand-picked	10	Monthly	n/a
Ball Hill	B035U	Ball Hill West	SW 93427428	50°31.904'N 04°54.977'W	*Mytilus* spp.	Bags on trestles	Hand-picked from bags	Hand-picked	10	Monthly	n/a
Pinkson Creek	B35AF	Pinkson Creek B	SW 94527369	50°31.609'N 04°54.027W	*Mytilus* spp.	Bags on trestles	Hand-picked from bags	Hand-picked	10	Monthly	n/a
Tregunna	B35AG	Tregunna C	SW 96177412	50°31.876'N 04°52.647'W	*S. plana*	Wild	Hand-picked from river bed	Hand-picked	10	Monthly	There are no plans to classify this bed at present. However these recommend ations apply if the bed is reclassified in the future.

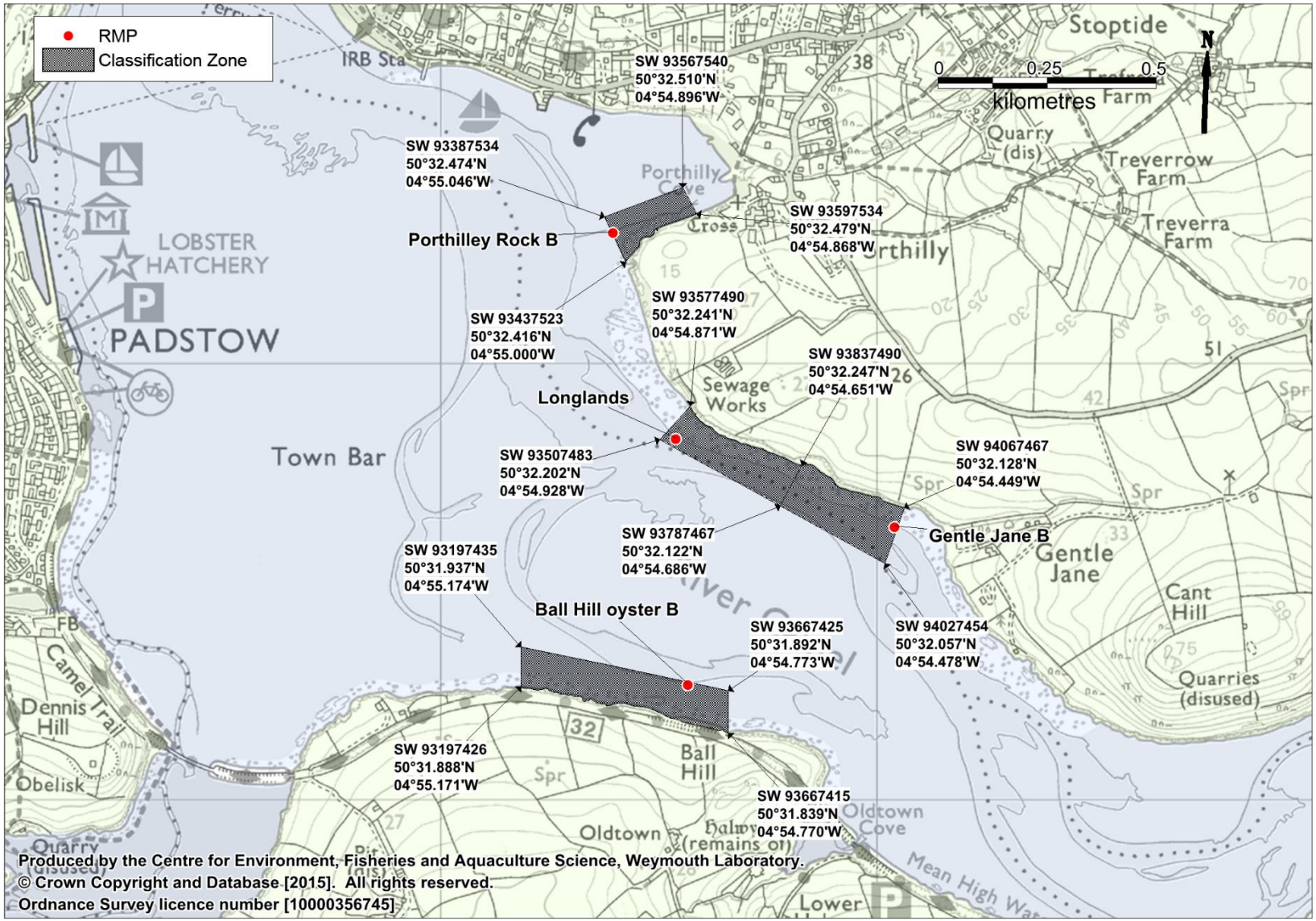

Figure 4.1: Recommended zoning and monitoring arrangements – Pacific oysters (*C. gigas*)

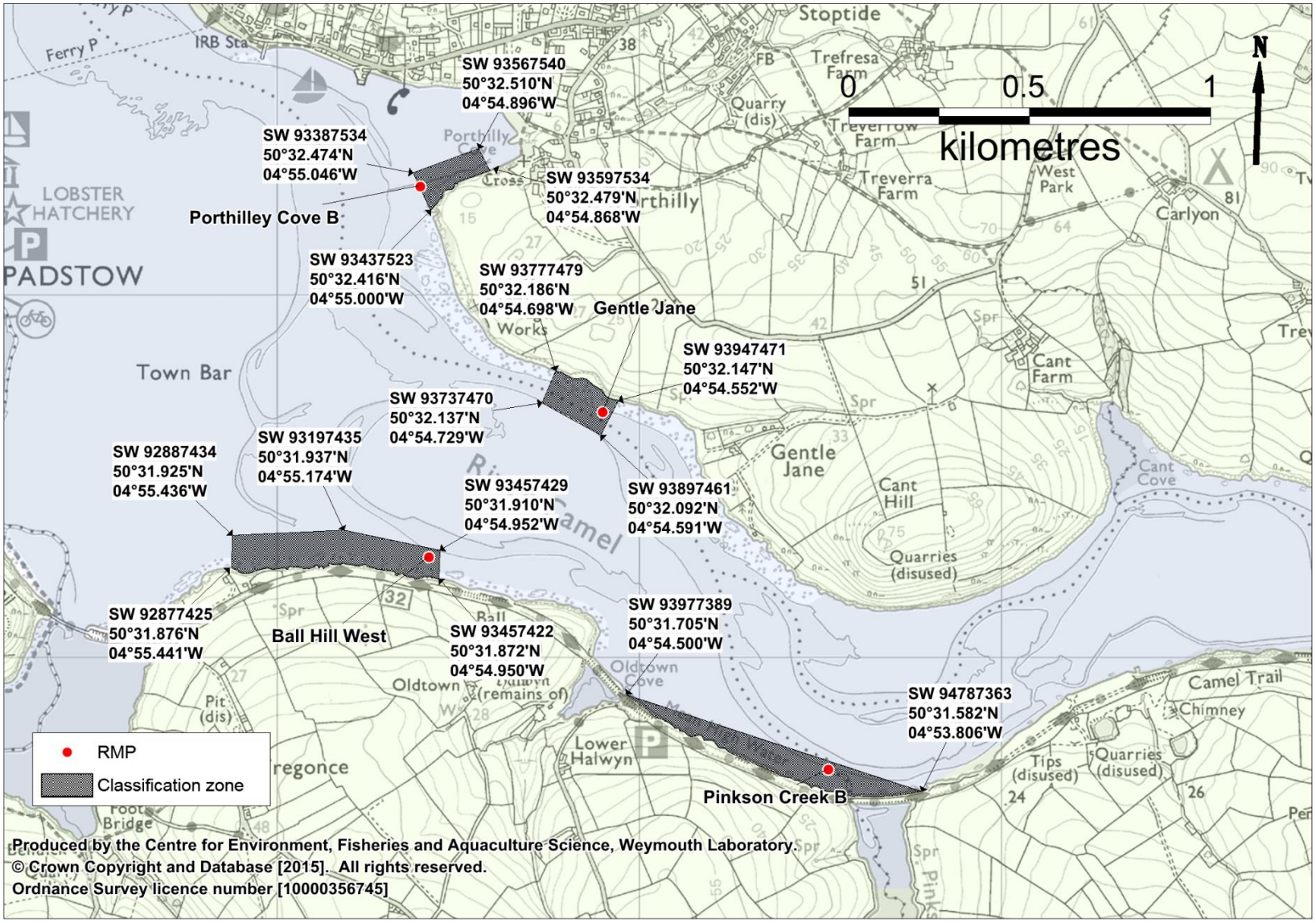

Figure 4.2: Recommended zoning and monitoring arrangements – Mussels (*Mytilus spp.*)

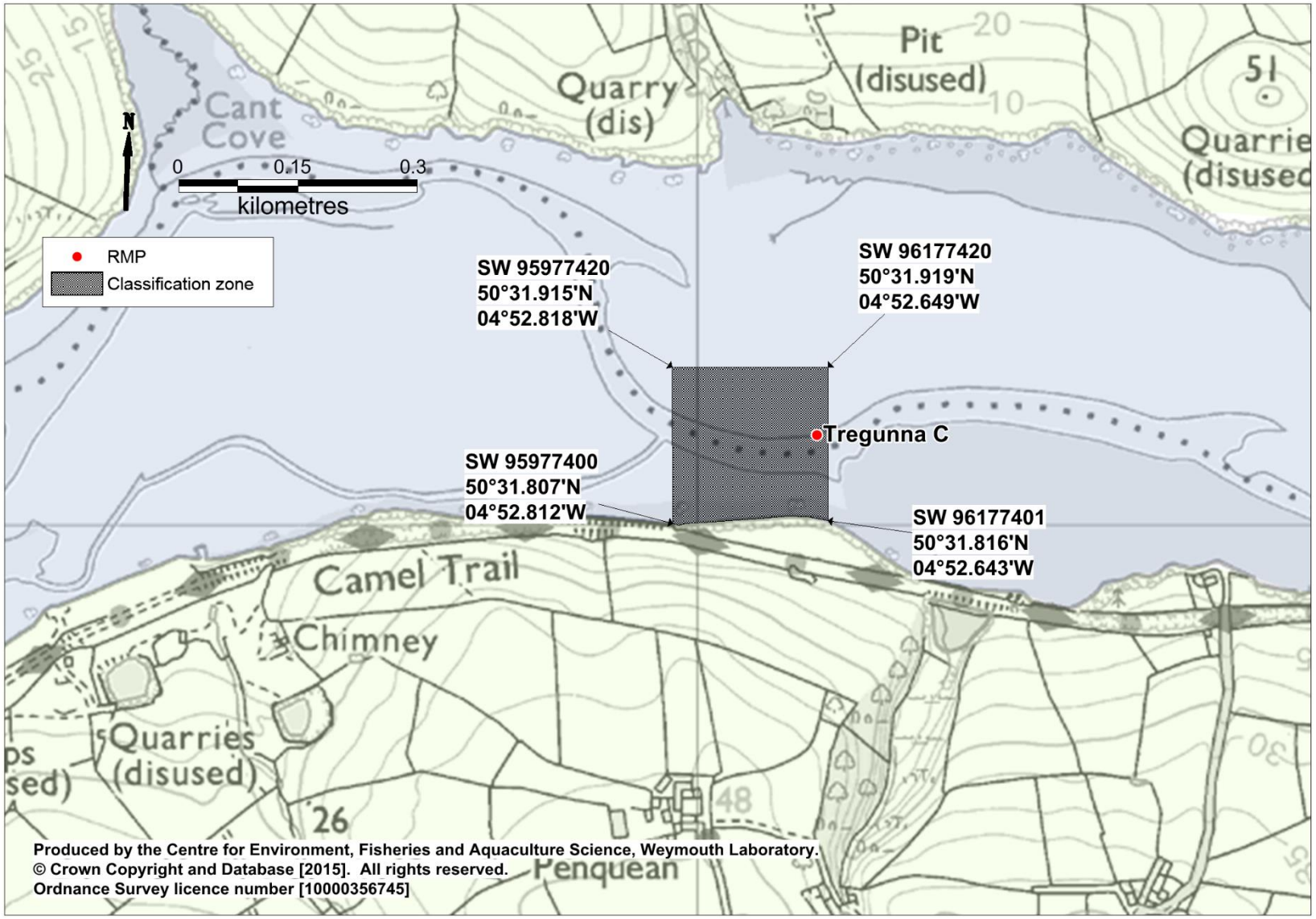

Figure 4.3: Recommended zoning and monitoring arrangements – Peppery furrow shell (*S. plana*)

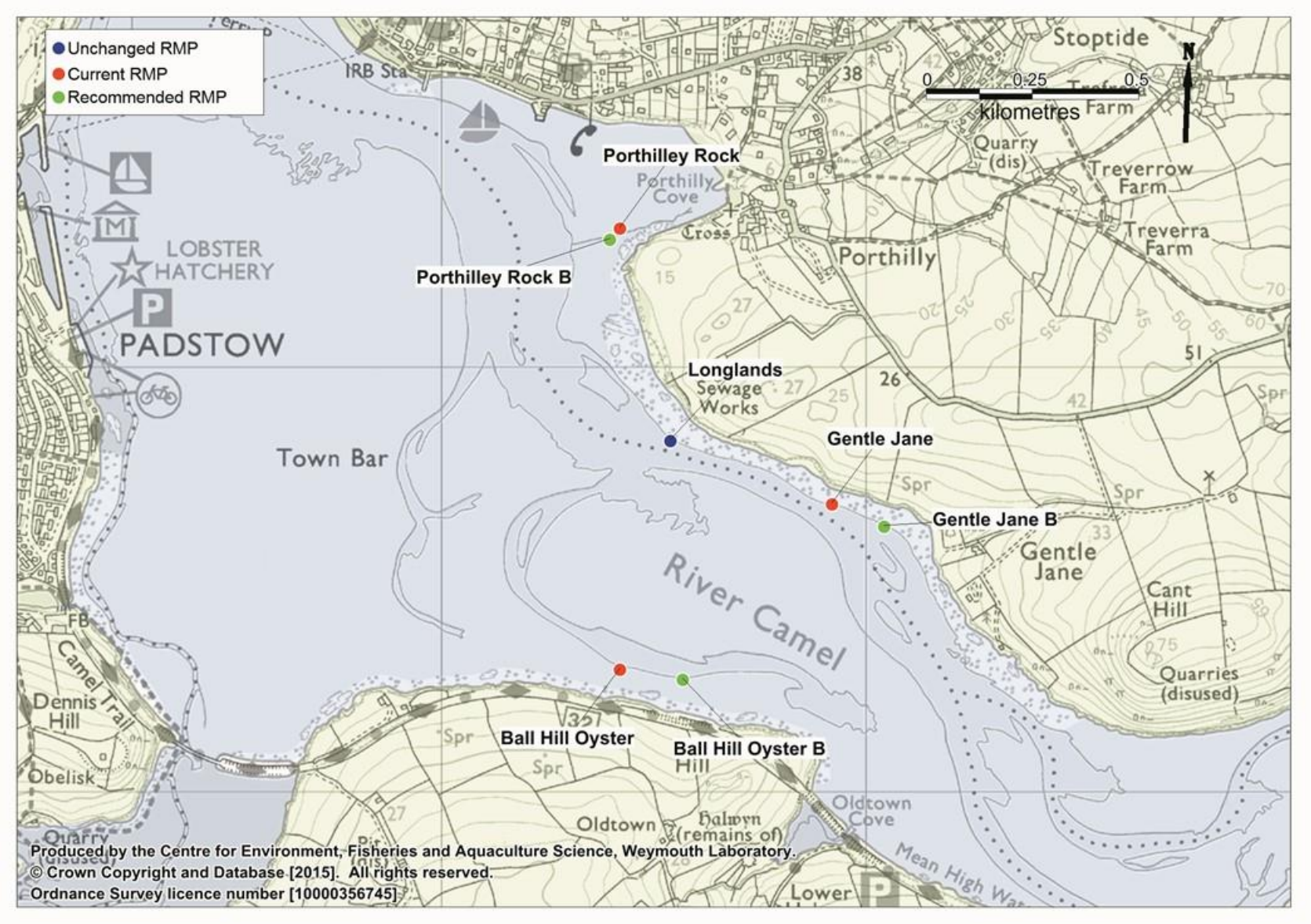

Figure 4.4: Current and recommended Pacific oyster RMPs. Longlands RMP remains unchanged

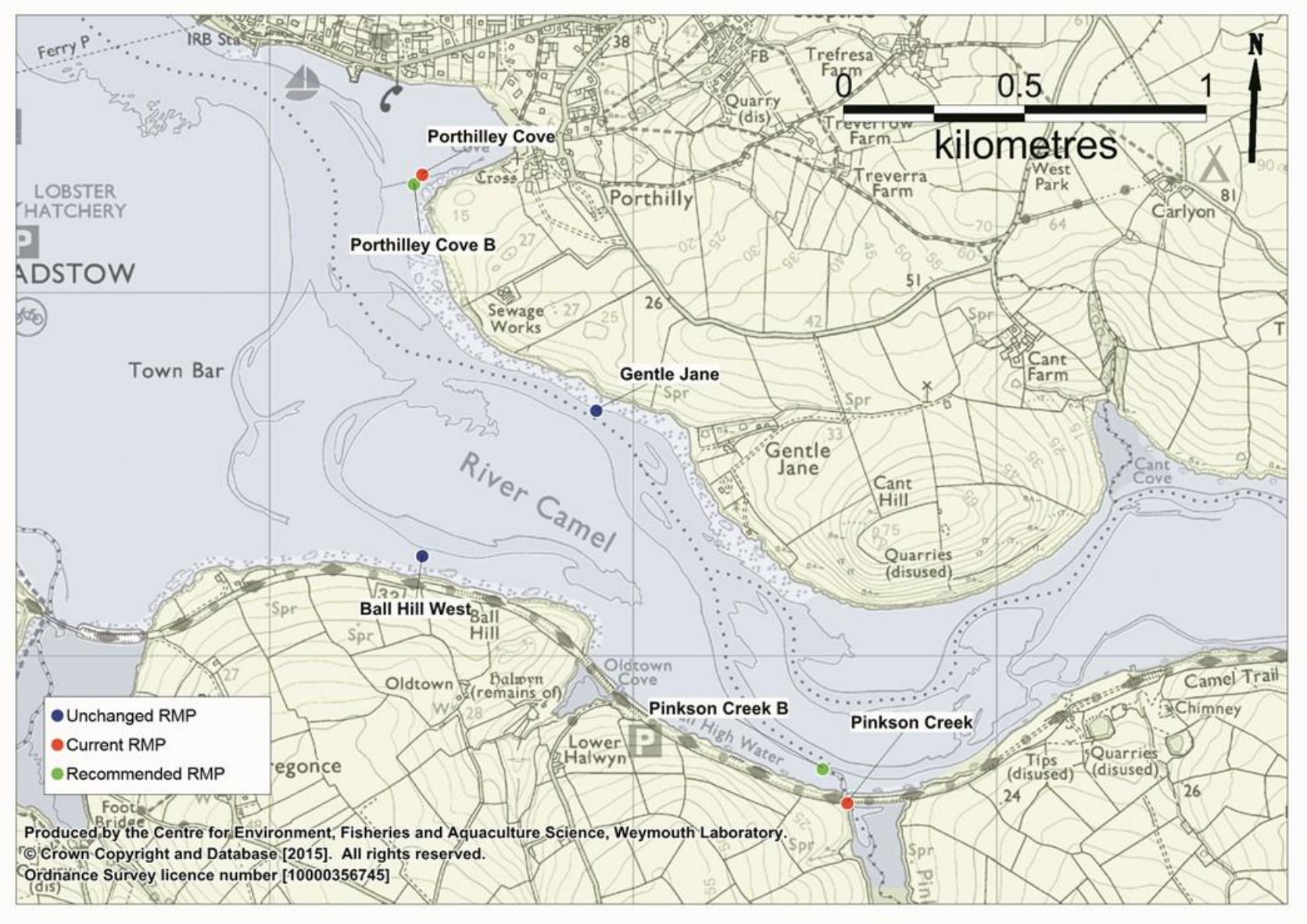

Figure 4.5: Current and recommended mussel RMPs. Ball Hill West and Gentle Jane RMPs remain unchanged

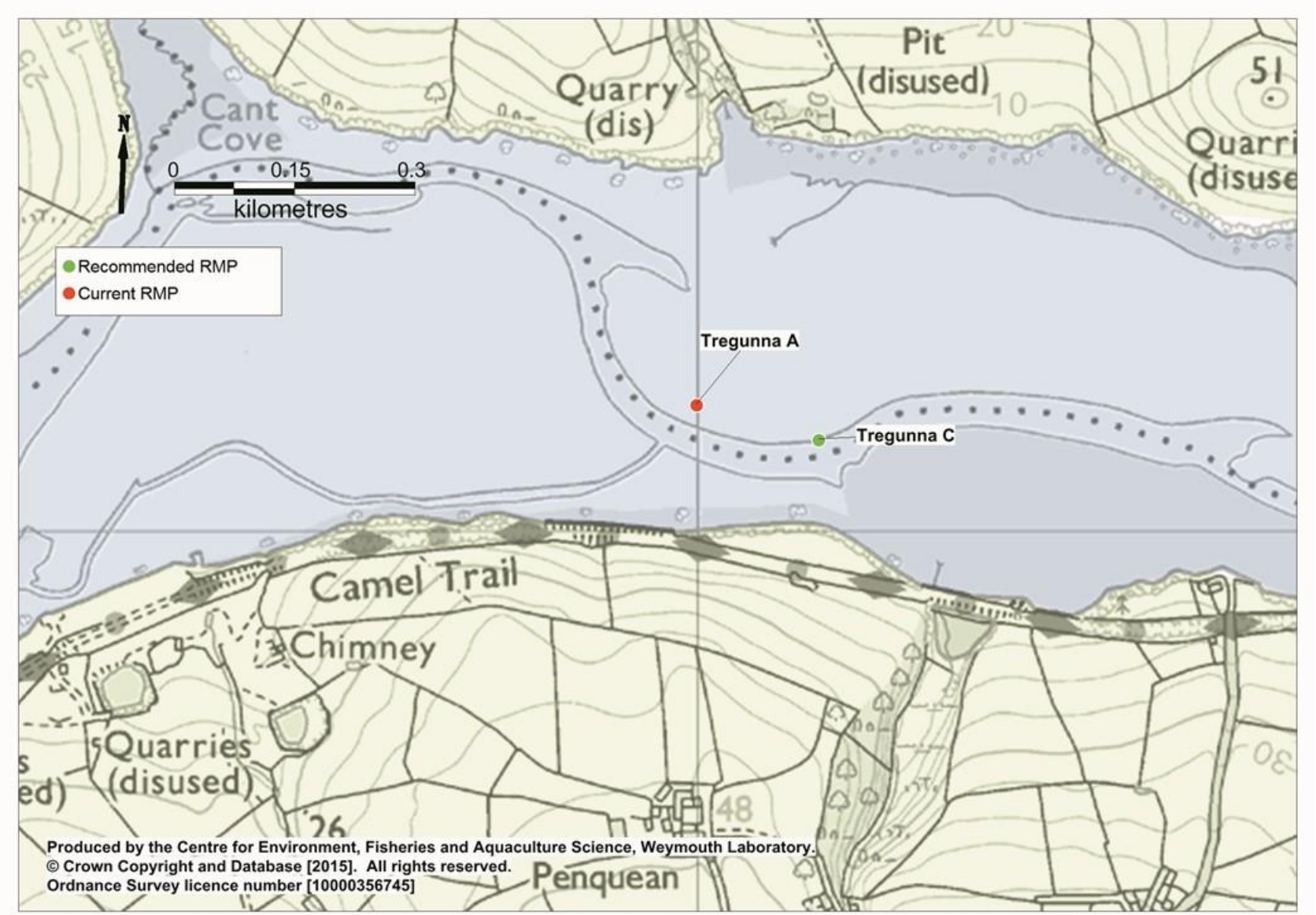

Figure 4.6: Current and recommended clam RMPs.

5. Pollution sources

5.1. Human Population

Population data presented in the 2009 Camel Sanitary Survey Report were collected in the 2001 census. Since then a further census was conducted in 2011 and subsequent changes in human population within the catchment are discussed below.

Figure 5.1 shows population densities in census Lower Layer Super Output Areas (LLSOAs) within or partially within the Camel catchment area, derived from data collected from the 2001 and 2011 censuses. Total resident population within the census areas contained within or partially within the catchment area was approximately 60,116 in 2001 and 59,579 in 2011. This is a decrease of around 1% at the time of the 2011 census.

The population density within the catchment has changed between censuses with a higher population density in the main urbanised area of Wadebridge, Bodmin, Camelford and Rock (across the Camel from Padstow). However due to the subtlety of these changes only that for Rock is picked up by the density categories illustrated in Figure 5.1.

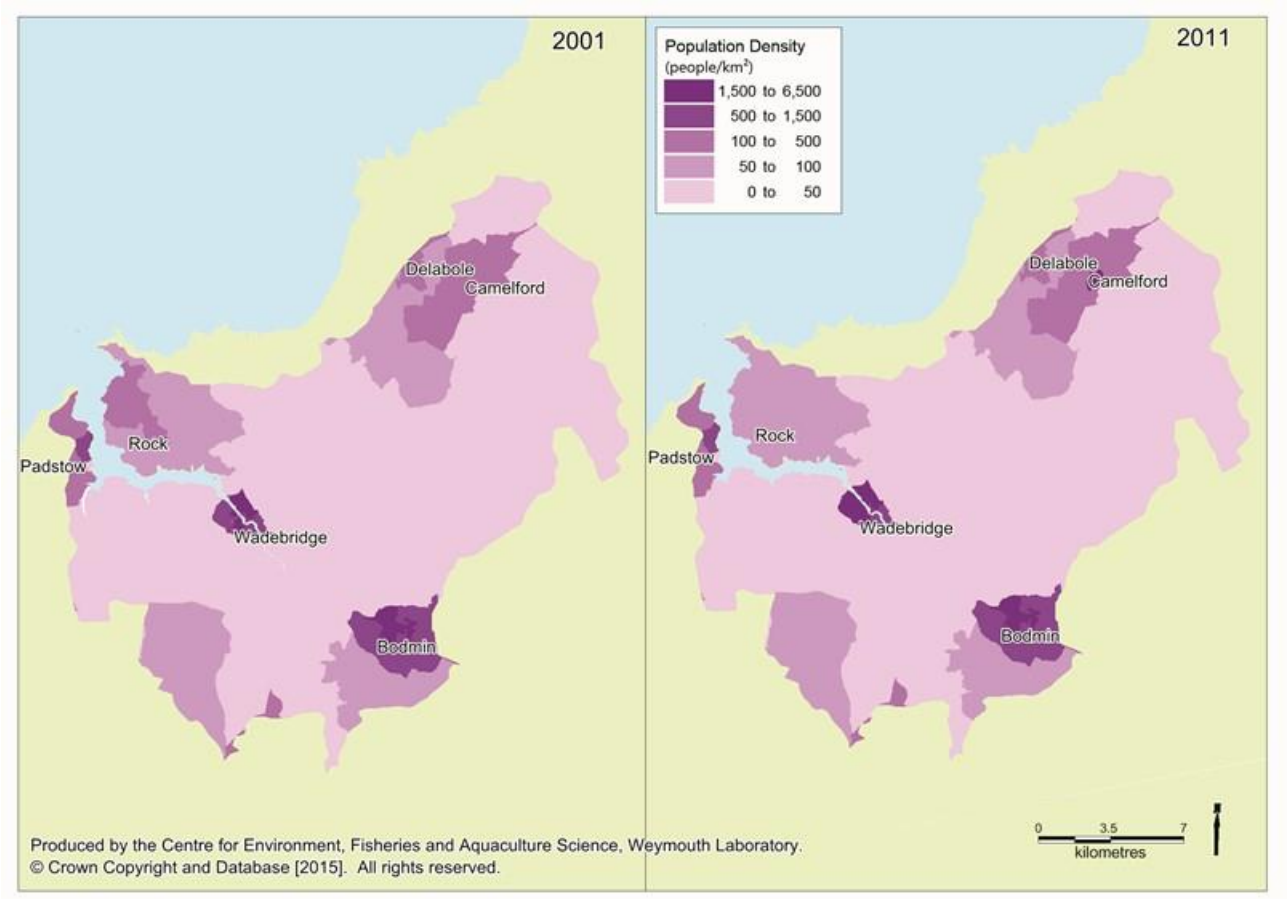

Figure 5.1: Human population density in the Camel catchment from the 2001 census and 2011 census

5.2. Sewage

Figure 5.2 shows the locations of all of the current discharges identified in the Environment Agency (EA) national permit database as of October 2014 which fall within the catchment area for the Camel production area.

The 2009 sanitary survey reported a small number of discharges and did not consider those in the upper catchment or private discharges. The only discharge reported in the 2009 report that is no longer consented is Bodmin (Scarletts Well) STW Overflow (Appendix II, Table 4.2).

There are 17 water company owned, continuous discharges (Table 5.1) within the catchment, six of these were reported in the 2009 sanitary survey report. Thirteen of these discharges had dry weather flows (DWF) reported in the current Environment Agency (EA) national permit database. The highest dry weather flow is recorded at Bodmin (Nanstallon) STW (3,588 m^3/day). Chapel Amble WwTW previously had a DWF of 90 m^3/day, but this has since decreased to 20 m^3/day. Four sewage treatment works have had upgrades made to their treatment level since the 2009 survey. Bodmin (Nanstallon) STW and Little Petherick were upgraded from secondary treatment to UV treatment on 31st January 2011 and Bodmin Scarletts Well STW from secondary treatment to UV treatment on the 15th June 2011. Chapel Amble WwTW was upgraded from a tertiary septic tank to a reedbed system on 31st July 2013.

A total of 58 water company owned intermittent discharged are consented in the Camel production area catchment (Table 5.2**Error! Reference source not found.**). Seven of these were reported in the 2009 report. There are a cluster of intermittent discharges located at Rock and Padstow which discharge directly to the estuary in close vicinity to the shellfish beds.

There are also 44 private discharges in the Camel catchment with consented DWFs of 5 or greater m^3/day (Table 5.3). The majority discharge up-estuary of the shellfish beds. One discharges directly to the outer estuary, at Padstow (Map No. P38, 1-6 Pilot Cottages, 5m^3/day).

Table 5.4, Table 5.5 and Figure 5.3 show the spill information associated with seven intermittent discharges within the catchment. Much of the spill data before 2010 were unavailable at the time of writing. Discharges appear to have spilled quite regularly from January 2011 and there was the occasional large spill in 2012.

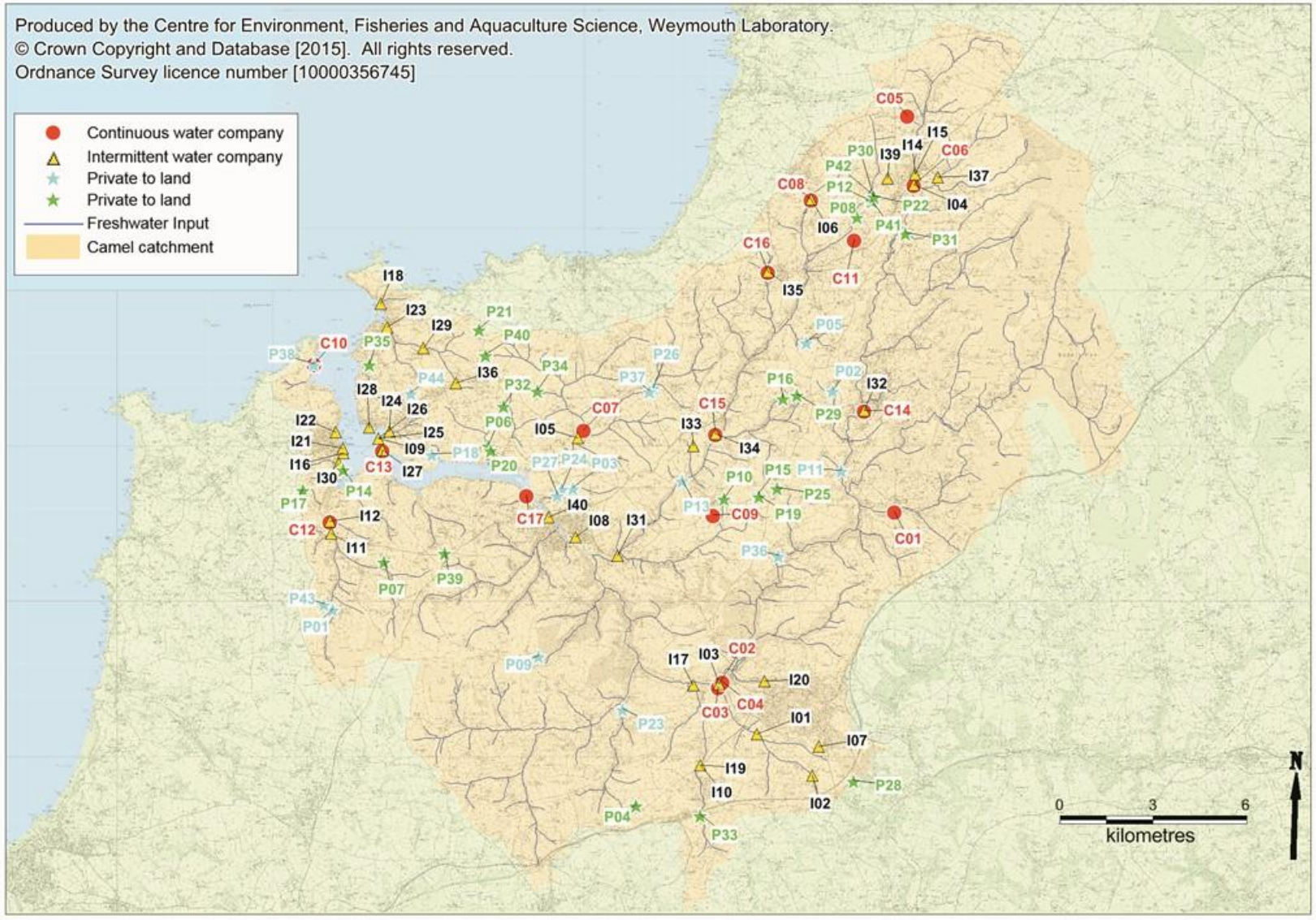

Figure 5.2: Discharges in the Camel production area catchment (Table 5.1,Table 5.2 and Table 5.3 for details)

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Table 5.1: Continuous water company discharges within the Camel production area catchment.

Number on Map	Name on current database	Name in 2009 report	NGR	Treatment	Dry Weather Flow (m^3/day)	Receiving Environment	Fluvial distance to nearest CZ	Estimated loading
C01	Blisland STW	NR	SX0998072890	2° (Biological)	NR	Freshwater river	24.1	-
C02	Bodmin Nanstallon STW	Bodmin Nanstallon STW	SX0433267349	3° (UV)	3,588	Freshwater river	14.1	$1.00x10^{10}$
C03	Bodmin Nanstallon STW	NR	SX0432167244	3° (UV)	NR	Freshwater river	14.2	-
C04	Bodmin Scarletts Well STW	Bodmin Scarletts Well STW	SX0445067430	3° (UV)	1,270	Freshwater river	14.3	$3.56 x10^{9}$
C05	Camelford Station (Cottages)STW	NR	SX1039085630	2° (Biological)	NR	Freshwater river	38.2	-
C06	Camelford STW	NR	SX1060083400	2° (Chemical)	338	Freshwater river	35.7	$1.12 x10^{12}$
C07	Chapel Amble WwTW	Chapel Amble Septic Tank	SW9997275534	2° (Reedbed)	20	Freshwater river	6.3	$6.60 x10^{10}$
C08	Delabole STW	NR	SX0729082940	2° (Chemical)	240	Freshwater river	22.0	$7.92 x10^{11}$
C09	Dwellings At Wadebridge Road	NR	SX0415072780	2° (Package Treatment Plant)	4.5*	Freshwater river	12.4	$1.49 x10^{10}$
C10	Hawkers Cove STW	NR	SW9131077640	2° (Biological)	8	Saline Estuary	4.7	$2.64 x10^{10}$
C11	Helstone STW	NR	SX0868081640	2° (Biological)	NR	Freshwater river	21.4	-
C12	Little Petherick STW	Little Petherick STW	SW9182072580	3° (UV)	187	Freshwater river	2.8	$5.24 x10^{8}$
C13	Porthilley STW	Porthilley STW	SW9351074870	3° (UV)	968	Saline Estuary	<0.1	$2.71 x10^{9}$
C14	St Breward STW	NR	SX0901076150	2° (Biological)	308	Freshwater river	27.1	$1.02 x10^{12}$
C15	St Mabyn STW	NR	SX0422075400	2° (Biological)	282	Freshwater river	13.0	$9.29 x10^{11}$
C16	St Teath STW	NR	SX0590080600	2° (Biological)	191	Freshwater river	19.1	$6.30 x10^{11}$
C17	Wadebridge STW	Wadebridge STW	SW9815073430	3° (UV)	3,370	Saline Estuary	3.7	$9.44 x10^{9}$

NR=Not Reported. * Maximum daily flow (m^3/s)

Table 5.2: Intermittent water company discharges within the Camel production area catchment.

Number on map	Name in current database	Name in 2009 Survey	NGR	Dry Weather Flow (m^3/day)	Receiving environment	Fluvial distance to nearest CZ
I01	Blowing House Lane CSO	NR	SX0554665724	NR	Freshwater river	16.3
I02	Bodmin Golf Course PSCSO/EO	NR	SX0733064400	NR	Freshwater river	18.7
I03	Bodmin Nanstallon STW	Bodmin (Nanstallon) STW	SX0433267349	NR	Freshwater river	14.1
I04	Camelford STW	NR	SX1060083400	NR	Freshwater river	35.7
I05	Chapel Amble WWTW	NR	SW9978675264	NR	Freshwater river	5.9
I06	Delabole STW	NR	SX0729082940	NR	Freshwater river	22.0
I07	Dragons Pit Green Lane CSO	NR	SX0753965347	NR	Freshwater river	18.7
I08	Egloshayle Pumping Station	Egloshayle CSO	SW9970972074	609	Saline Estuary	6.0
I09	Harbour Lights CSO	NR	SW9337975240	NR	Freshwater river	<0.1
I10	Lanivett Inn CSO	NR	SX0373064730	NR	Freshwater river	16.2
I11	Little Petherick PSEO	NR	SW9186072180	NR	Saline Estuary	6.6
I12	Little Petherick STW	Little Petherick STW	SW9182072580	NR	Freshwater river	2.8
I14	Market Square CSO	NR	SX1063083735	NR	Freshwater river	36.0
I15	Methodist Church CSO	NR	SX1063083735	NR	Freshwater river	36.0
I16	Moyle Road CSO	Moyles Road	SW9225074780	NR	Saline Estuary	1.0
I17	Nanstallon PSEO	NR	SX0350067300	NR	Freshwater river	13.5
I18	New Polzeath Pumping Station	NR	SW9346079570	NR	Saline Estuary	4.9
I19	Old Coach Road	NR	SX0372964729	NR	Freshwater river	16.2
I20	Old Jail CSO	NR	SX0580467434	NR	Freshwater river	16.1
I21	Padstow Foreshore Pumping Station	Padstow Foreshore CSO	SW9224074920	NR	Saline Estuary	1.1
I22	Padstow Harbour Pumping Station	Padstow Harbour CSO	SW9201075450	NR	Saline Estuary	1.4
I23	Polzeath Pumping Station	NR	SW9366078830	NR	Saline Estuary	4.7
I26	Porthilley CSO	Porthilley CSO	SW9337975240	NR	Freshwater river	<0.1
I24	Porthilley Cove PS	NR	SW9373075460	840	Freshwater river	0.2
I25	Porthilley Cove PS	NR	SW9338075240	NR	Freshwater river	<0.1
I27	Porthilley Sewage Treatment Works	Porthilley STW	SW9351074870	NR	Saline Estuary	<0.1

Number on map	Name in current database	Name in 2009 Survey	NGR	Dry Weather Flow (m³/day)	Receiving environment	Fluvial distance to nearest CZ
I28	Rock Pumping Station	NR	SW9307075600	78	Saline Estuary	0.4
I29	Roserrow Pumping Station	NR	SW9483078150	NR	Freshwater river	6.2
I30	Sarah's View Pumping Station	Sarah's View	SW9211074430	NR	Saline Estuary	1.1
I31	Sladesbridge PSEO	NR	SX0107271480	NR	Freshwater river	7.9
I32	St Breward STW	NR	SX0901076150	NR	Freshwater river	27.1
I33	St Kew Highway PSEO	NR	SX0350075000	NR	Freshwater river	12.7
I34	St Mabyn STW	NR	SX0422075400	NR	Freshwater river	13.0
I35	St Teath STW	NR	SX0590080600	NR	Freshwater river	19.1
I36	Tredrizzick Bridge Pumping Station	NR	SW9588077030	NR	Freshwater river	7.9
I37	Tregoodwell PSEO	NR	SX1137683641	NR	Into land	36.7
I39	Trevoa PSEO	NR	SX0975183602	NR	Into land	23.9
I40	Wadebridge PS	Wadebridge	SW9885072720	1,624	Saline Estuary	4.7

NR=Not Reported

Table 5.3: Private discharges within the Camel production area catchment with maximum daily flows ≥ 5 m³.

Number on Map	Name in current database	NGR	Treatment	Maximum daily flow (m³/day)	Receiving environment	Fluvial Distance to Nearest CZ	Calculated Loading
P01	Crealy Great Adventure Park	SW9191169767	3° (UV)	100	Freshwater river	9.2	$2.80x10^{8}$
P02	Hengar Manor And Country Club	SX0800076800	2° (PTP)	90	Freshwater river	27.4	$2.97x10^{11}$
P03	Little Bodieve Holiday Park	SW9963873667	2° (PTP)	63.5	Freshwater river	5.6	$2.10x10^{11}$
P04	Lakeview Country Club	SX0166063470	2° (PTP)	63.4	Into land	17.0	$2.09x10^{11}$
P05	Michaelstow Holiday Village	SX0715078360	Unspecified	60	Freshwater river	18.4	
P06	Dinham Farm Caravan Park	SW9691975044	1° (Septic Tank)	58	Soakaway	3.8	$5.80x10^{12}$
P07	Trewince Farm Holiday Park	SW9355771303	1° (Septic Tank)	58	Into land	9.0	$5.80x10^{12}$
P08	Lanteglos Country House Hotel	SX0877082400	4 - Sewage unknown	56	Soakaway	22.0	
P09	The Hustyns	SW9854068260	2° (Biological)	41	Freshwater river	11.5	$1.35x10^{11}$
P10	Development At Chapel Lane St Mabyn	SX0450473333	2° (PTP)	37.8	Into land	12.8	$1.25x10^{11}$
P11	Stp Serving Wenford Dries	SX0828174233	2° (PTP)	35	Freshwater river	24.4	$1.16x10^{11}$
P12	Juliots Well Holiday Park	SX0919082900	1° (Septic Tank)	34	Soakaway	22.8	$3.40x10^{12}$
P13	Stp@ 1-12 & 14-36 Greenwix Parc	SX0316073910	2° (PTP)	25.2	Freshwater river	11.3	$8.32x10^{10}$
P14	Dennis Farm	SW9226074260	2° (PTP)	20	Soakaway	0.9	$6.60x10^{10}$
P15	Glenmorris Park	SX0559073460	1° (Septic Tank)	20	Soakaway	13.9	$2.00x10^{12}$
P16	Oak Park	SX0639076560	2° (PTP)	20	Soakaway	15.8	$6.60x10^{10}$
P17	Padstow Holiday Park	SW9095073620	1° (Septic Tank)	20	Soakaway	3.2	$2.00x10^{12}$
P18	Cant Farm	SW9510074750	4 - Sewage unknown	19.8	Freshwater river	1.4	
P19	Glenmorris Park	SX0562073410	1° (Septic Tank)	19	Soakaway	13.9	$1.90x10^{12}$
P20	Little Dinham Woodland Caravan Pk	SW9700074880	4 - Sewage unknown	19	Soakaway	3.7	
P21	Windmill Court Nursing Home	SW9663078770	2° (PTP)	16.3	Soakaway	8.4	$5.38x10^{10}$
P22	Juliots Well Holiday Park	SX0931983054	1° (Septic Tank)	15.6	Soakaway	23.0	$1.56x10^{12}$
P23	Ruthern Valley Holidays	SX0123066560	4 - Sewage unknown	13.7	Freshwater river	13.0	
P24	Great Bodieve Farm	SW9928073650	4 - Sewage unknown	13.2	Freshwater river	5.1	
P25	Longstone Garage Site	SX0620173673	2° (PTP)	11.2	Soakaway	22.2	$3.70x10^{10}$
P26	St Kew Inn	SX0224076890	4 - Sewage unknown	10	Freshwater river	9.5	
P27	Little Bodieve House	SW9913673445	2° (PTP)	9.2	Freshwater river	4.9	$3.04x10^{10}$

Number on Map	Name in current database	NGR	Treatment	Maximum daily flow (m^3/day)	Receiving environment	Fluvial Distance to Nearest CZ	Calculated Loading
P28	Lanhydrock Visitors Lavatories	SX0866064250	1° (Septic Tank)	8.4	Into land	20.3	$8.40x10^{11}$
P29	Septic Tank @ Normans Way	SX0684276678	1° (Septic Tank)	8	Into land	16.5	$8.00x10^{11}$
P30	Juliots Well Holiday Park	SX0930083020	1° (Septic Tank)	7.5	Soakaway	23.0	$7.50x10^{11}$
P31	Trethin	SX1033081860	1° (Septic Tank)	7.2	Soakaway	34.3	$7.20x10^{11}$
P32	Lower Treglyn Farm Cottages	SW9741076320	2° (PTP)	6.8	Soakaway	5.9	$2.24x10^{10}$
P33	Penmount Grange Residential Home	SX0373063140	1° (Septic Tank)	6	Into land	18.0	$6.00x10^{11}$
P34	Tregwarmond	SW9850076800	1° (Septic Tank)	6	Into land	8.5	$6.00x10^{11}$
P35	Bodare Apartments	SW9309077650	1° (Septic Tank)	5.94	Into land	3.1	$5.94x10^{11}$
P36	Stp @ Riverside	SX0625571484	2° (PTP)	5.8	Freshwater river	19.2	$1.91x10^{10}$
P37	St Kew Churchtown Stw	SX0210076780	2° (PTP)	5.7	Freshwater river	9.3	$1.88x10^{10}$
P38	1-6 Pilot Cottages	SW9132077640	4 - Sewage unknown	5	Saline Estuary	4.27	
P39	Broadmeadows Mews	SW9550971577	2° (PTP)	5	Soakaway	2.2	$1.65x10^{10}$
P40	Gunvenna Touring Caranan & Camping	SW9682077940	1° (Septic Tank)	5	Soakaway	10.9	$5.00x10^{11}$
P41	Juliots Well Holiday Park	SX0924082910	1° (Septic Tank)	5	Soakaway	22.8	$5.00x10^{11}$
P42	Juliots Well Holiday Park	SX0931983054	1° (Septic Tank)	5	Soakaway	23.0	$5.00x10^{11}$
P43	Trevibban Barton Farm	SW9163069940	2° (PTP)	5	Freshwater river	9.2	$1.65x10^{10}$
P44	Trewiston Lodge Nursing Home	SW9443076720	2° (PTP)	5	Freshwater river	5.0	$1.65x10^{10}$

NR=Not reported

Table 5.4: Number of spills from intermittent discharges in the Camel production area catchment.

Number in Table 5.2	Discharge name	Number of spills										
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
I08	Egloshayle Pumping Station	17	NDP	2	2	NDP						
	Little Petherick STW SO Wadebridge	NDP							3	26	3	NDP
I16	Moyles Road CSO	22	6	10	22	5	24	7	10	17	11	7
	Nanstallon STW SSO Bodmin	NDP							22	66	18	NDP
I21	Padstow Foreshore Pumping Station	30	13	19	25	22	10	8	11	30	30	30
I22	Padstow Harbour Pumping Station	2	4	3	2	5	NDP	1	NDP	11	14	2
I24	Porthilley Cove PS	NDP			34	11	NDP	14	8	10	6	3
I27	Porthilley Sewage Treatment Works	NDP						3	6	38	1	NDP
I28	Rock Pumping Station	1	NDP			1	NDP		1	NDP	1	NDP
I30	Sarah's View Pumping Station	NDP									1	3
I40	Wadebridge PS	52	93	42	65	NDP						

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Spills assessment derived using EA 12/24 hour block counting method.
NDP (No Data Provided)

Table 5.5: The percentage of time spilling for intermittent discharges in the Camel production area catchment.

Number in Table 5.2	Discharge name	% time spilling										
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
I08	Egloshayle Pumping Station	0.76	NDP		0.14	NDP						
	Little Petherick STW SO Wadebridge	NDP							0.02	3.34	0.12	NDP
I16	Moyles Road CSO	0.99	0.02	0.01	4.16	0.22	3.07	0.58	0.17	0.44	0.67	0.02
	Nanstallon STW SSO Bodmin	NDP							3.21	11.91	3.27	NDP
I21	Padstow Foreshore Pumping Station	3.18	0.97	1.14	1.64	1.81	0.08	0.81	0.64	4.56	4.24	6.34
I22	Padstow Harbour Pumping Station	0.01	0.11	0.10	0.01	0.17	NDP	0.02	0.00	2.09	2.34	0.15
I24	Porthilley Cove PS	NDP			2.02	0.24	NDP	3.15	0.31	0.63	0.29	0.53
I27	Porthilley Sewage Treatment Works	NDP						0.02	0.21	5.60	0.03	0.00
I28	Rock Pumping Station	0.01	NDP						0.02	NDP	0.02	0.00
I30	Sarah's View Pumping Station	NDP									0.08	0.41
I40	Wadebridge PS	4.46	8.54	2.15	3.27	NDP						

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*% time spilling were adjusted to account for missed reporting days.
Spills assessment derived using EA 12/24 hour block counting method.
NDP (No Data Provided)

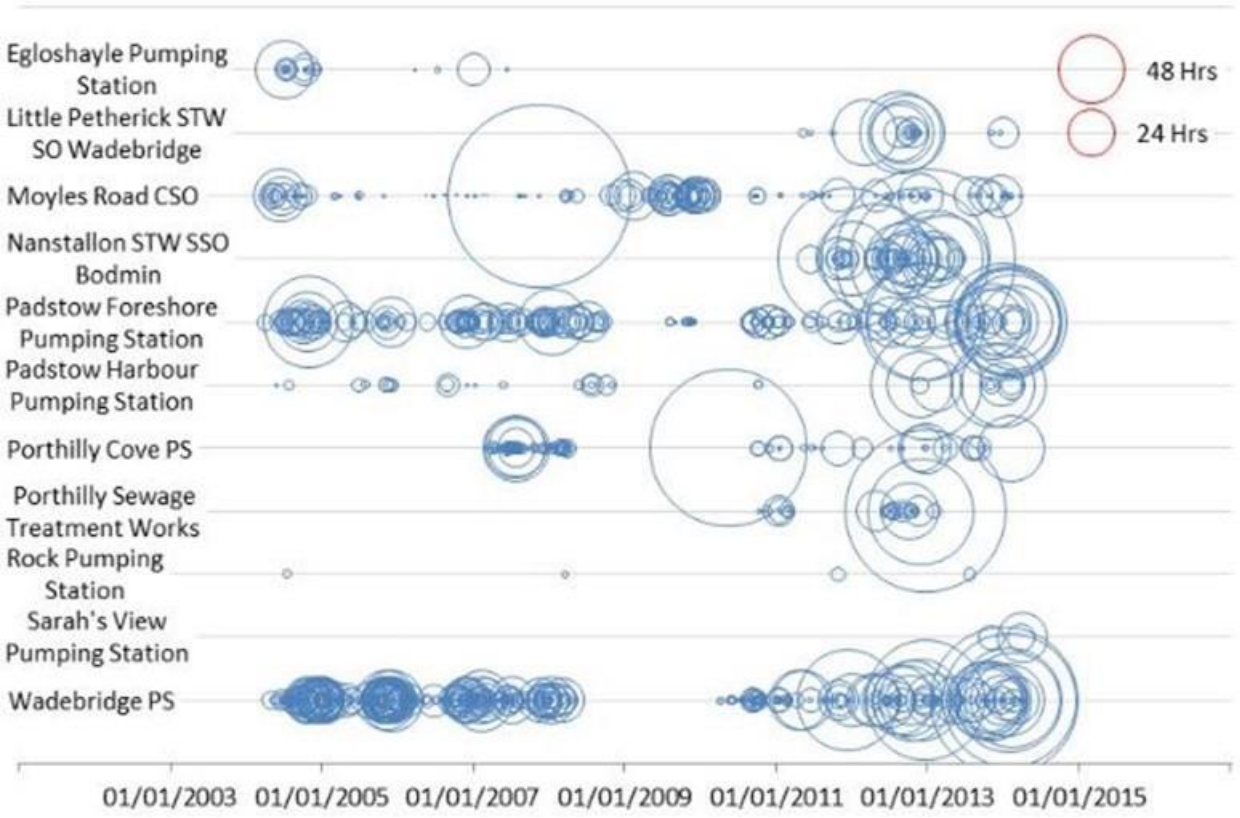

Figure 5.3: Bubble plot of spills from intermittent discharges in the Camel production area catchment.

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5.3. Agriculture

Livestock data were not freely available for the same area assessed in the 2009 sanitary survey report (Camel, Camel and Menallhyll, Allen and De Lank). However, livestock numbers for three historical districts within the Camel catchment were available for 2007 and 2013 (Defra, 2014). The Camel catchment falls partially within three districts; North Cornwall, Restormel and Caradon, principally North Cornwall. As these catchments made up only a proportion of the total area of the catchment, the livestock numbers were adjusted to represent the percentage of land cover that the districts occupy in the catchment. The adjusted data are presented in Table 5.6 and Figure 5.4.illustrates the locations of these districts and the extent of which they fall within the catchment. It should be noted that the adjustments for these data assume uniform distribution of livestock across the district and therefore there is some degree of inaccuracy within the adjusted data.

There has been an overall decline in livestock numbers across the catchment for most livestock types. The largest overall decline was for pigs (-9%). However, there has been an overall 20% increase in poultry within the catchment.

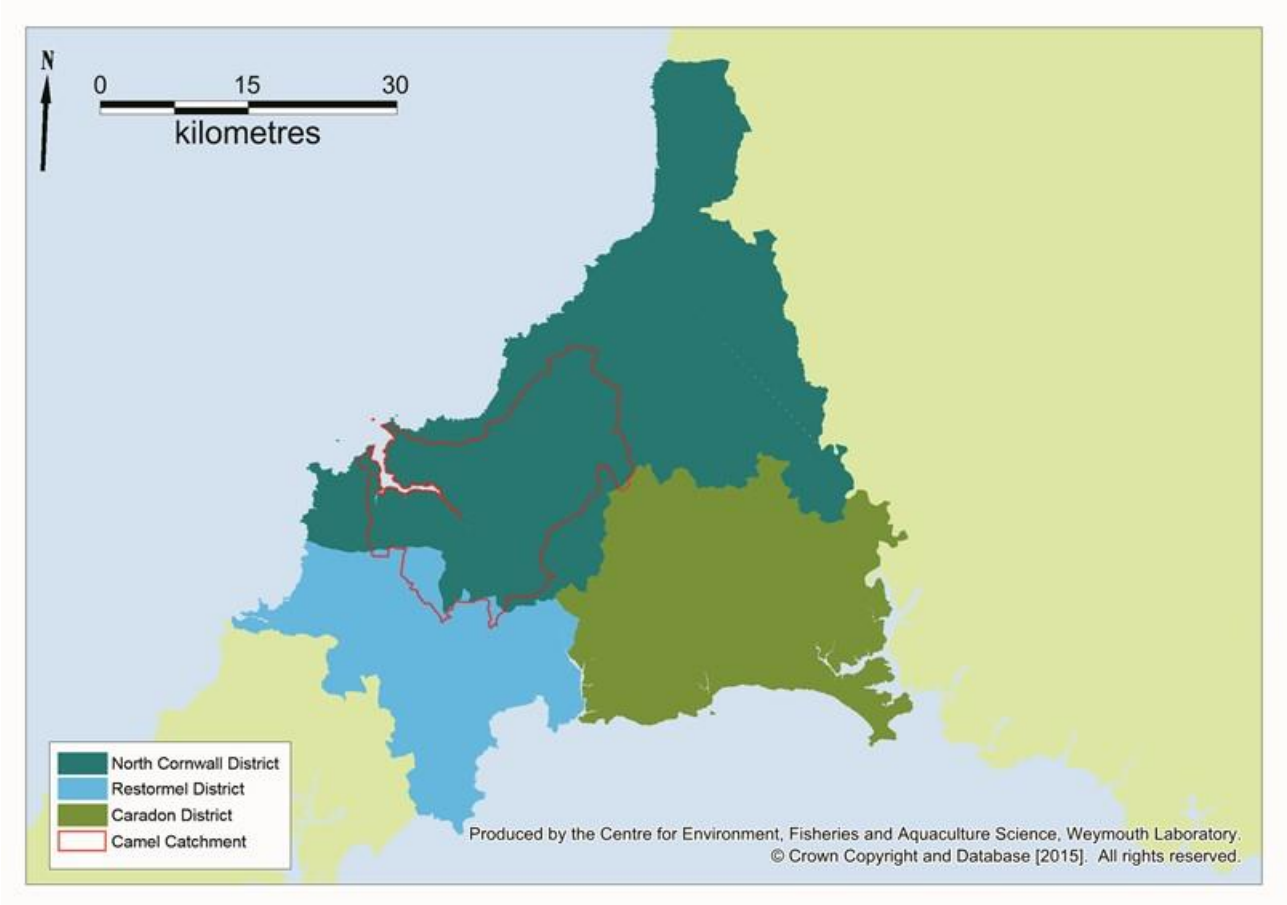

Figure 5.4: Livestock districts that lie partially within the Camel Estuary catchment

Table 5.6: Livestock data for the Camel estuary catchment in 2007 and 2013.

District	District area (km²)	% district area within catchment	Adjusted cattle numbers			Adjusted sheep numbers			Adjusted pig numbers			Adjusted poultry numbers		
			2007	2013	% change	2007	2013	% change	2007	2013	% change	2007	2013	% change
North Cornwall	1,191	30.6%	41,917.7	41,523.1	-0.9	84,853.6	84,837.3	0.0	6,473.4	5,856.6	-9.5	89,757.0	111,653.3	+24.4
Restormel	450	7.5%	2,858.6	3,054.7	+6.9	3,900.4	3,826.5	-1.9	311.1	309.5	-0.5	3,748.6	2,641.7	-29.5
Caradon	662	0.07%	42.5	39.7	-6.5	89.7	80.2	-10.6	9.1	8.4	-7.9	#	149.0	#
Camel Catchment TOTAL			44,818.8	44,617.5	-0.4	88,843.8	88,744.0	-0.1	6,793.6	6,174.5	-9.1	93,505.6	114,295.0	+22.2

Data from Defra (2014)

- Missing data

5.4. Wildlife

The Camel estuary hosts internationally important migratory and overwintering populations of wading birds and wildfowl. Since the 2009 sanitary survey the number of birds residing in the Camel estuary has remained fairly similar. An average of 10,601 waders and wildfowl were recorded for the five winters up to 2007/2008 (Holt et. al, 2009) compared to an average of 10,371 waders and wildfowl over the five winters running up to 2012/2013 (Austin et. al, 2014). However, it is unclear whether these are significant changes or due to natural fluctuation. As concluded in the 2009 survey, birds are likely to be a source of contamination to shellfish beds, predominantly in the winter months when migratory birds are present. However, due to the diffuse and spatially unpredictable nature of contamination from birds it is difficult to select specific RMP locations to capture this.

Seals were not assessed as a source of microbiological contamination to the shellfish beds in the 2009 survey. A number of websites anecdotally suggest that seals are occasionally sighted within the Camel estuary, however no formal counts or haul out locations have been identified within the survey area. The SCOS, 2013 report confirms that grey seals often make movements south to Cornwall (SCOS, 2013). The closest identified haul out site is located on Gulland Rock located offshore of the Camel mouth (Cornish Sea Tours, 2014). The moulting and pupping season for grey seals is between June and August and in these months they will spend more time at their haul out sites. Therefore grey seals may enter the survey area from time to time but given the small numbers and large area that they are likely to forage, their impacts are likely to be minor and unpredictable in spatial terms. Consequently, the presence of seals will not influence the sampling plan.

6. Hydrodynamics

The bathymetry within the Camel estuary has remained largely unchanged since the 2009 sanitary survey. Comparisons of the 2002 edition (with notice to mariners updates to 2009) and 2012 edition (with notice to mariners updates to 2014) of Admiralty Chart No. 1168 show there have been minor changes to the depths throughout the estuary. It is unlikely that these minor changes will significantly change hydrographical flows within the Camel estuary.

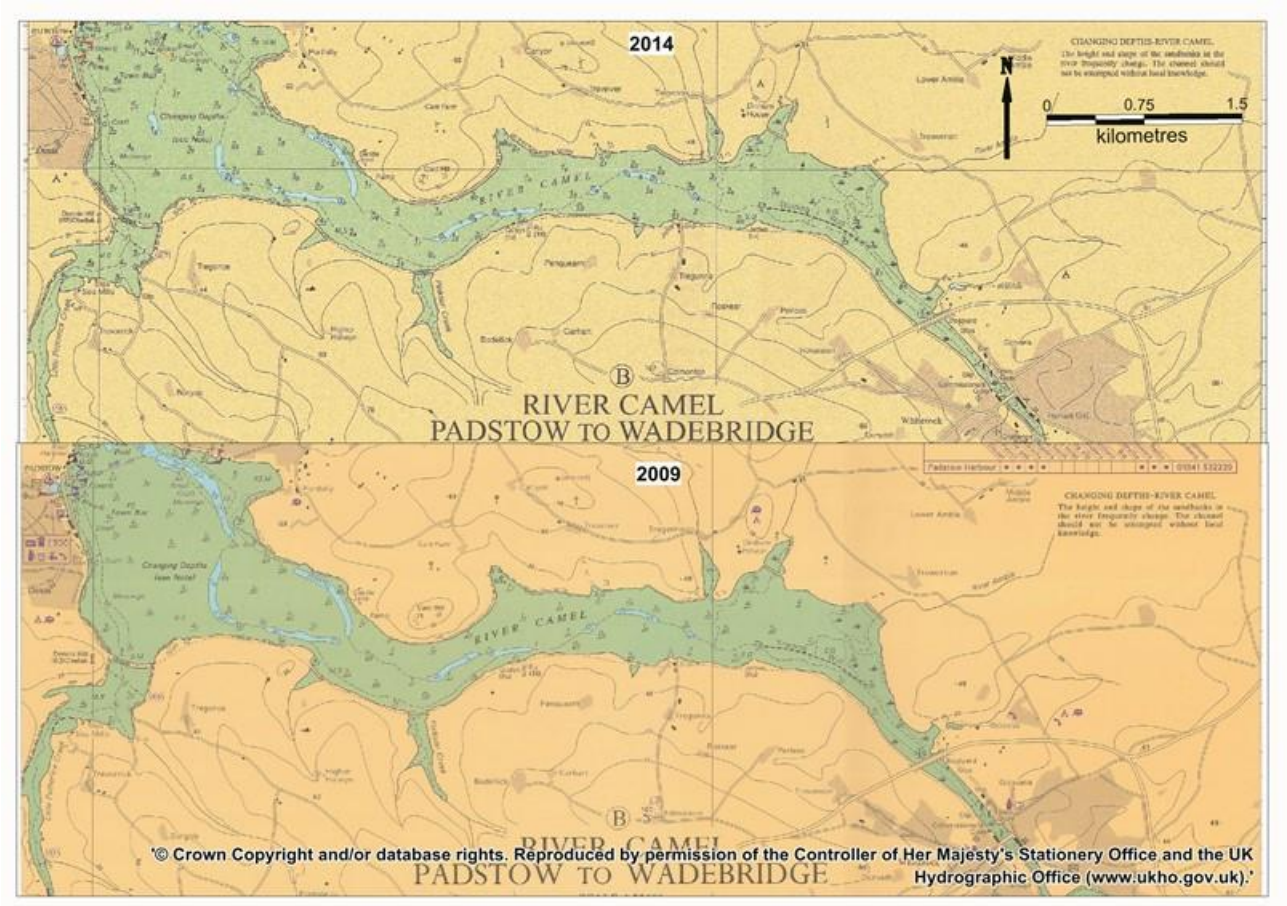

Figure 6.1: Bathymetry of the Camel estuary in 2009 and in 2014

7. Rainfall

There were no freely available rainfall data available that were relevant to this report.

8. Microbial Monitoring Results

8.1. Summary statistics and geographical variation

Between January 2003 and December 2014, there have been a total of 21 recommended monitoring points (RMPs) for bivalve shellfish in the Camel Estuary. Four of these RMPs were for cockles, two were for peppery furrow shell clams, nine were for mussels and six were for Pacific oysters. Eleven of these RMPs have been sampled both before and after the original sanitary survey.

RMPs have been split into two time periods representing samples taken before the sanitary survey (January 2003 – December 2008) and after the sanitary survey (January 2009 – December 2014) where data were available. The *E. coli* data for bivalve samples before and after the original sanitary survey are presented in Figure 8.1 and Figure 8.2.

Summary statistics are presented in Table 8.1 and boxplots for are shown in Figure 8.3 to Figure 8.6. Lifeboat Slipway Rock, Porthilley Rock A and Tregunna B (2008 & 2009) were sampled on fewer than 10 occasions and so will not be considered further.

Table 8.1: Summary statistics for *E. coli* results (MPN/100 g) from bivalve RMPs in the Camel Estuary from 2003 to 2014.

Sampling Site	Species	No.	Date of first sample	Date of last sample	Geometric mean	Min.	Max.	% over 230	% over 4,600	% over 46,000
Upper Town Bar	Cockle	49	28/01/2003	17/12/2007	356.1	20	9,100	61.2	10.2	0.0
Lower Town Bar		48	28/01/2003	17/12/2007	426.7	<20	16,000	62.5	10.4	0.0
Town Bar		18	27/07/2010	07/02/2012	764.1	<20	54,000	72.2	16.7	5.6
Little Petherick Creek (2003-2007)		51	28/01/2003	17/12/2007	496.2	<20	>18,000	68.6	11.8	0.0
Little Petherick Creek (2009-2012)		18	27/07/2010	20/03/2012	609.8	<20	9,200	72.2	5.6	0.0
Trebetherick Rocks (2003-2008)	Mussel	69	23/01/2003	15/12/2008	163.7	<20	9,100	39.1	4.3	0.0
Trebetherick Rocks (2009-2011)		26	27/01/2009	09/11/2011	157.8	<20	9,200	50.0	3.8	0.0
Lifeboat Slipway Rock		2	06/12/2003	08/12/2003	20.0	20	20	0.0	0.0	0.0
Porthilley Rock A		1	19/04/2004	19/04/2004	5,400.0	5,400	5,400	100.0	100.0	0.0
Porthilley Rock B		13	16/02/2009	19/08/2009	107.2	<20	5,400	38.5	7.7	0.0
Porthilley Cove		71	16/02/2009	08/12/2014	298.9	<20	35,000	50.7	8.5	0.0
Gentle Jane (2003-2008)		71	21/01/2003	15/12/2008	812.4	20	>18,000	74.6	15.5	0.0
Gentle Jane (2009-2014)		82	26/01/2009	08/12/2014	930.7	50	>180,000	82.9	12.2	1.2
Ball Hill West		76	16/02/2009	08/12/2014	259.8	<20	24,000	44.7	5.3	0.0
Ball Hill East		11	16/02/2009	05/05/2009	102.0	20	700	27.3	0.0	0.0
Pinkson Creek (2003-2008)		43	06/12/2003	09/12/2008	734.0	20	>18,000	65.1	20.9	0.0
Pinkson Creek (2009-2014)		64	26/01/2009	08/12/2014	180.9	<20	16,000	42.2	7.8	0.0
Porthilley Rock (2003-2008)	Pacific oyster	70	21/01/2003	15/12/2008	468.6	20	>18,000	70.0	2.9	0.0
Porthilley Rock (2009-2014)		67	26/01/2009	08/12/2014	257.4	<20	24,000	49.3	1.5	0.0
Porthilley Site		55	21/01/2003	26/11/2007	323.5	<20	5,400	60.0	1.8	0.0
Longlands (2003-2008)		71	21/01/2003	15/12/2008	586.9	40	16,000	81.7	2.8	0.0
Longlands (2009-2014)		69	26/01/2009	08/12/2014	370.4	<20	9,200	62.3	8.7	0.0
Gentle Jane (2003-2008)		70	21/01/2003	15/12/2008	593.4	70	16,000	72.9	5.7	0.0
Gentle Jane (2009-2014)		71	26/01/2009	08/12/2014	517.7	20	54,000	60.6	7.0	1.4
Ball Hill Oyster (2006-2008)		31	20/06/2006	15/12/2008	495.2	20	9,200	64.5	9.7	0.0
Ball Hill Oyster (2009-2014)		70	26/01/2009	08/12/2014	176.5	20	>180,000	37.1	1.4	1.4
Pinkson Creek (2007-2008)		21	10/04/2007	09/12/2008	333.6	<20	5,400	61.9	9.5	0.0
Pinkson Creek (2009-2012)		35	26/01/2009	23/01/2012	99.5	<20	3,500	31.4	0.0	0.0

Sampling Site	Species	No.	Date of first sample	Date of last sample	Geometric mean	Min.	Max.	% over 230	% over 4,600	% over 46,000
Tregunna A (2008)	Peppery furrow shell	3	28/10/2008	09/12/2008	2,356.7	1,700	3,500	100.0	0.0	0.0
Tregunna A (2009-2014)		58	26/01/2009	20/10/2014	816.7	<20	92,000	72.4	15.5	1.7
Tregunna B (2008)		3	28/10/2008	09/12/2008	2,568.3	2,200	3,500	100.0	0.0	0.0
Tregunna B (2009)		8	26/01/2009	05/05/2009	263.5	80	790	37.5	0.0	0.0

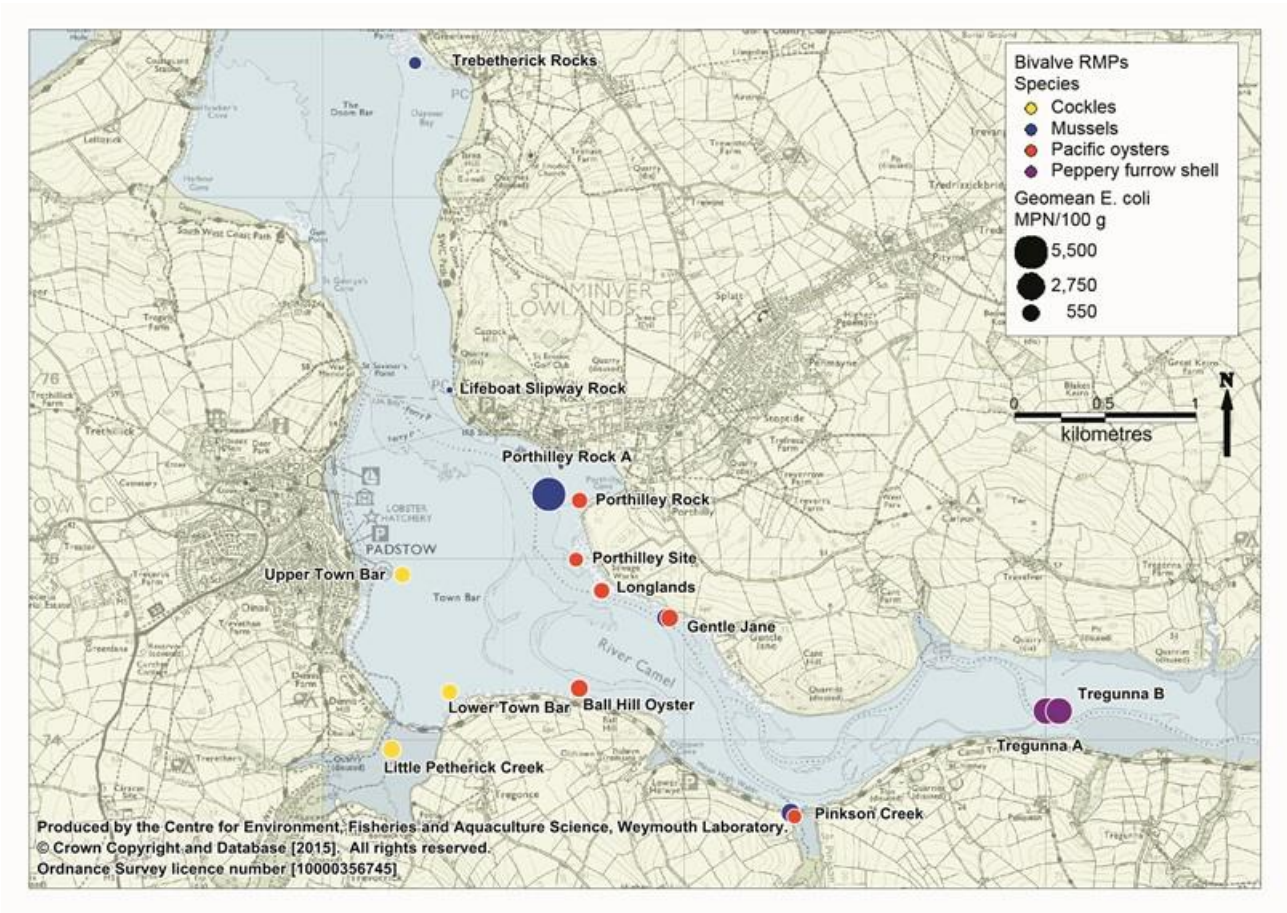

Figure 8.1: Historical shellfish RMPs sampled 2003-2008

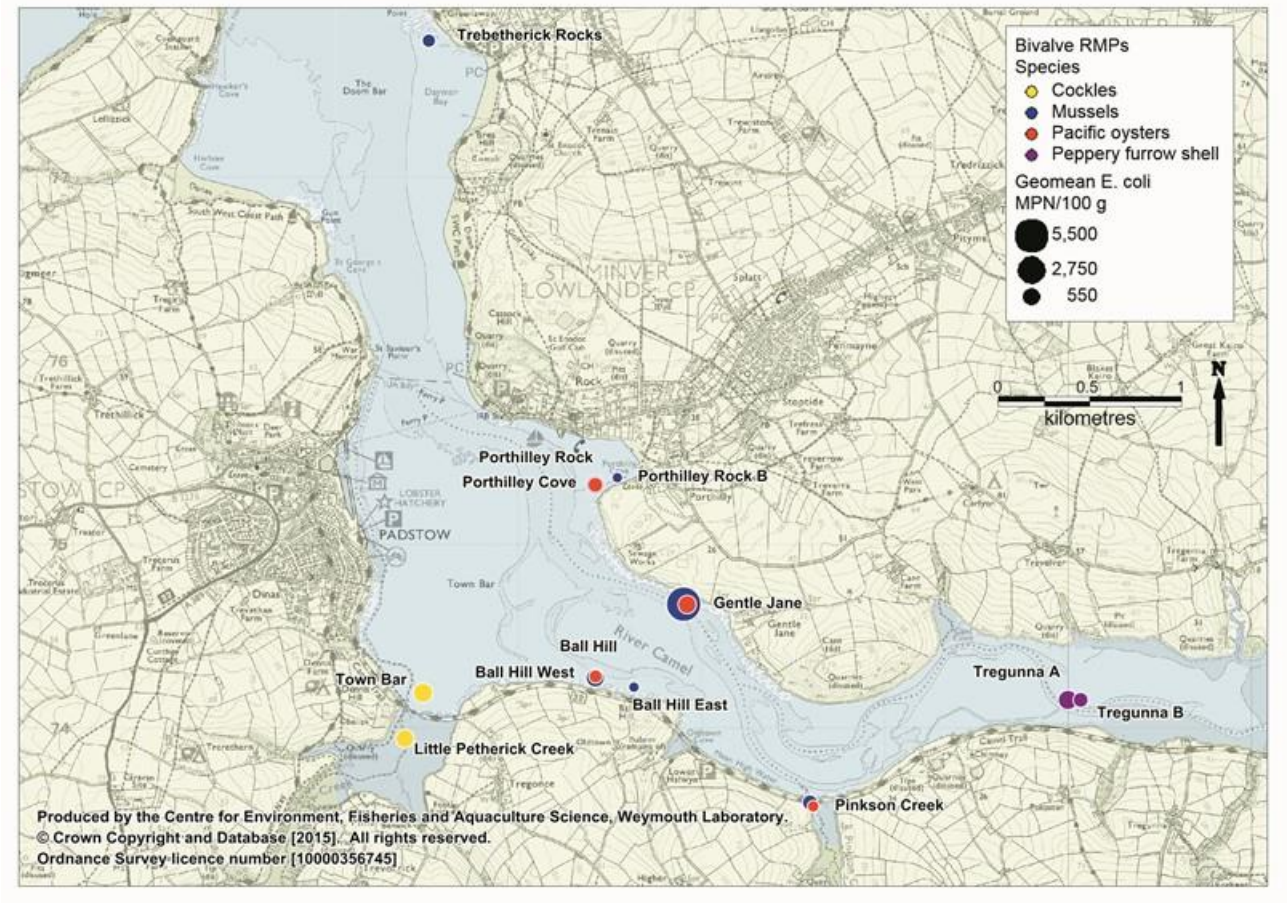

Figure 8.2: Shellfish RMPs sampled 2009-2014

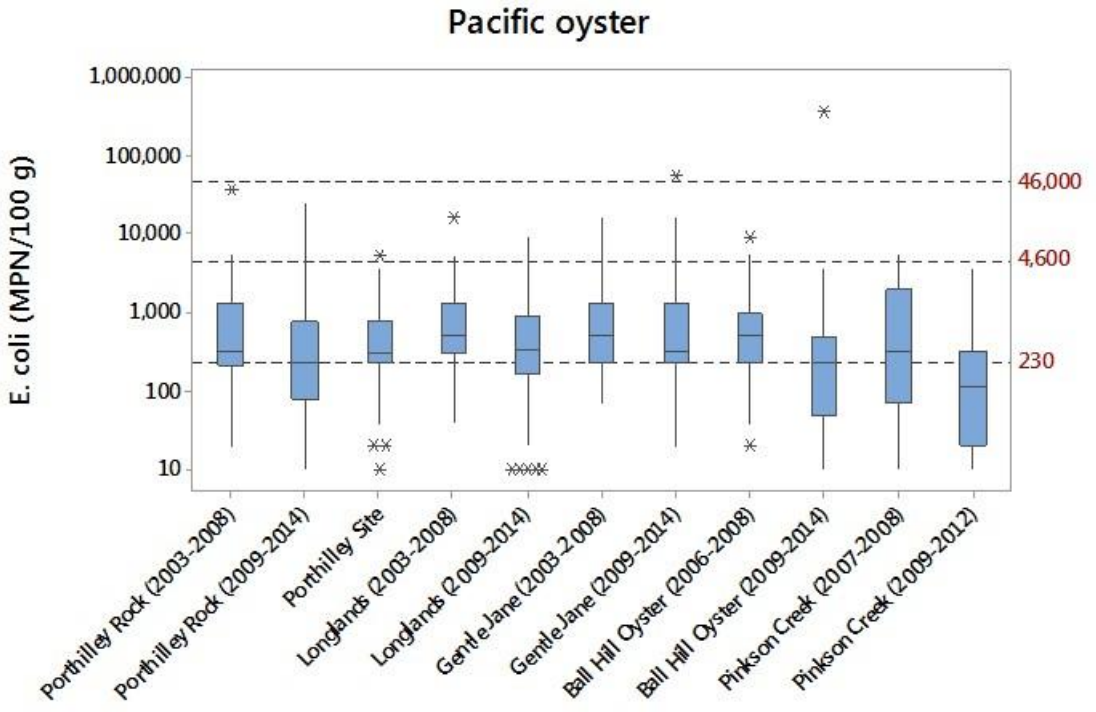

Figure 8.3: Boxplots of *E. coli* results from Pacific oyster RMPs from 2003 onwards.

One-way ANOVA tests showed that there were significant differences in *E. coli* levels between sites for Pacific oysters ($p<0.001$). Post ANOVA Tukey tests showed that Ball Hill RMP for the period 2006-2008 had significantly higher *E. coli* levels than the period 2009-2014. RMPs on the northern shore of the estuary generally had significantly higher *E. coli* levels than RMPs located on the southern shore. There appeared to be a trend of higher *E. coli* levels at RMPs located towards the head of the estuary on the northern shore. This trend was also seen on the southern shore with an increase in *E. coli* levels towards the head of the estuary.

Comparisons of RMPs were carried out on a pair-wise basis by running correlations (Pearson's) between Pacific oyster sites that shared sampling dates, and therefore environmental conditions, on at least 20 occasions. Gentle Jane Pacific oysters correlated significantly with Porthilley and Longlands sites. Ball Hill correlated significantly with Longlands, Gentle Jane and Pinkson Creek Pacific oyster sites and Longlands and Porthilley sites significantly correlated. These correlations indicate that all sites are likely to share contamination sources, or are affected by environmental conditions in a similar manner

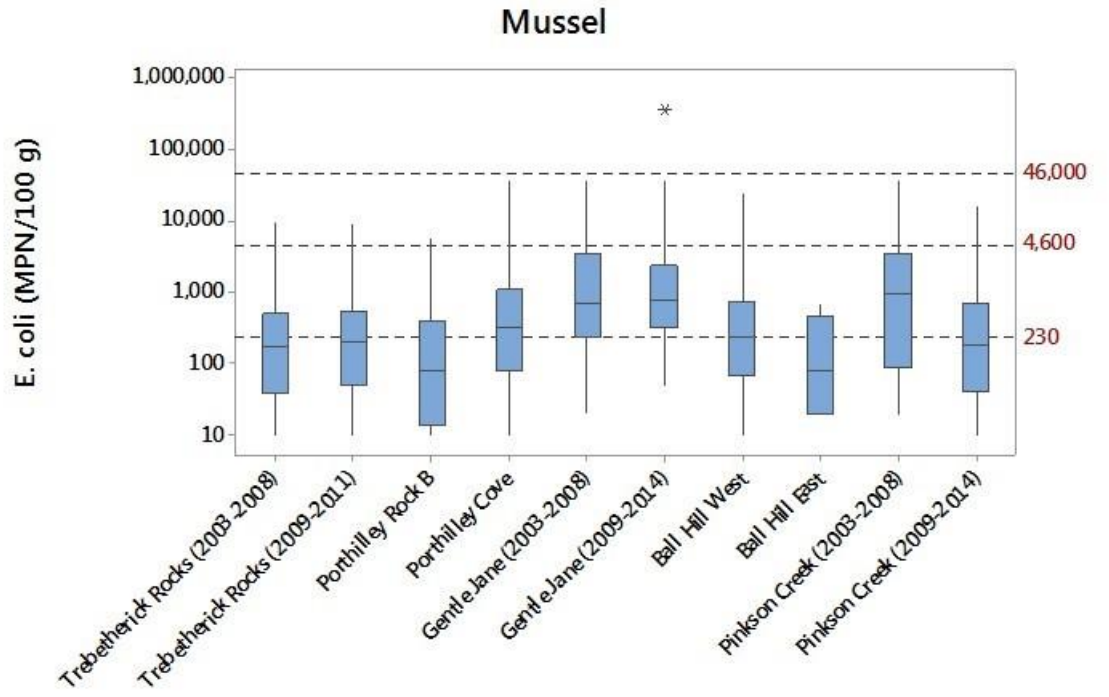

Figure 8.4: Boxplots of *E. coli* results from mussel RMPs from 2003 onwards.

Figure 8.4 shows that nearly all mussel RMP samples returned *E. coli* levels below 4,600 MPN/100 g. One sample at Gentle Jane taken between 2003 and 2008 recorded a result above 46,000 MPN/100 g. One-way ANOVA tests showed that there were significant differences in *E. coli* levels between sites for mussels ($p<0.001$). Post ANOVA Tukey tests showed that Gentle Jane RMP over both time periods (2003-2008 and 2009-2014) had significantly higher *E. coli* levels than Trebetherick Rocks (2003-2008 and 2009-2011), Porthilley Rock B, Porthilley Cove, Ball Hill East and West and Pinkson Creek (2009-2014). Pinkson Creek had significantly higher *E. coli* levels for the time period 2003-2008 than 2009-2014. Pinkson Creek mussels (2003-2008) also had significantly higher *E. coli* levels than Trebetherick Rocks (2003-2008 and 2009-2011), Porthilley Rock B and Ball Hill East.

Comparisons of RMPs were carried out on a pair-wise basis by running correlations (Pearson's) between mussel sites that shared sampling dates, and therefore environmental conditions, on at least 20 occasions. Trebetherick Rocks mussels correlated significantly for the period 2009-2011 with Porthilley Cove, Gentle Jane, Ball Hill West and Pinkson Creek mussel sites. Porthilley Cove for the period 2009-2011 correlated significantly with Gentle Jane, Ball Hill West and Pinkson Creek mussel sites. Gentle Jane for the same time period correlated with Ball Hill West and Pinkson Creek mussel sites and Ball Hill West and Pinkson Creek correlated significantly. These correlations indicate that all sites are likely to share contamination sources, or are affected by environmental conditions in a similar manner.

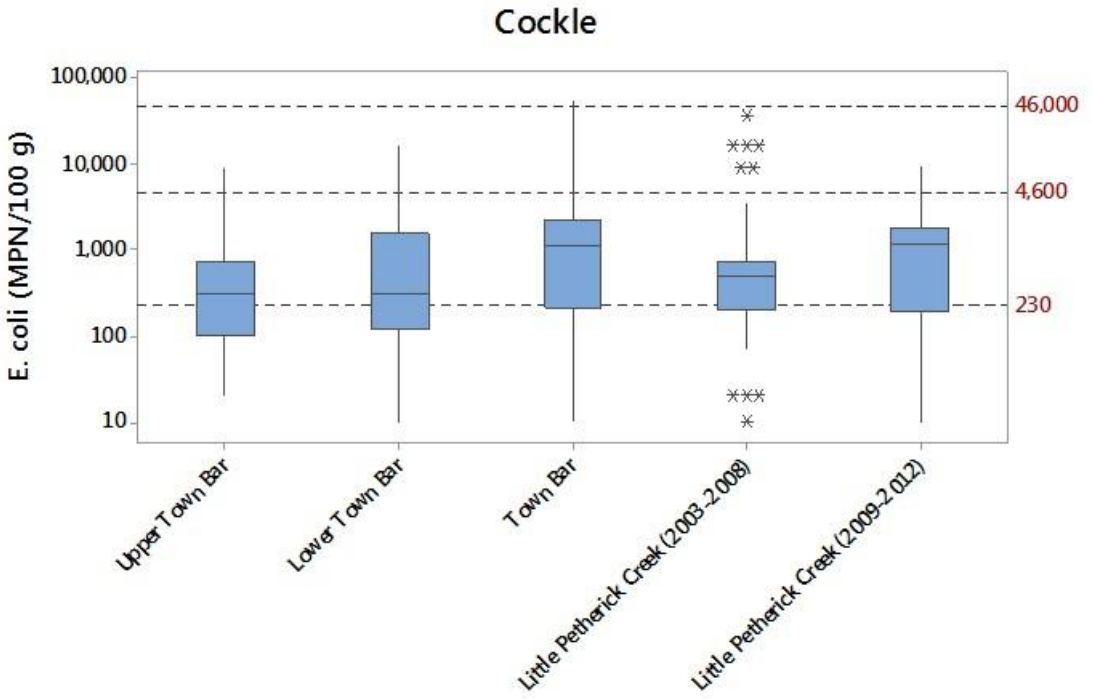

Figure 8.5: Boxplots of *E. coli* results from cockle RMPs from 2003 onwards.

E. coli levels at all cockle sites were predominantly below 4,600 MPN/100 g (61% to 72% at all beds). Geometric means were highest at Town Bar and Little Petherick Creek (2009-2012). One-way ANOVA tests showed that there were no significant differences in *E. coli* levels between sites for cockles (p=0.526).

Comparisons of RMPs were carried out on a pair-wise basis by running correlations (Pearson's) between cockle sites that shared sampling dates, and therefore environmental conditions, on at least 20 occasions. Lower Town Bar, Upper Town Bar and Little Petherick Creek cockle sites correlated significantly for the period 2003-2008, indicating that they are likely to share contamination sources, or are affected by environmental conditions in a similar manner.

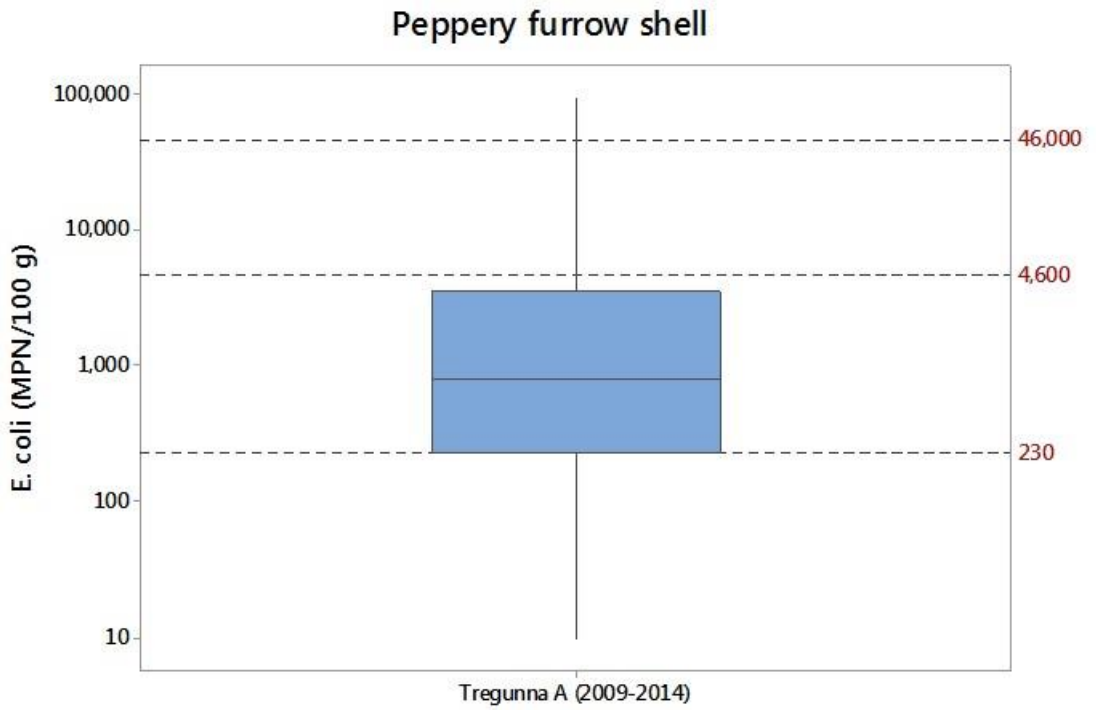

Figure 8.6: Boxplots of *E. coli* results from Peppery furrow shell clam RMPs from 2009 onwards.

73% of *E. coli* levels at Tregunna A for the period 2009-2014 were below 4,600 MPN/100 g. The highest recorded level exceeded 46,000 MPN/100 g.

8.2. Overall temporal pattern in results

Figure 8.7 to Figure 8.10 show time series of *E. coli* results in Pacific oysters, mussels, cockles and peppery furrow shell clam samples taken between 2003 and 2014.

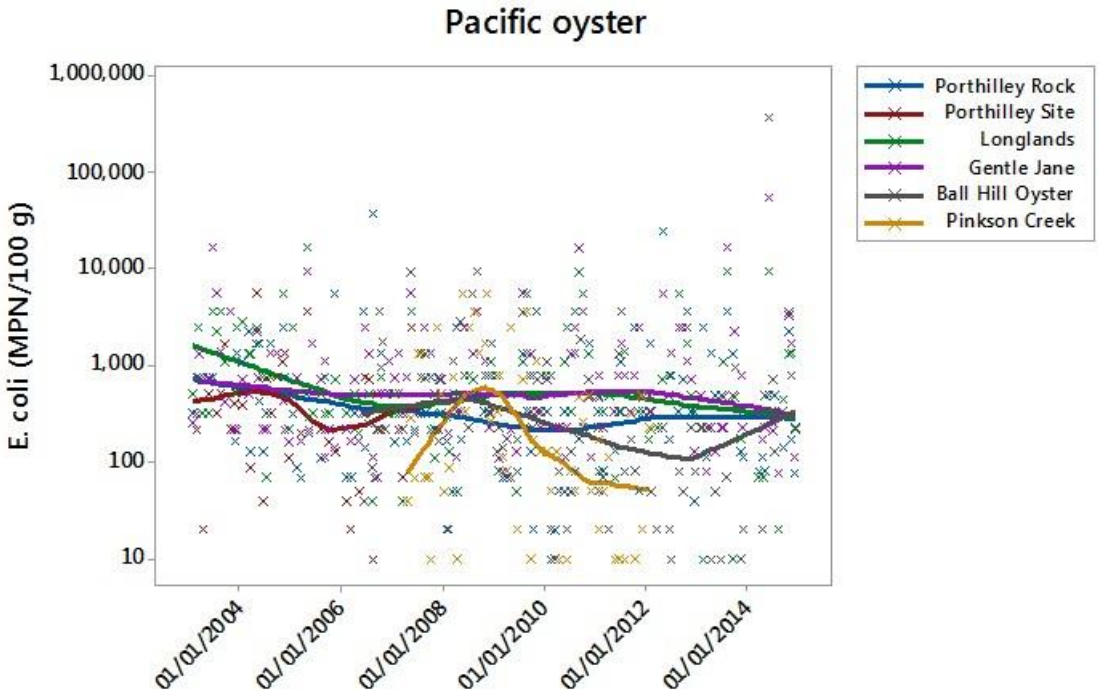

Figure 8.7:Scatterplot of *E. coli* results for Pacific oysters overlaid with loess lines.

Overall *E. coli* levels have remained stable with a decline at some sites. Such as Ball Hill there was a slight decrease in *E. coli* levels in late 2012 and this is supported by a post ANOVA Tukey test which shows that at Ball Hill the time period 2006-2008 showed higher *E. coli* levels than the time period 2009-2014.

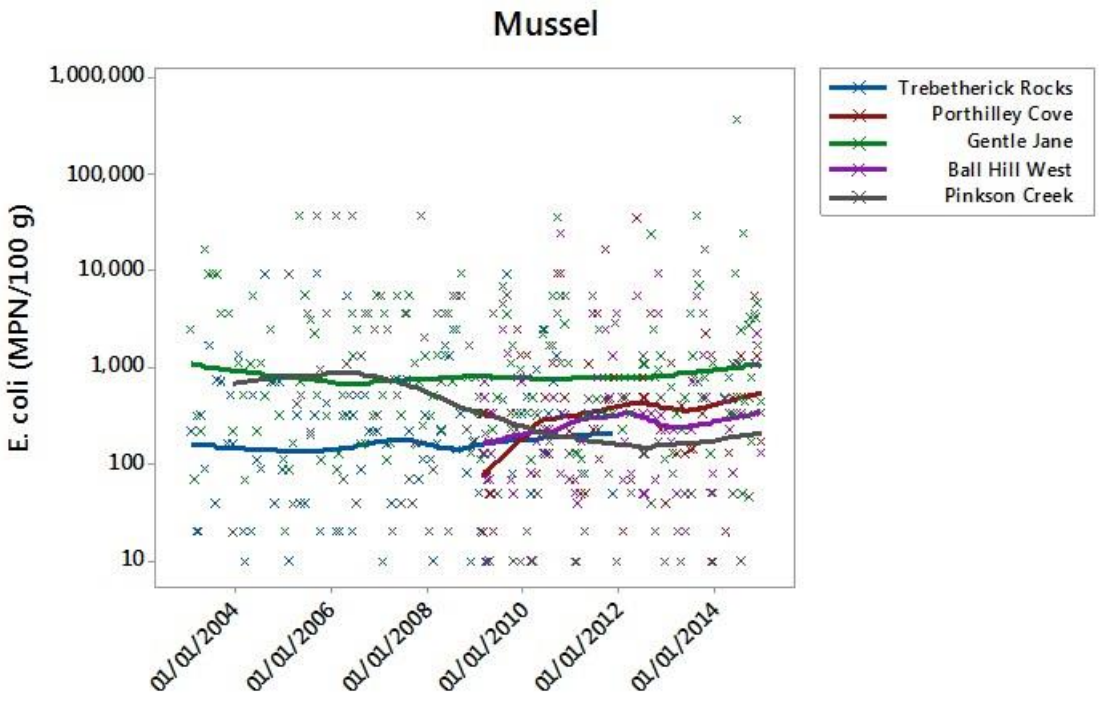

Figure 8.8: Scatterplot of *E. coli* results for mussel overlaid with loess lines.

E. coli levels have remained fairly stable at Gentle Jane, Trebetherick Rocks, Ball Hill West and Porthilley Cove mussel RMPs. There appears to be a decline in *E. coli* levels at Pinkson Creek from 2007 onwards. This is supported by post ANOVA Tukey tests which show that *E. coli* levels were significantly lower for the time period 2009-2014 compared to 2003-2008.

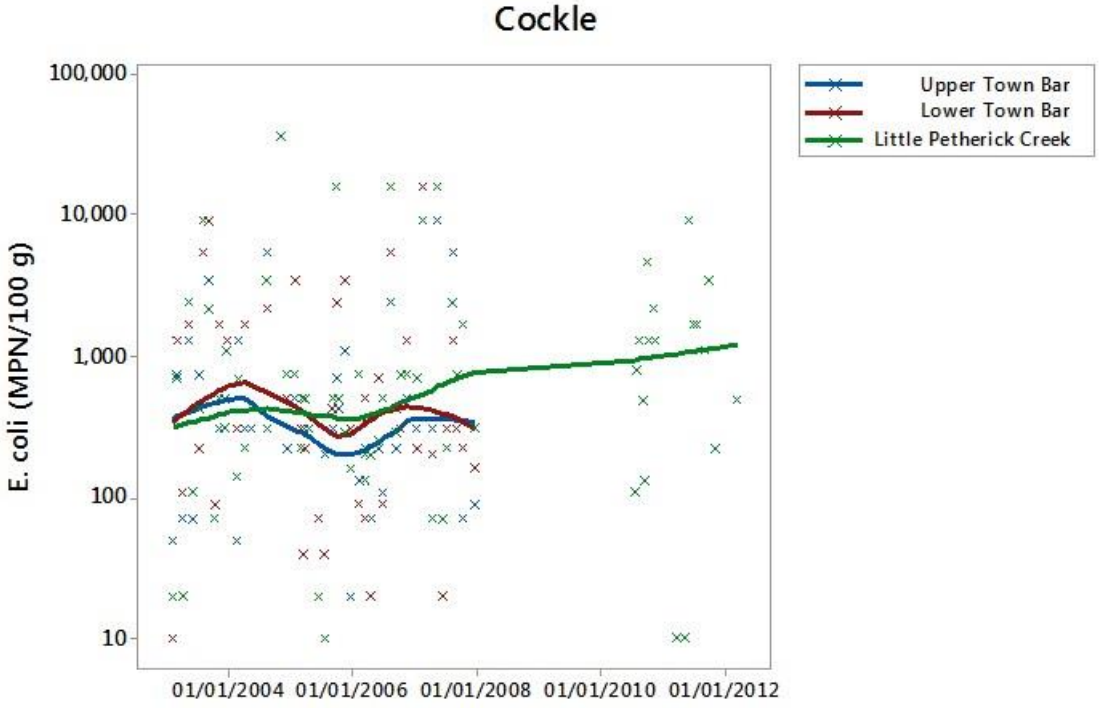

Figure 8.9: Scatterplot of *E. coli* results for cockles overlaid with loess lines.

E. coli levels have remained fairly stable at all cockle RMPs with a slight increase at Little Petherick Creek.

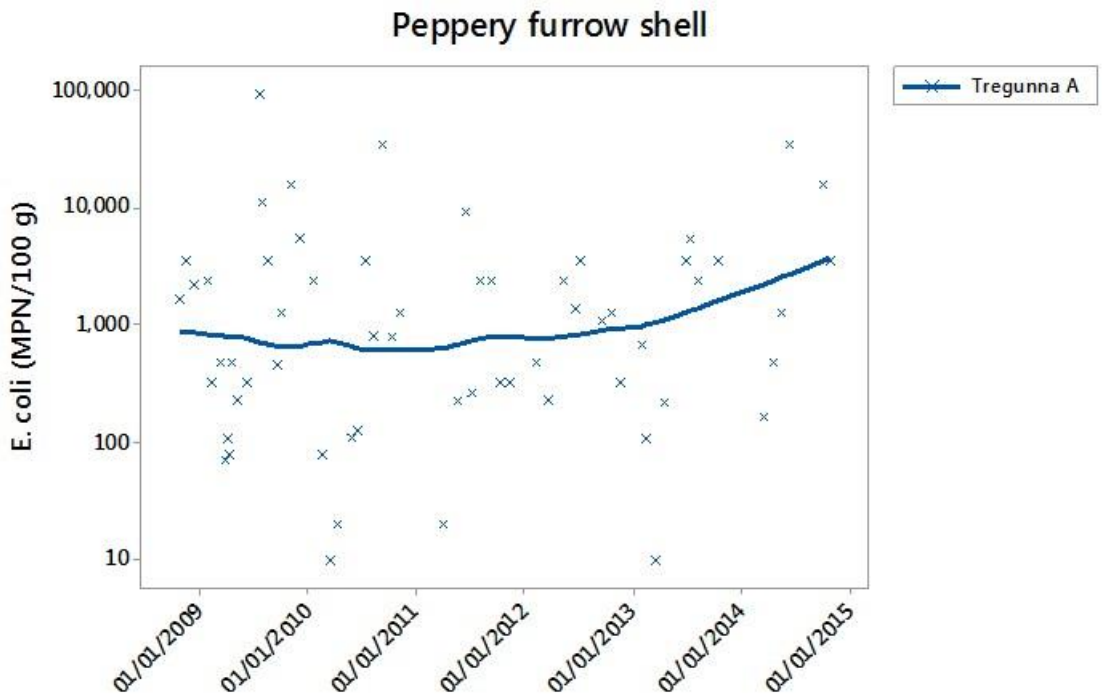

Figure 8.10: Scatterplot of *E. coli* results for Peppery furrow shell clams overlaid with loess lines.

E. coli levels remained fairly stable for Peppery furrow shell clams between 2009 and 2014.

8.3. Seasonal Patterns of Results

Figure 8.11 and Figure 8.12 shows the overall pattern in seasonal variation at the Pacific oyster RMPs and mussel RMPs for the time periods 2003-2008 and 2009-2014. Figure 8.13 shows the overall pattern in seasonal variation at the cockles RMPs for the time periods 2003-2008 and 2009-2012. Figure 8.14 shows the overall pattern in seasonal variation at the peppery furrow clam RMPs from 2009-2014.

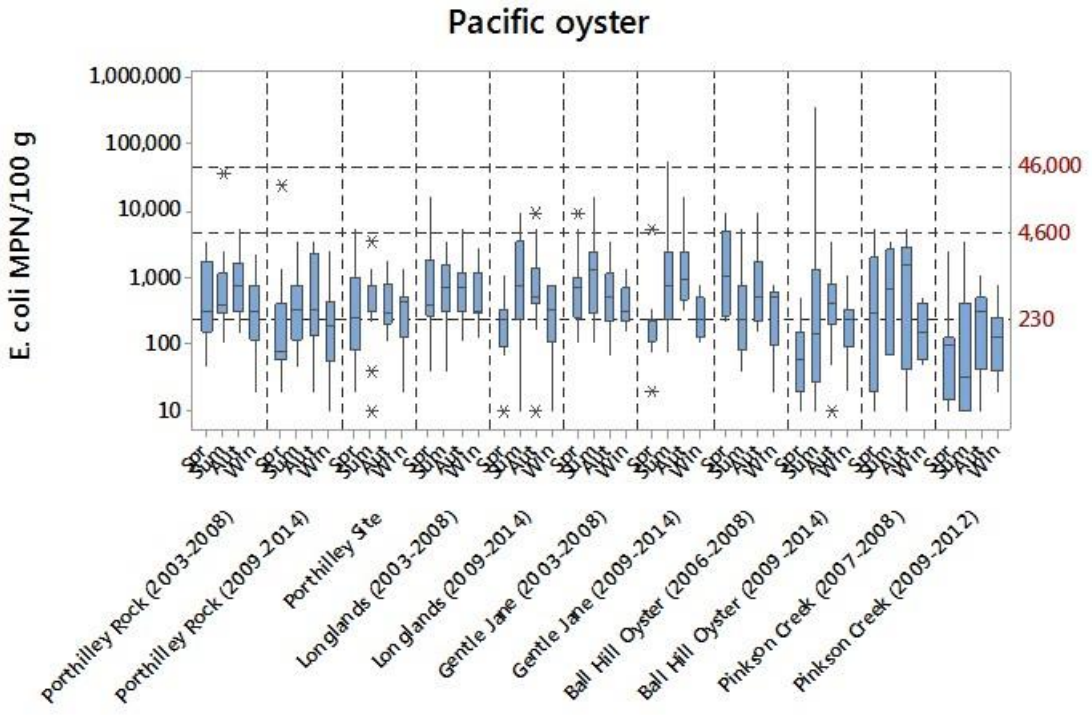

Figure 8.11: Boxplot of *E. coli* results in Pacific oysters by RMP and season

One-way ANOVA tests showed that there was no significant variation in *E. coli* results between seasons at most of the Pacific oyster RMPs (p=0.096 – 0.73). The exceptions to this were Longlands (2009-2014) (p=0.041), Gentle Jane (2003-2008) (p<0.001) and Ball Hill (2009-2014) (p=0.015). Post-ANOVA Tukey tests revealed that at Gentle Jane *E. coli* levels were significantly higher in the summer and autumn than in spring and winter and *E. coli* levels were higher in the autumn months than in the spring at Ball Hill. The Tukey test did not reveal a seasonal variation at Longlands (2009-2014).

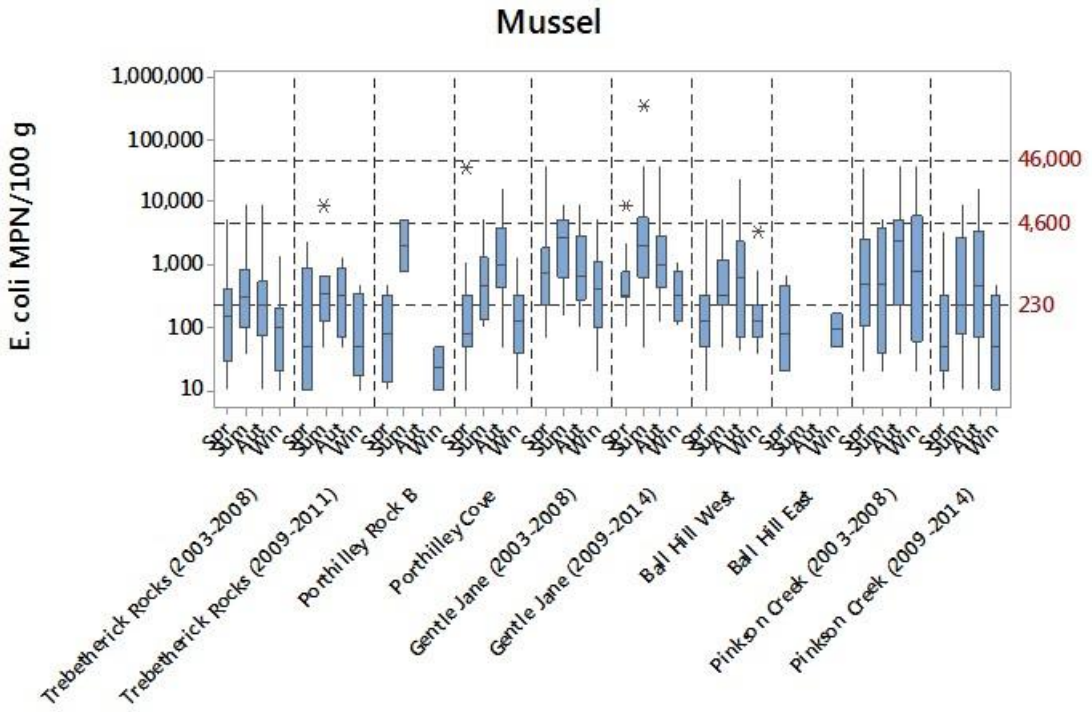

Figure 8.12: Boxplot of *E. coli* results in mussels by RMP and season

One-way ANOVA tests showed that there was a significant variation in *E. coli* results between seasons at most of the mussel RMPs: Trebetherick Rocks (2003-2008) (p=0.024), Porthilley Rock B (p=0.026), Porthilley Cove (p<0.001), Gentle Jane (2003-2008) (p=0.009), Gentle Jane (2009-2014) (p<0.001), Ball Hill West (p=0.001) and Pinkson Creek (2009-2014) (p=0.005). Post-ANOVA Tukey tests revealed that at all significant RMPs except Ball Hill West, summer had higher *E. coli* levels than winter. *E. coli* levels were higher in summer than spring at Porthilley Rock B, Porthilley Cove, Gentle Jane (2009-2014) and Ball Hill West. *E. coli* levels were higher in autumn than spring at Porthilley Cove, Gentle Jane (2009-2014) and Ball Hill West. *E. coli* levels were higher in autumn than winter at Porthilley Cove and Pinkson Creek (2009-2014).

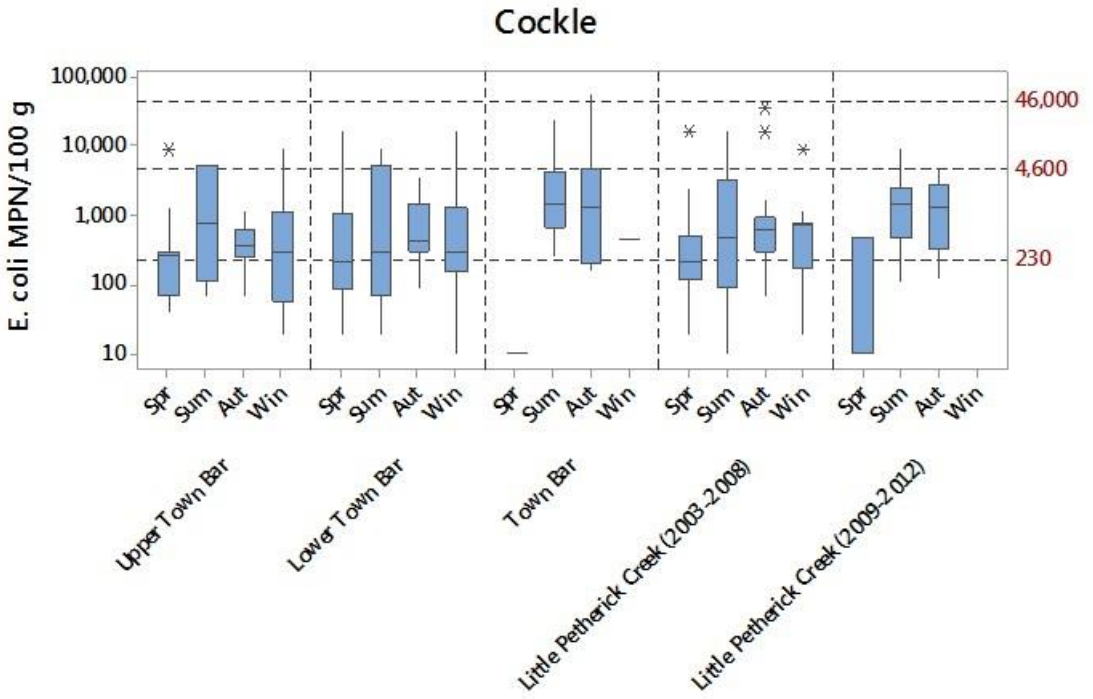

Figure 8.13: Boxplot of *E. coli* results in cockles by RMP and season

One-way ANOVA tests showed that there was no significant variation in *E. coli* results between seasons at Upper Town Bar, Lower Town Bar and Little Petherick Creek (2003-2008) cockle RMPs (p=0.272, 0.833 & 0.513). A significant difference between seasons was found at Town Bar (p=0.016) and Little Petherick Creek (2009-2012) (p=0.008). Post-ANOVA Tukey tests revealed that at both sites summer and autumn had higher *E. coli* levels than in the spring.

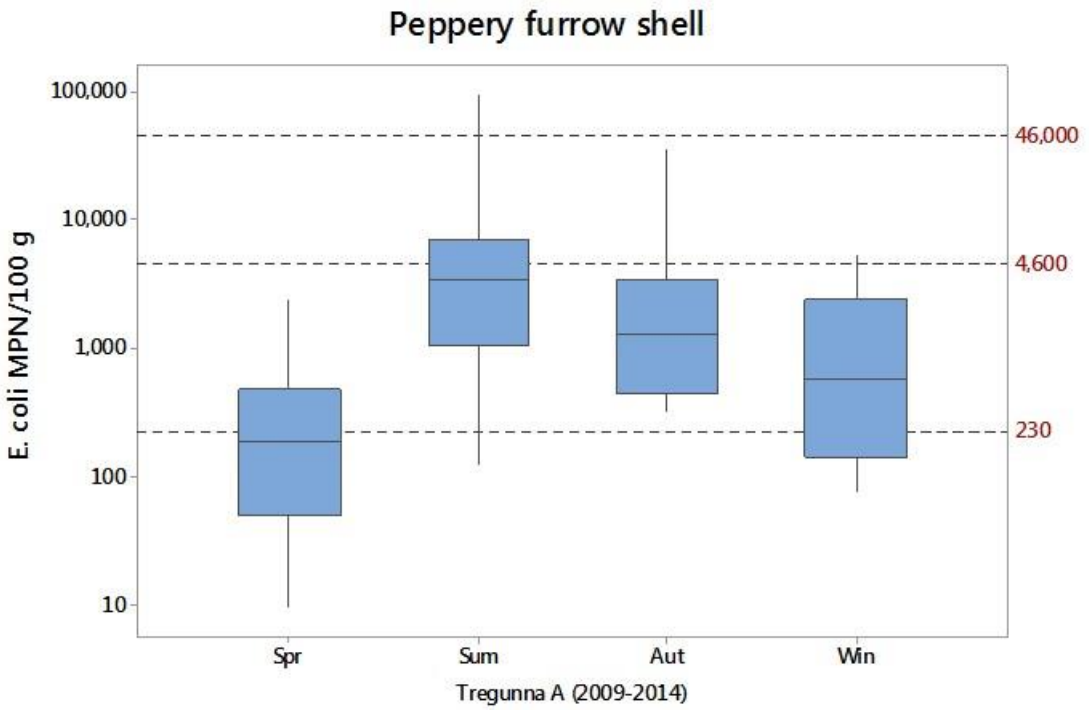

Figure 8.14 Boxplot of *E. coli* results in peppery furrow shell clams by RMP and season

One-way ANOVA tests showed that there was a significant variation in *E. coli* results between seasons at Tregunna A RMPs ($p<0.001$) for the period 2009-2014. A post-ANOVA Tukey test revealed that summer and autumn had higher *E. coli* levels than spring.

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

		High/low tides		Spring/neap tides	
Site Name	**Species**	**r**	**p**	**r**	**p**
Upper Town Bar	Cockle	0.040	0.929	0.151	0.351
Lower Town Bar		0.209	0.140	0.110	0.579
Little Petherick Creek (2003-2008)		0.113	0.544	0.161	0.286
Trebetherick Rocks (2003-2008)	Mussel	0.086	0.611	0.152	0.215
Porthilley Cove		0.397	0.000	0.184	0.099
Gentle Jane (2003-2008)		0.041	0.890	0.176	0.122
Gentle Jane (2009-2014)		0.232	0.014	0.141	0.206
Ball Hill West		0.211	0.039	0.048	0.844
Pinkson Creek (2003-2008)		0.203	0.193	0.353	0.007
Pinkson Creek (2009-2014)		0.200	0.087	0.260	0.016

Porthilley Rock (2003-2008)	Pacific oyster	0.092	0.567	0.136	0.288
Porthilley Rock (2009-2014)		0.247	0.020	0.016	0.983
Porthilley Site		0.059	0.837	0.088	0.667
Longlands (2003-2008)		0.105	0.469	0.153	0.203
Longlands (2009-2014)		0.264	0.010	0.178	0.123
Gentle Jane (2003-2008)		0.160	0.179	0.275	0.006
Gentle Jane (2009-2014)		0.313	0.001	0.172	0.133
Ball Hill Oyster (2006-2008)		0.440	0.004	0.474	0.002
Ball Hill Oyster (2009-2014)		0.120	0.381	0.143	0.253
Pinkson Creek (2009-2012)		0.420	0.003	0.248	0.140
Tregunna A (2009-2014)	Peppery furrow shell	0.181	0.165	0.188	0.143

Significant correlations with the high/low tidal cycle was found at Porthilley Cove, Gentle Jane (2009-2014) and Ball Hill West mussel RMPs and at Porthilley Rock (2009-2014), Longlands (2009-2014), Gentle Jane (2009-2014), Ball Hill Oyster (2006-2008) and Pinkson Creek (2009-2012) pacific oyster RMPs. Significant correlations were found for the period 2003-2008 and the 2009-2014 period at Pinkson Creek mussel RMP, Gentle Jane oyster RMP for the period 2003-2008 and Ball Hill oyster RMP for 2006-2008 against the spring/neap tidal cycle. No correlation between tidal state and *E. coli* level was found at any cockle or peppery furrow shell RMPs.

Figure 8.15 and Figure 8.16 present polar plots of $\log_{10}$ *E. coli* results against tidal states on the high/low cycle for the correlations indicating a statistically significant effect. High water at Padstow is at 0° and low water is at 180°. 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.

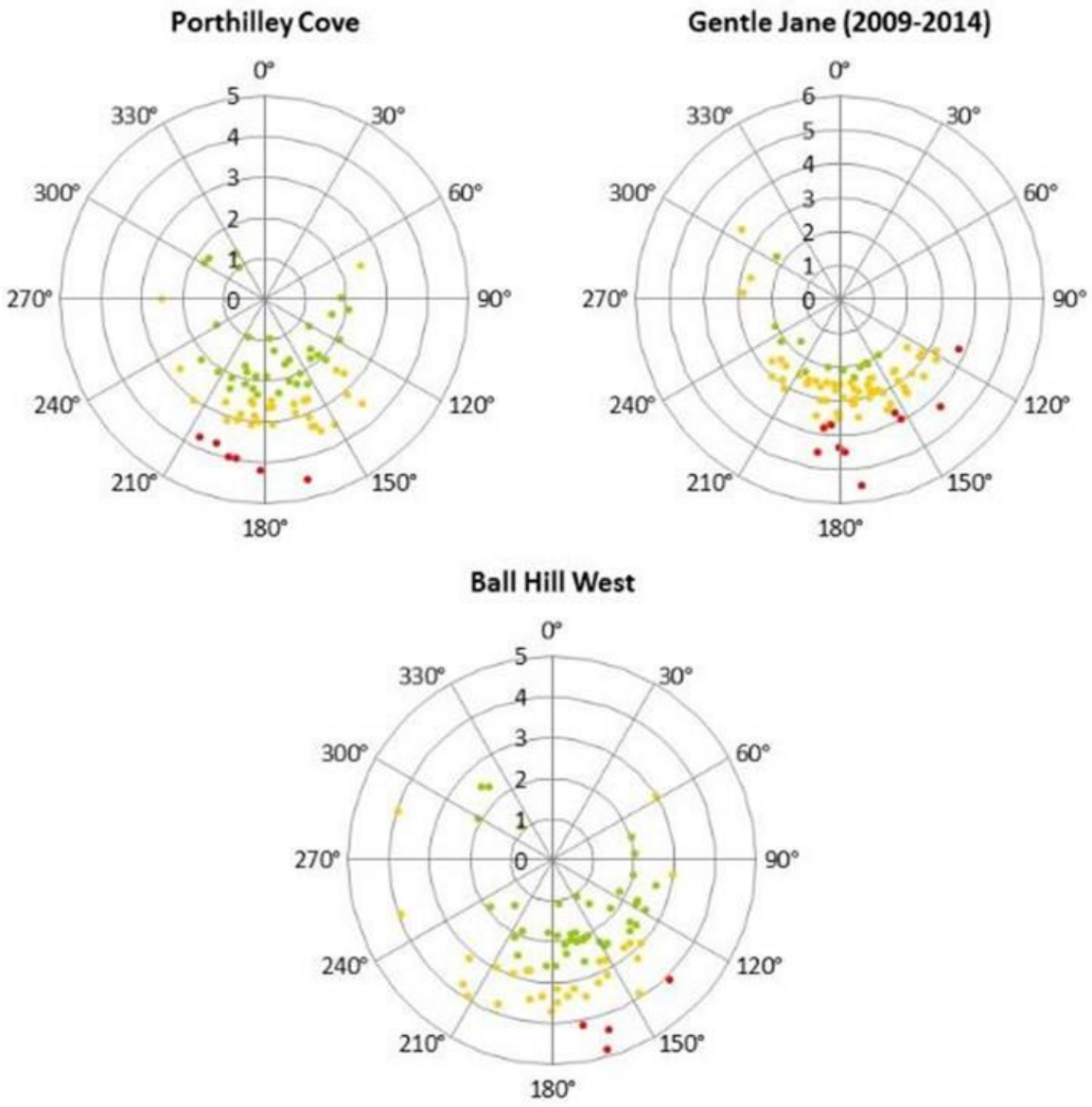

Figure 8.15: Polar plots of log_{10} *E. coli* results (MPN/100 g) at mussel RMPs against high /low tidal state

Polar plots for mussels in Figure 8.15 indicate that the majority of samples were collected around low tide at Porthilley Cove, Gentle Jane (2009-2014) and Ball Hill West mussel RMPs. At Porthilley Cove and Gentle Jane (2009-2014) it appears that lower *E. coli* results tend to be more spread out around low water whereas the higher *E. coli* results cluster closer to low water. This may indicate a lower dilution rate for the source of contamination at low water.

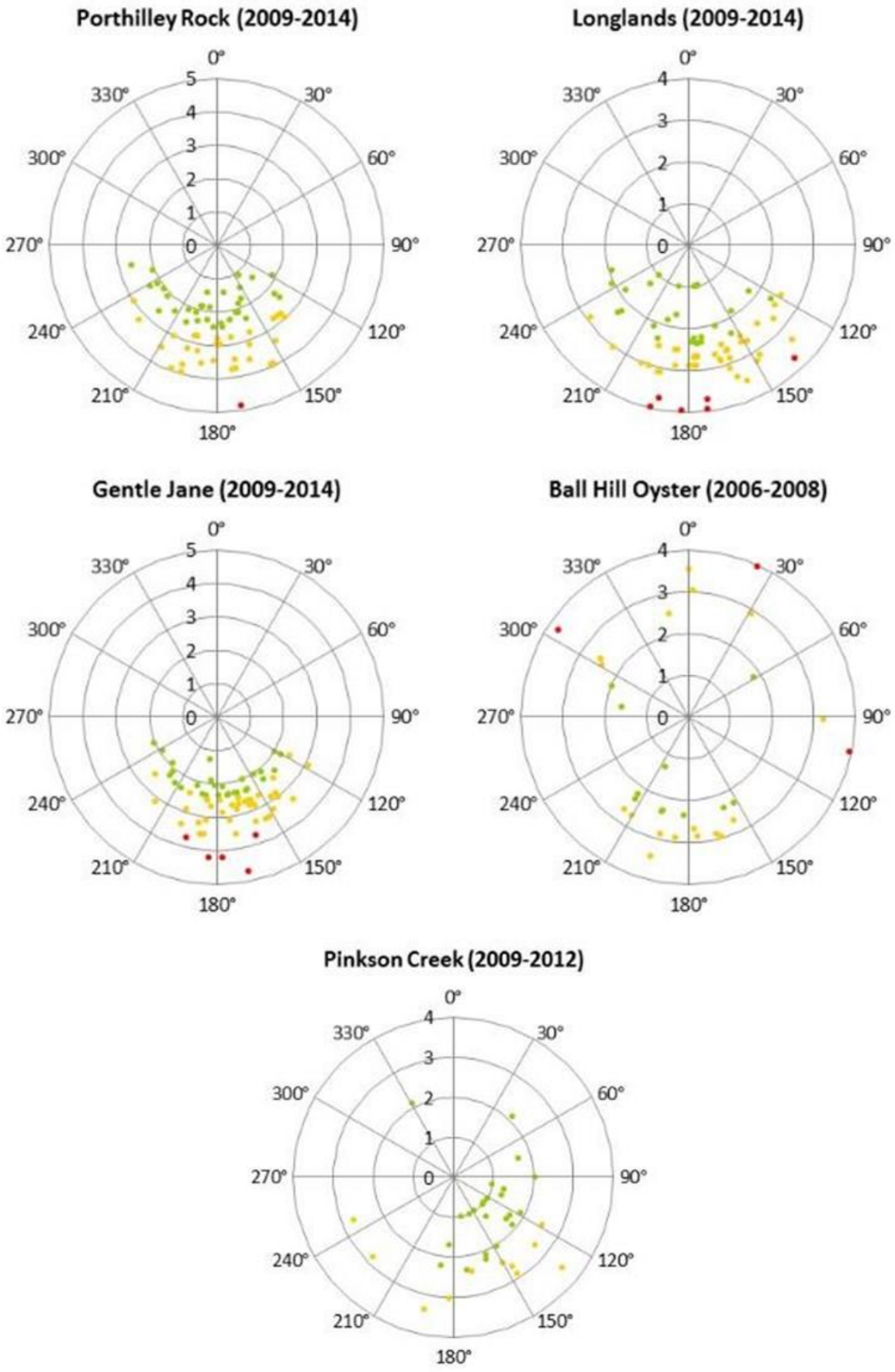

Figure 8.16: Polar plots of log10 *E. coli* results (MPN/100 g) at Pacific oyster RMPs against high/low tidal state

Polar plots for Pacific oysters in Figure 8.16 indicate that samples were predominantly taken on a low tide at Porthilley Rock, Longlands and Gentle Jane. At Ball Hill and Pinkson Creek RMPs results have no obvious pattern with results spread across high water and low water.

Figure 8.17 and Figure: 8.18 present polar plots of log10 *E. coli* results against the spring neap tidal cycle for each RMP. Full/new moons occur at 0º, and half moons occur at 180º, and the largest (spring) tides occur about 2 days after the full/new moon, or at about 45º, then decrease to the smallest (neap tides) at about 225º, 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.

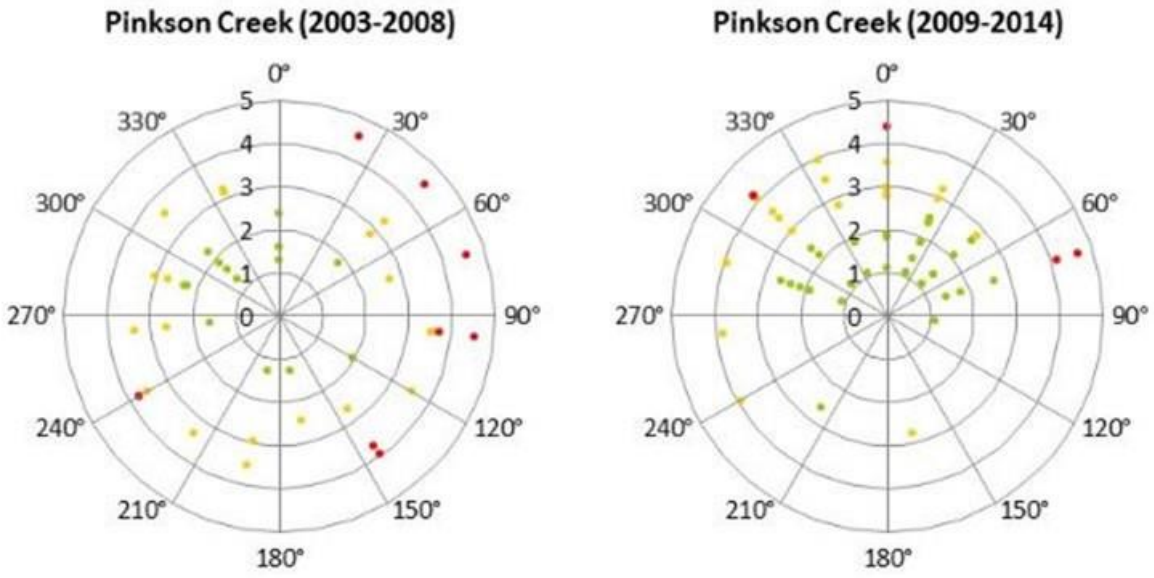

Figure 8.17: Polar plots of log10 *E. coli* results (MPN/100 g) at mussel RMPs against spring/neap tidal state

At Pinkson Creek (2003-2008), *E. coli* results tended to be higher on/around spring tides which indicates that an additional source of contamination which is more remote reaches the bed on a spring tide when the tidal excursion is greater. At Pinkson Creek (2009-2014) it appears that the majority of samples were taken on the run up to and on a spring tide, samples taken on a neap tide were below 46,000 MPN/100 g.

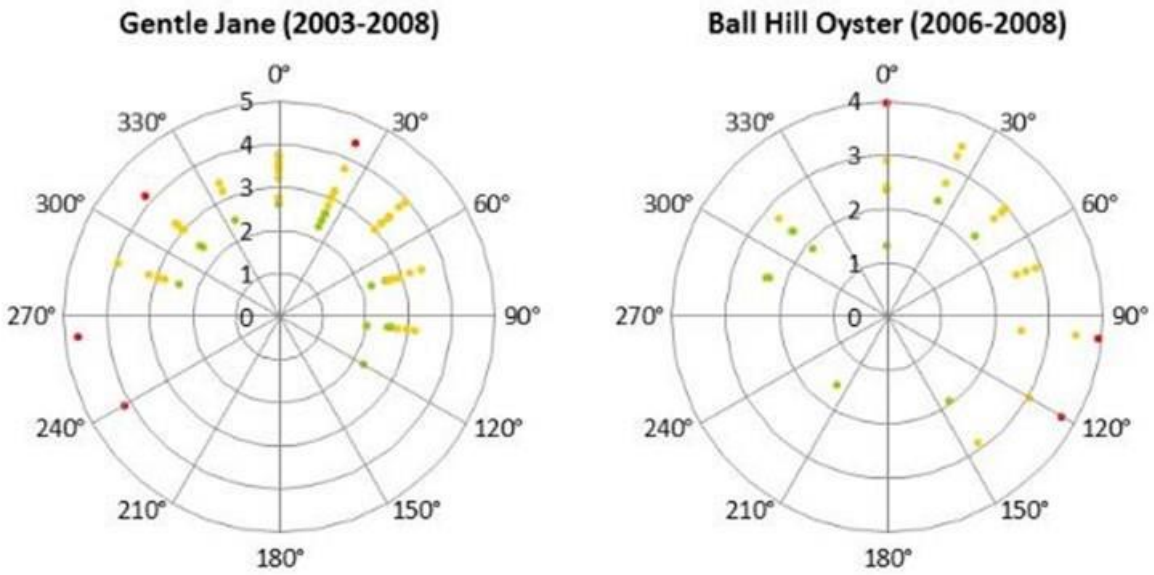

Figure: 8.18 Polar plots of log10 *E. coli* results (MPN/100 g) at Pacific oyster RMPs against spring/neap tidal state

Similar to mussel samples, the majority of oyster samples at Gentle Jane (2003-2008) were taken on the run up to and on a spring tide indicating a remote source of contamination which only reaches the shellfish bed when the tidal excursion in large. However, samples taken on and around a neap tide showed high *E. coli* levels indicating a nearby source of contamination. Suggesting that on a neap tide a contamination source which is nearby is causing contamination to the shellfish beds. At Ball Hill (2006-2008) it appears that the majority of sampling took place around spring tides, with a larger proportion of elevated *E. coli* results after the spring tidal state.

9. References

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10. Acknowledgements

Deborah Lewis (Cornwall Port Health Authority), Tim Marshall (Rock Shellfish)

Appendices

Appendix I. Shoreline Survey Report

Date (time):
08/10/2014 (09:30 – 13:30)
09/10/2014 (09:30 – 13:00)

Cefas Officers:
Rachel Parks

Local Enforcement Authority Officers:
Deborah Lewis (Cornwall Port Health Authority)

Area surveyed:
Day 1: Wadebridge to Padstow
Day 2: Daymer Bay to Cant Cove

Weather:
08th October – Overcast with heavy showers and sunny spells 13.7°C, wind bearing 214° at 13 km/h
09th October – Overcast with heavy showers and sunny spells 13.2°C, wind bearing 242° at 11 km/h

Tides:
Admiralty TotalTide© predictions for Padstow. All times in this report are BST.

08/10/2014		09/10/2014	
High 05:47	7.6 m	Low 00:39	0.4 m
Low 12:17	0.6 m	High 06:31	7.8 m
High 18:09	7.9 m	Low 13:00	0.5 m
		High 18:53	7.9 m

I.1. Objectives:

The shoreline survey aims to obtain samples of freshwater inputs to the area for bacteriological testing; confirm the location of previously identified sources of potential contamination; locate other potential sources of contamination that were previously unknown and find out more information about the fishery. A full list of recorded observations is presented in Table I.1 and the locations of these observations are shown in Figure I.1. The shoreline survey was undertaken over 2 days by foot.

I.2. Description of Fishery

Floating cages holding juvenile Pacific oysters were observed east of Pinkson Creek and offshore of Porthilley headland. Pacific oyster trestles were observed on the intertidal foreshore at Ball Hill.

Pacific oyster trestles and mussels were observed on the foreshore south east of Porthilley headland representing the Longlands and Gentle Jane classification zones. Mussels were seen on the muddy foreshore between the Longlands and Gentle Jane oyster trestles.

I.3. Sources of contamination

Sewage discharges

Wadebridge Pumping Station, Wadebridge Sewage Treatment Works and Porthilley Pumping Station locations were confirmed (observation 1, 4 and 24). A water sample (C02, observation 4) was taken from what is assumed to be the discharge pipe from the Wadebridge Sewage Treatment Works, and returned a relatively low concentration of *E. coli* 1,000 cfu/100 ml.

A large pipe with flap adjacent to the Sewage Works was flowing at the time of the survey; however it could not be sampled as works were being done (Figure I.4). This pipe is not on the latest version of the Environment Permit Database and is therefore assumed to be a surface drainage pipe.

A water sample (C06, observation 26) taken from an unnamed stream which was thought to receive the Porthilley intermittent discharge returned a relatively low concentration of *E. coli*, 2,200 cfu/100 ml.

Freshwater inputs

Eight unnamed streams were observed on the survey all of which were flowing at the time of survey (Observations 7, 8, 9, 10, 11, 19, 26 and 28). Where possible water samples and flow measurements were taken. Streams discharging to the northern shore of the Camel estuary were accessible (observations 19, 26 and 28) and samples from these streams returned *E. coli* concentrations of between 1,500 to 8,700 cfu/100 ml (see Table I.2 for details) and the streams discharging to Daymer Bay (16) and Porthilley Cove (26) gave daily *E. coli* loadings of $1.4x10^{11}$ and $6.19x10^{8}$ cfu/100 ml respectively. The stream discharging to Cant Cove had a very low flow and therefore could not be measured.

A series of drainage pipes were observed throughout the survey area predominantly in the more built up areas of Padstow and Rock (see Table I.1 for details). The majority were not flowing at the time of survey. An elevated concentration of *E. coli* was taken from a pipe discharging to the beach beneath the Padstow sailing club, sampled after a period of heavy rain. An Environment Agency sluice gate was observed west of Wadebridge but did not appear to be discharging at the time of survey.

Livestock

Around 20 cows, were observed in the fields adjacent to the Camel Trail (observation 10). No other livestock were observed along the shoreline survey.

Wildlife

Aggregations of birds (approximately between 10 and 40) were observed at four locations within the estuary (observations 1, 6, 7 and 27).

Dog walking was evident along the Camel Trail which runs between Wadebridge and Padstow and on Daymer Bay.

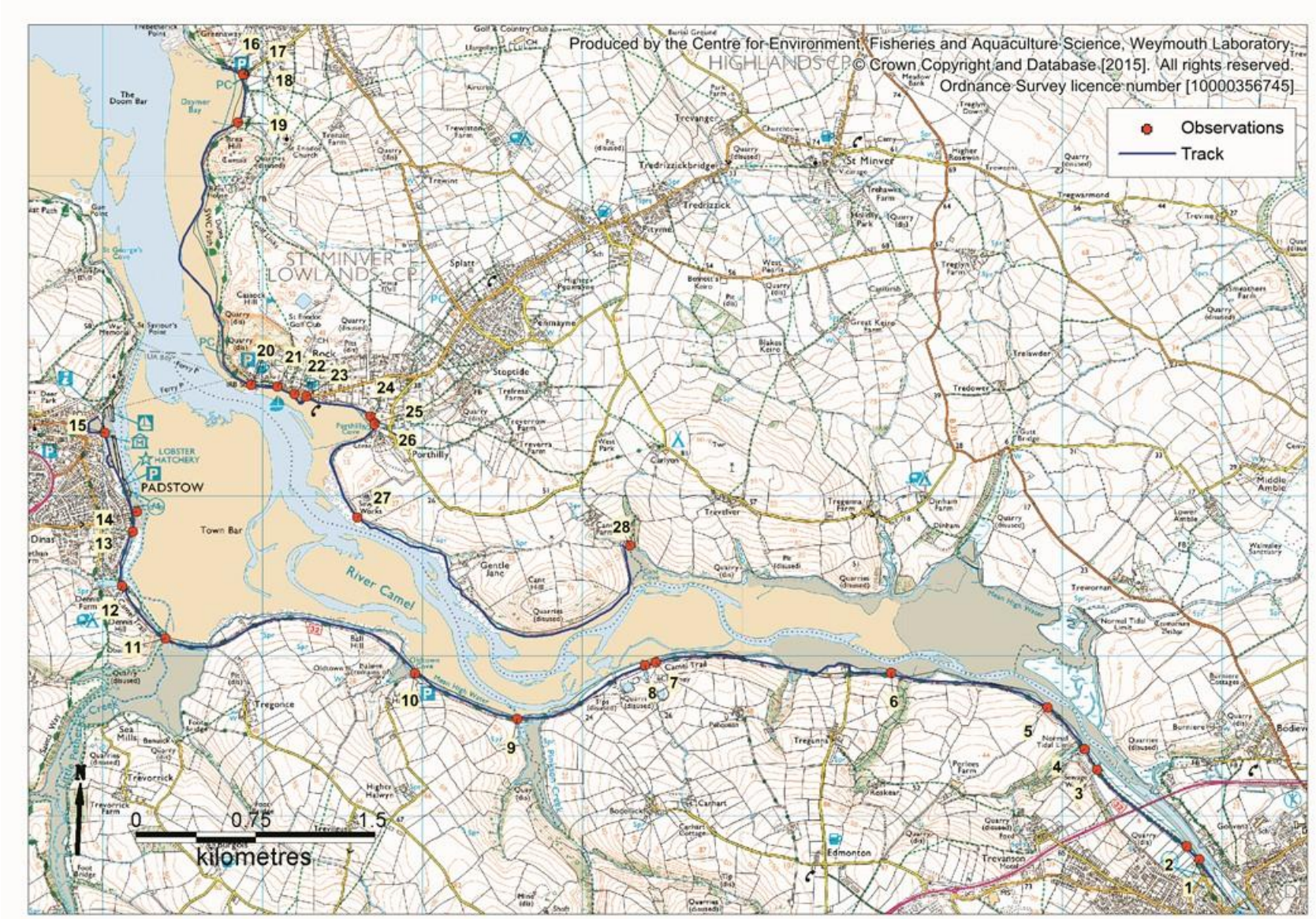

Figure I.1: Locations of Shoreline Observations (Table I.1 for details)

Table I.1: Details of Shoreline Observations

Observation No.	NGR	Date	Time	Description	Photo
1	SW9885472726	08/10/2014	08:48:27	Wadebridge PS & pipe with grid flowing, C01 & ~10 gulls	Figure I.3
2	SW9877772811	08/10/2014	08:55:39	Environment Agency sluice gate & dog walking along Camel Trail	
3	SW9821873287	08/10/2014	09:08:31	Sewage Works & pipe with flap flowing (flap being replaced at time of survey) & ~80 gulls on mudflats	Figure I.4
4	SW9813973415	08/10/2014	09:16:29	Possibly Wadebridge STW Pipe (~500mm with flap) flowing, C02 & smaller pipe, not flowing	Figure I.5
5	SW9790773677	08/10/2014	09:30:35	~30 gulls	
6	SW9692973896	08/10/2014	09:48:09	~40 birds	
7	SW9545573960	08/10/2014	10:22:34	Unnamed stream flowing (not accessible)	Figure I.6
8	SW9538873941	08/10/2014	10:27:13	Large rectangular structure (~ 15m) with stream flowing from it (not accessible)	Figure I.7
9	SW9458873605	08/10/2014	10:43:14	Pinkson Creek (not accessible)	Figure I.8
10	SW9395173893	08/10/2014	10:55:51	Oldtown Cove flowing (not accessible) & 20 cows in field	
11	SW9239074110	08/10/2014	11:15:00	Little Petherick Creek, flowing (not accessible)	Figure I.9
12	SW9212074438	08/10/2014	11:27:53	~80 moorings and pipe flowing with pond behind	Figure I.10
13	SW9218674778	08/10/2014	11:36:01	3 x broken pipes not flowing & 1 pipe with manhole cover flowing from pipe, C03	Figure I.11
14	SW9221074901	08/10/2014	11:51:34	broken pipe & series of drainage pipes not flowing	Figure I.12
15	SW9201275395	08/10/2014	12:11:59	Drainage pipe flowing (not accessible)	
16	SW9288677638	09/10/2014	08:47:02	Stream flowing, C04	Figure I.13
17	SW9287977644	09/10/2014	08:53:14	4 x pipes not flowing	Figure I.14
18	SW9287477635	09/10/2014	08:54:24	4 x pipes not flowing	
19	SW9284577336	09/10/2014	09:03:09	Unnamed stream flowing, C05	Figure I.15
20	SW9292475694	09/10/2014	09:41:16	~300 moorings and boat unloading dredged sand	
21	SW9308975684	09/10/2014	09:46:54	Pipe ~300 mm trickling & pipe ~10 mm not flowing	Figure I.16
22	SW9319775638	09/10/2014	09:50:06	2 x pipes not flowing	
23	SW9327075622	09/10/2014	09:53:34	2 x pipes trickling	Figure I.17
24	SW9367075499	09/10/2014	10:01:56	Porthilley Pumping Station	
25	SW9369675459	09/10/2014	10:04:13	Manhole Cover - possibly cesspit?	
26	SW9369575447	09/10/2014	10:05:00	Unnamed stream flowing, C06	Figure I.18

27	SW9359074866	09/10/2014	10:24:42	~ 10 gulls on/near to trestles
28	SW9529674690	09/10/2014	11:16:13	Unnamed stream flowing, Cant Cove C07 (low flow)

Figure I.2: Water sample results (Table I.1 and 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	*E. coli* concentration (cfu/100 ml)	Flow (m^3/s)	*E. coli* loading (cfu/day)	NGR
C01	1	08/10/2014 08:48	Pipe with grid	2,800	Not accessible		SW9885472726
C02	4	08/10/2014 09:16	Pipe ~500mm with flap	1,000	Not accessible		SW9813973415
C03	13	08/10/2014 11:36	Pipe flowing	17,000	0.012	$1.69x10^{11}$	SW9218674778
C04	16	09/10/2014 08:47	Stream flowing	1,600	0.000	$4.44x10^{7}$	SW9288677638
C05	19	09/10/2014 09:03	Stream flowing	8,700	0.019	$1.40x10^{11}$	SW9284577336
C06	26	09/10/2014 10:05	Stream flowing	2,200	<0.001	$6.19x10^{8}$	SW9369575447
C07	28	09/10/2014 11:16	Stream flowing	1,500	Low flow		SW9529674690

Figure I.3

Figure I.4

Figure I.5

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

Figure I.16

Figure I.17

Figure I.18

Appendix II. Camel Sanitary Survey Report 2009