Sanitary Survey - Review

The Wash – 2021

Document No. – *J0591/21/02/10*

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Document QA and Approval

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Initial Consultation

Consultee	Date of response
Boston Borough Council	08 February 2021
Kings Lynn & West Norfolk Borough Council	08 February 2021
Fenland District Council	08 February 2021

Eastern Inshore Fisheries and Conservation Authority	08 February 2021

Consultation on draft report

Consultee	Date of consultation	Date of response
Boston Borough Council	09 April 2021	07 May 2021
Environment Agency	09 April 2021	07 May 2021

A sanitary survey relevant to the bivalve mollusc beds in The Wash was undertaken in 2013 in accordance with Regulation (EC) 854/2004 (which was replaced by retained EU Law Regulation (EU) 2017/625, with sanitary survey requirements now specified in retained EU Law Regulation (EU) 2019/627). This provided appropriate hygiene classification zoning and monitoring plan based on the best available information with detailed supporting evidence. In line with regulatory and EU guidance the Food Standards Agency undertake targeted sanitary survey reviews to ensure public health protection measures continue to be appropriate. This report provides a review of information and recommendations for a revised sampling plan if required. Carcinus Ltd. (Carcinus) undertook this work on behalf of the FSA. Carcinus Ltd accepts no liability for any costs, losses or liabilities arising from the reliance upon or use of the contents of this report other than by its client.

Dissemination

Food Standards Agency, Boston Borough Council, King's Lynn & West Norfolk Borough Council and Fenland District Council. The report is publicly available via the Carcinus Ltd. website.

Recommended Bibliographic Citation:

Carcinus Ltd., 2021. Review of The Wash 2013 Sanitary Survey. Carcinus 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 retained EU Law Regulation (EU) 2019/627.

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1 Introduction

1.1 Background

In line with Article 58 of retained EU Law Regulation (EU) 2019/627 and the EU Good Practice Guide (European Commission, 2017) and, Carcinus is contracted to undertake reviews of sanitary surveys on behalf of the Food Standards Agency. The FSA undertake targeted sanitary survey reviews to ensure public health protection measures continue to be appropriate.

The report considers changes to bacterial contamination sources (primarily from faecal origin) and the associated loads of the faecal indicator organism *Escherichia coli* (*E. coli*) that may have taken place since the original sanitary survey was undertaken. It does not assess chemical contamination, or the risks associated with biotoxins. The assessment also determines the necessity and extent of a shoreline survey based on complexity and risk. The desktop assessment is completed through analysis and interpretation of publicly available information, in addition to consultation with stakeholders.

1.2 The Wash Review

This report reviews information and makes recommendations for a revised sampling plan for existing cockle (*Cerastoderma edule*) and mussel (*Mytilus* spp.) classification zones in The Wash (Figure 1.1). This review explores any changes to the main microbiological contamination sources that have taken place since the original sanitary survey was conducted. Data for this review was gathered through a desk-based study and consultation with stakeholders.

An **initial consultation** with Local Authorities (LAs) and the Environment Agency (EA) responsible for the production area was undertaken in February 2021. This supporting local intelligence is valuable to assist with the review and was incorporated in the assessment process.

Following production of a draft report, a wider **external second round of consultation** with LAs and Local Action Group (LAG) members was undertaken in April and May 2021. It is recognised that dissemination and inclusion of a wider stakeholder group, including local industry, is essential to sense-check findings and strengthen available evidence. The draft report is reviewed taking into account the feedback received.

The review updates the assessment originally conducted in 2013 and sampling plan as necessary and the report should read in conjunction with the previous survey.

Specifically, this review considers:

(a) Changes to the shellfishery (if any);

(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 of the area; and

(e) Change in environmental conditions;

Sections 2 - 6 detail the changes that have occurred to the shellfishery, environmental conditions and pollution sources within the catchment since the publication of the original sanitary survey. A summary of the changes is presented in section 7 and recommendations for an updated sampling plan are described in section 8.

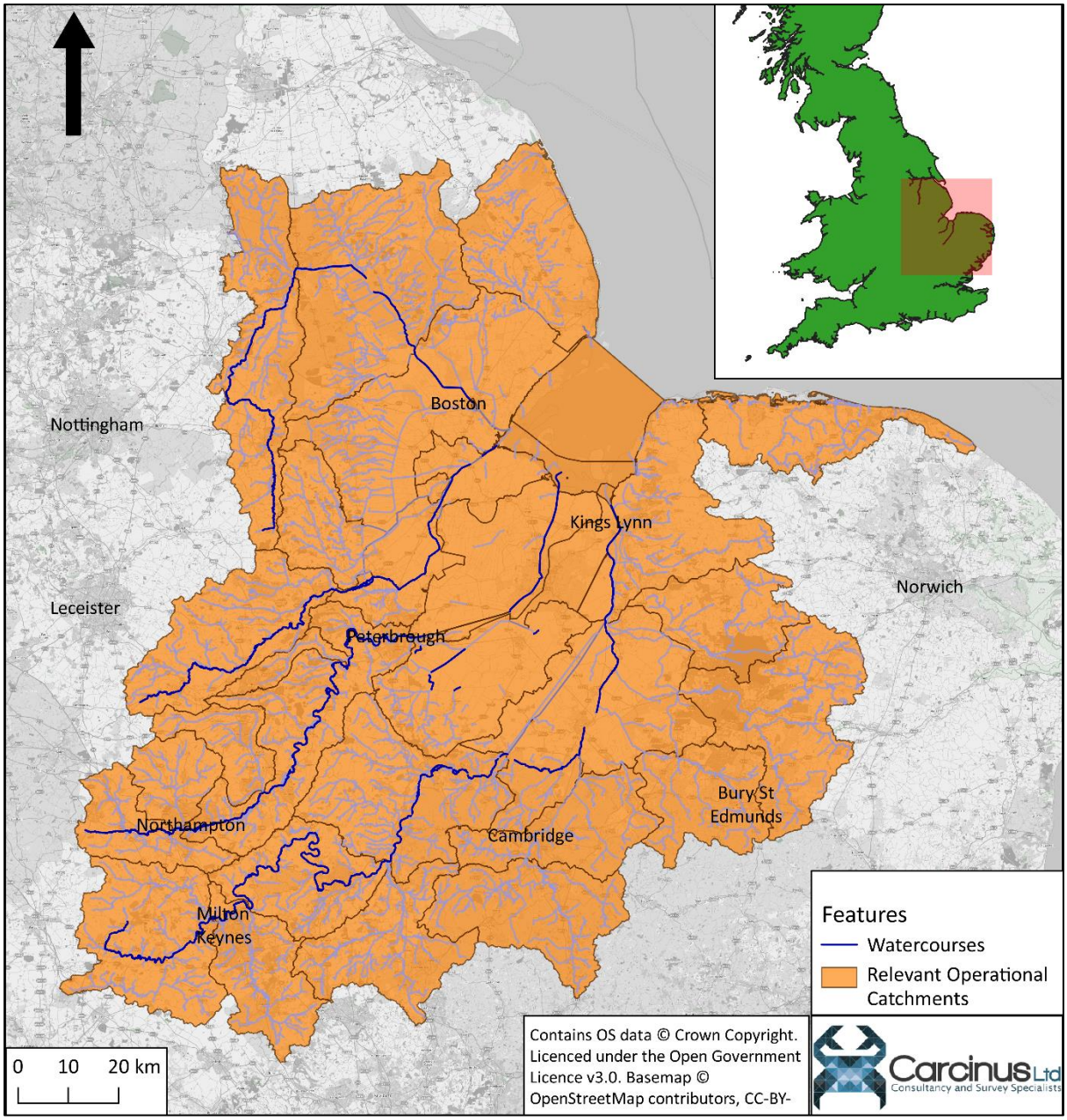

Figure 1.1. Location of The Wash.

1.3 Assumptions and limitations

This desktop assessment is subject to certain limitations and has been made based on several assumptions, namely:

- Accuracy of local intelligence provided by the Local Authorities and Environment Agency;
- The findings of this report are based on information and data sources up to and including February 2021;
- Only information that may impact on the microbial contamination was considered for this review; and
- Official Control monitoring data have been taken directly from the Cefas data hub[1], with no additional verification of the data undertaken. Results up to and including February 2021 have been used within this study. Any subsequent samples have not been included.

2 Shellfisheries

2.1 Description of Shellfishery

The Wash embayment on the North Norfolk Coast supports large natural populations of the harvested species. The Bivalve Mollusc Production Area (BMPA) is under the jurisdiction of three councils for the purpose of food safety and public health: Boston Borough Council, Kings Lynn & West Norfolk Borough Council and Fenland District Council. The BMPA covers the entire embayment, an area of approximately 590 km^2. Brancaster BMPA is approximately 5 km to the east.

Harvesting of shellfish within the BMPA is managed by the Eastern Inshore Fisheries and Conservation Authority (EIFCA). Most of the area is controlled by The Wash Fishery Order 1992[2] (WFO), which was established to manage the shellfishery within the embayment. Since 2011, EIFCA have responsible for the management of the wild fishery, although the order also enables EIFCA to grant exclusive fishing rights to individuals for aquaculture purposes. In addition to the area covered by the WFO, the Le Strange estate holds exclusive rights to an area on the western side of the embayment. The precise boundary between the Le Strange fishery and the WFO is contentious, although a court ruling in 2018 granted additional areas to the public fishery.

EIFCA set out strict management practices for the fishery that are updated regularly. The 2019 management plan for the cockle fishery (EIFCA, 2019b) sets minimum landing sizes at 14 mm width and limits daily landings to 2 tonnes for fishermen working the hand-worked fishery. EIFCA also have in place byelaws that enable them to temporarily close the WFO shellfishery for the purposes of fishery protection, fishery management and controlling the level of exploitation. A closure under this byelaw is in place until the updated Wash Restricted Area Byelaw, 2019 is implemented. The anticipated implementation date of this byelaw was not available at the time of this review. No management practices apply to the Le Strange private fishery.

[1] Cefas shellfish bacteriological monitoring data hub. Available at: https://www.cefas.co.uk/data-and-publications/shellfish-classification-and-microbiological-monitoring/england-and-wales/.
[2] Secretary of State, 1992. The Wash Fishery Order, 1992. Available at: https://www.eastern-ifca.gov.uk/wp-content/uploads/2016/03/1992_the_wash_fishery_order_1992.pdf.

The fishery involves mainly wild stocks of the harvested species, although under the WFO, some aquaculture lays are licenced. At the time of the original sanitary survey, the area was divided into two separate production areas, with active classifications for both mussels and cockles. The original sanitary survey recommended merging the area into one zone, and provided recommended classification zones and RMPs for the cockles and mussels, as well as an experimental razor clam (*Ensis directus*) dredge fishery. The razor fishery never progressed, as the dredging of this species remains prohibited under The Razor Shells, Trough Shells and Carpet Shells (Specified Sea Area) (Prohibition of Fishing) Order 1998[3]. Classification zones in the BMPA were defined to roughly align with latitude/longitude lines for ease of use by the harvesters.

Summaries of the classification zones currently active in the Wash BMPA for the two harvested species are described below.

2.1.1 Cockles

The original sanitary survey (conducted in 2013) cites the 2013 spring cockle survey completed by EIFCA, and reported that the WFO supported 7,107 tonnes of 'adult' (>14 mm width) cockles. The sanitary survey recommended the creation of five classification zones for cockle harvesting, covering the entire embayment. These were: *Heacham & Hunstanton*, *Ouse Mouth*, *Nene Mouth*, *Witham and Welland* and *Freiston to Wainfleet*. Whilst the names of several of these CZs are the same as those for mussels (see next section), the boundaries for all except *Ouse Mouth* are different, with cockle CZs typically covering a greater area than the mussel CZs of the same name.

Table 2.1 presents an estimate of the cockle landings from each of the CZs within the WFO since 2015. The *Freiston to Wainfleet* zone, which is on the northern side of the embayment, has consistently had the most landings (by weight). Overall, the cockle fishery has been relatively stable in terms of total landings, although has decreased in the past few years. Figure 2.1 presents the total biomass of cockle stock in the WFO areas since 2000, as estimated from the annual EIFCA spring biomass survey (Jessop, 2019a). It indicates that the stock levels have decreased since 2016 and current levels are lower than at the time of the original sanitary survey.

Table 2.1 Estimates of cockle landings from CZs in The Wash, provided by EIFCA during initial consultation.

	Cockle Landings (tonnes)					
Zone	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Welland and Witham	785	844	1,517	572	983	539
Freiston to Wainfleet	3,262	2,845	1,938	2,619	831	2,186

[3] Secretary of State, 1998. *The Razor Shells, Trough Shells and Carpet Shells (Specified Sea Area) (Prohibition of Fishing) Order 1998*. Available at: https://www.legislation.gov.uk/uksi/1998/1276/made.

	Cockle Landings (tonnes)					
Zone	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Nene Mouth	517	70	968	827	1,202	542
Ouse Mouth	329	4,368	797	459	645	264
Heacham and Hunstanton	This area is predominantly within the Le Strange private fishery. There is an active cockle fishery there but EIFCA have no access to landings data.					
Total*	**4,893**	**8,147**	**5,220**	**4,477**	**3,661**	**3,531**

**Total excludes any landings from Heacham and Hunstanton CZ.*

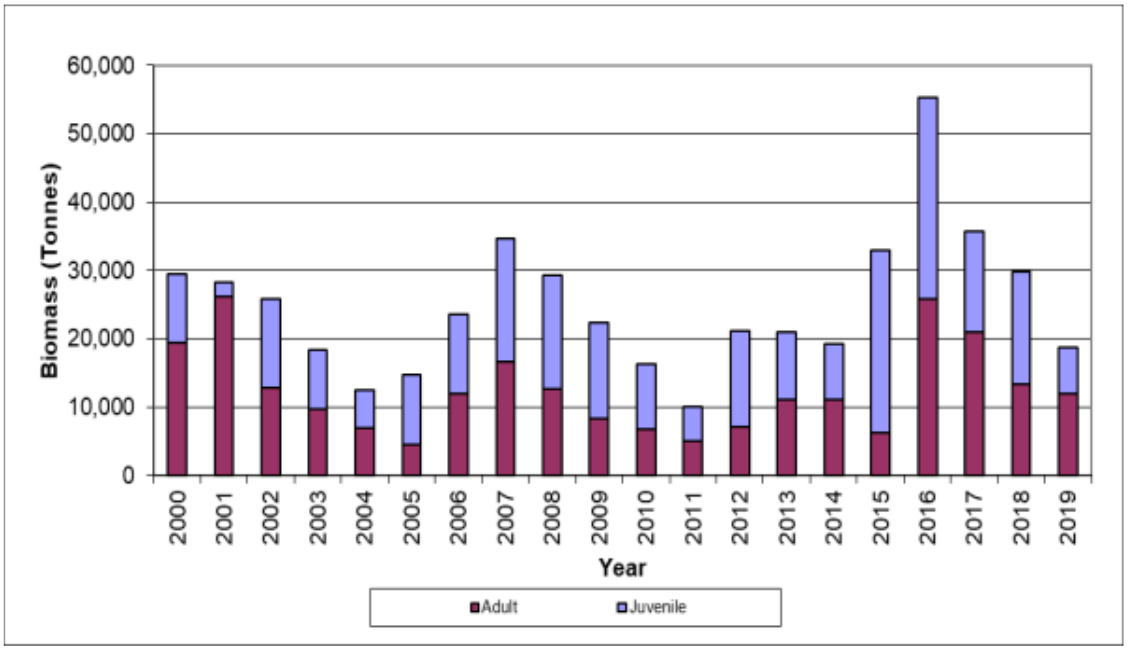

Figure 2.1 Adult and juvenile cockle stock levels between 2010 and 2019 on the WFO regulated beds. After Jessop (2019a).

2.1.2 Mussels

The original sanitary survey describes that mussel stock in The Wash comprise distinct raised beds on firm substrates such as stones or dead shells, and that the locations are relatively stable given that spat settles on established areas. The report recommended dividing the area into six classification zones: *Heacham & Hunstanton*; *Ouse Mouth*; *Nene Mouth; Mare Tail, Gat and Toft; Welland and Witham Inner* and *Welland and Witham Outer*, which cover a slightly smaller area than the cockle CZs, extending less far out into the embayment from the shore. All these CZs are still active.

Table 2.2 presents an estimate of the landings from mussel CZs within the Wash since 2015. Consultation with EIFCA indicated that intertidal mussel stocks in the area have been too low to support regular fishery since 2015. Figure 2.2 presents the total biomass of mussels

in The Wash since 2002, as calculated from the annual intertidal mussel stock assessment (Jessop, 2019b). At the most recent survey in 2018, the area of the embayment with mussel stock exceeded the area at the time of the original sanitary survey, although the total biomass was very similar, at just over 12,000 tonnes. However, the mussel stock in the area has not yet recovered from significant mortality events in 2010, and a further decline was expected for the 2019 survey, data for which are not yet available.

Table 2.2 Estimates of mussel landings from CZs in The Wash, provided by EIFCA during initial consultation.

	Mussel Landings (Tonnes)*					
Zone	2015	2016	2017	2018	2019	2020
Welland and Witham Inner	35	21	44	1.5	0	3
Welland and Witham Outer	No landings from regulated beds but area does support some lays that are actively fished.					
Mare Tail, Gat and Toft	This zone supports some of the most important mussel beds in The Wash including the Mare Tail and Gat beds. The Mare Tail beds have been opened on occasions during this period, during which approximately 500-1000 tonnes of mussels have been relayed onto private lays. The zone also contains the most important extent of private lays, most of which are still actively fished.					
Nene Mouth	This zone supports 4 wild mussel beds, all of which have been opened to fisheries on occasions since 2015. During this period, approximately 1000 tonnes of mussels will have harvested for relaying. Area also contains some private lays					
Ouse Mouth	Supports 3 wild mussel beds. Only one has been opened since 2015, during which approximately 100 tonnes of mussels were removed for relaying. Area supports several areas of important lays that are actively fished.					
Heacham and Hunstanton	Area falls within Le Strange Fishery for which I have little information. There are mussels beds in this area that are actively fished though.					

Note from WFO regulated beds only

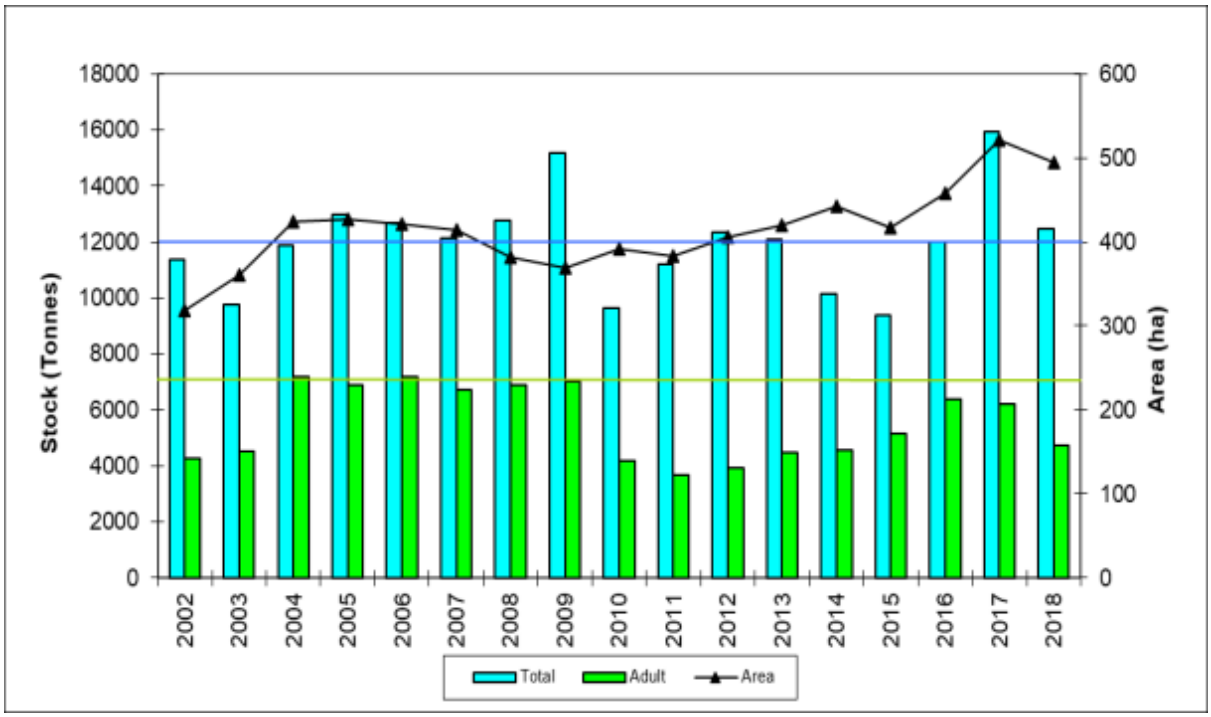

Figure 2.2 Intertidal mussel stock levels in The Wash since 2002. After Jessop (2019b).

2.2 Classification History

The original sanitary proposed the creation of 11 classification zones, 5 for cockles and 6 for mussels. All are currently active, and no additional zones have been classified. All but two of the CZs hold Class LT-B classifications, with *Witham and Welland Outer* (Cockles) holding a C classification and *Witham and Welland Inner* (Mussels) holding a Class B classification. The location of all active CZs, along with all RMPs sampled since 2013, are presented in Figure 2.3.

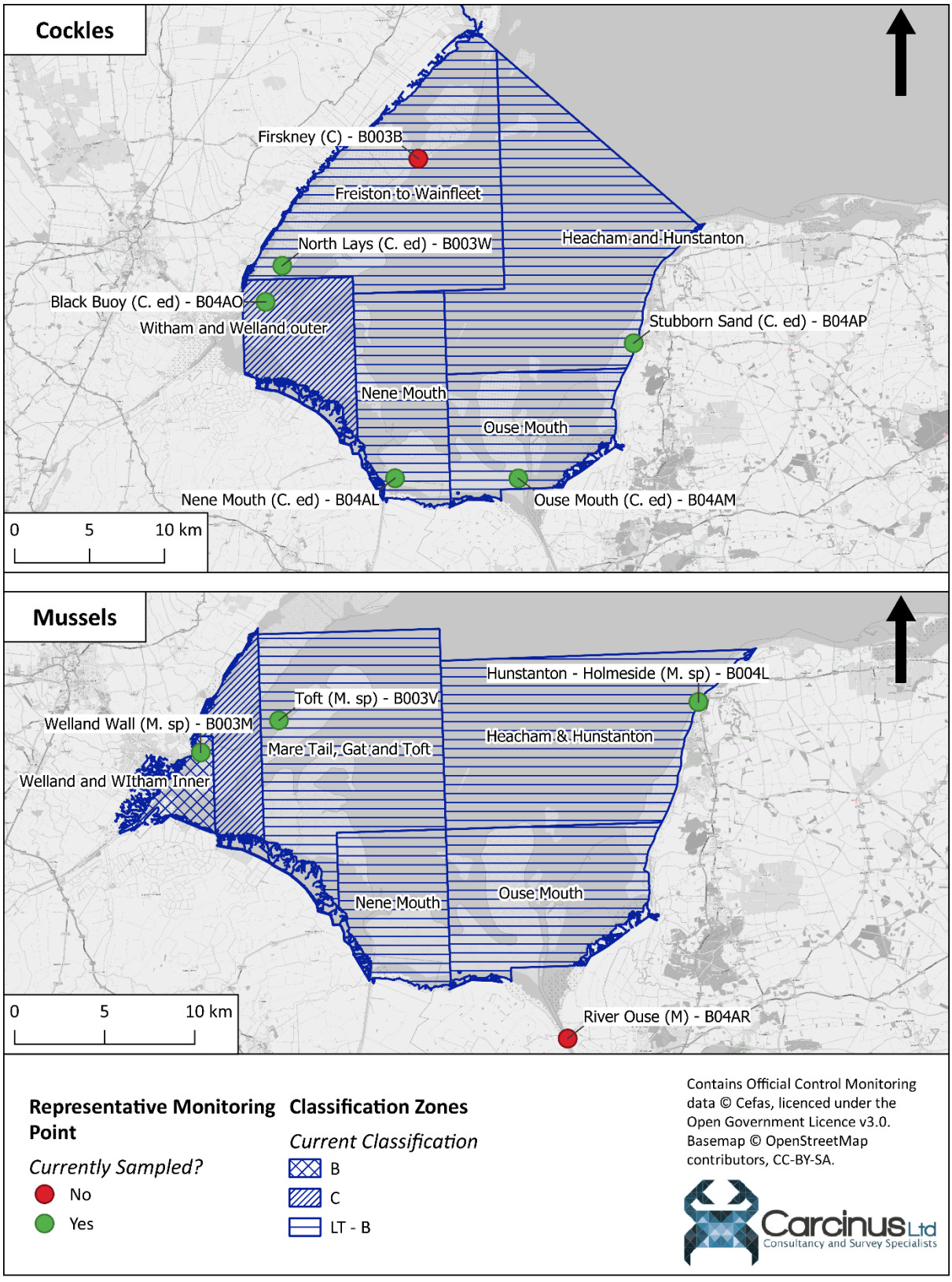

Figure 2.3 Current classification zones and associated RMPs for the different species harvested in The Wash BMPA.

3 Pollution sources

3.1 Human Population

The most recently available population data to the authors of the 2013 Sanitary Survey of The Wash was that of the 2011 Census. No freely available census data covering the catchment was available at the time of this review; the next full census of the United Kingdom is scheduled to take place in March 2021. The original sanitary survey stated that the total population of census output areas within or partially within the catchment was approximately 3,600,000 people at the time of the 2011 Census. The UK government estimate that the UK population increase between 2011 and 2021 will have been ~6.6% (Office for National Statistics, 2018) and an increase of this proportion would see the population within the catchment rise to 3,837,600 people. Figure 3.1 shows the change in land cover within The Wash's hydrological catchment from 2012 – 2018. Most of the catchment remains very rural, particularly around the banks of the embayment. The main urban centres, Northampton, Cambridge and Milton Keynes, are all located a significant distance from the shellfishery. The closest urban areas, and those most likely to impact the bacteriological health of the shellfish waters are Boston (to the north-west of the embayment), Hunstanton (to the east) and Kings Lynn (to the south). Whilst the geographical extents of these conurbations do not appear to have significantly increased (based on land cover data), it is likely that populations have increased. Any impacts from the increased loading on the wastewater treatment network will depend on the specific locations and nature of the discharges, changes to which are discussed in Section 3.1.

The original sanitary survey indicates that there is no major tourism across most of the Wash, although in the summer the population of Hunstanton roughly doubles due to holiday makers. No recent tourism statistics are available, although it is predicted that the patterns of tourist numbers, and the associated load on the wastewater treatment network, will have remained broadly similar.

As no recently available Census data was available to the authors of this review, a comparison of Land Cover maps produced in 2012 and 2018 have been used to identify whether any significant changes in urban conurbations have occurred since the original sanitary survey was published. As such, the recommendations made in the original sanitary survey to capture this source of pollution remain valid.

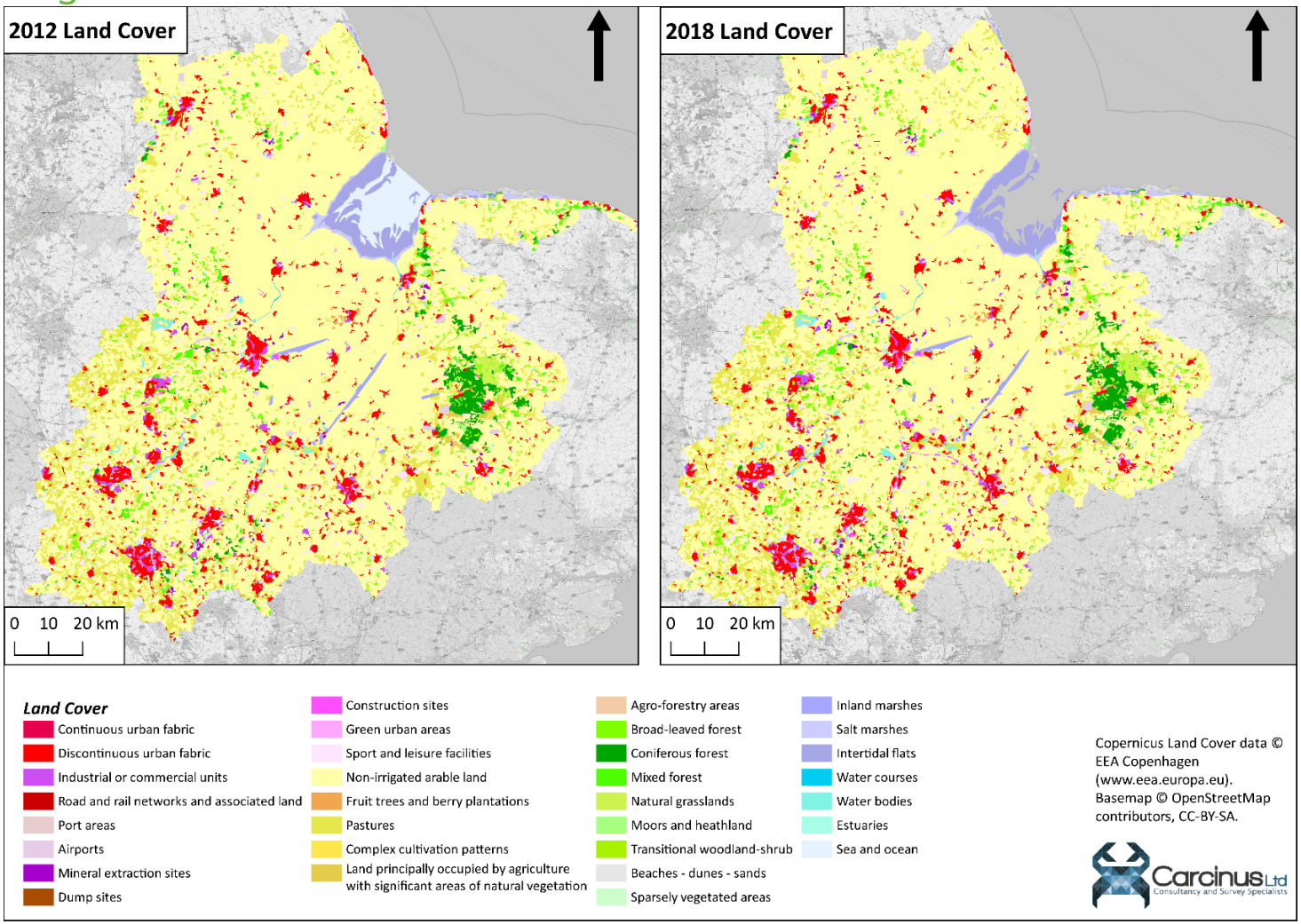

Figure 3.1 Land cover change within The Wash catchment from 2012 - 2018

3.2 Sewage

Due to the size of The Wash's catchment, there are a vast number of discharges, located up to 100 km from the embayment. These will contribute to background levels of contamination running through watercourses in the catchment. However, like in the original sanitary survey, it is beyond the scope of this report to present all of them. Instead, only those discharges within 20 km of a Classification Zone in the BMPA have been extracted from the most recent update to the EA's national permit database at the time of sampling (November 2020). The locations of these discharges are shown in Figure 3.2. All information in the database has been taken at face value.

The original sanitary survey identified a total of 61 discharges within 20 km of The Wash. That report identified that the King's Lynn STW, located approximately 3.7 km from the nearest CZ, was likely to have the most significant contribution in terms of bacterial loading, due to its large discharge volume, secondary treatment method and proximity to the BMPA. A further 11 discharges were also identified as being the ones most likely to contribute significant levels of contamination. All of the continuous discharges identified in the original sanitary survey are still active. Several of the discharges have seen their consented Dry Weather Flows decrease, which would result in a reduction in bacterial loading to the embayment, although no changes to the most significant discharges have occurred. Consultation with the Local Authority did not indicate any further changes or concerns regarding the continuous discharge network in the area, and the Environment Agency did not provide any further information during initial consultation. During the secondary consultation, the EA indicated that any changes to DWF were likely administrative, and not due to changes in population. As such no change in the risk of contamination from these sources exists.

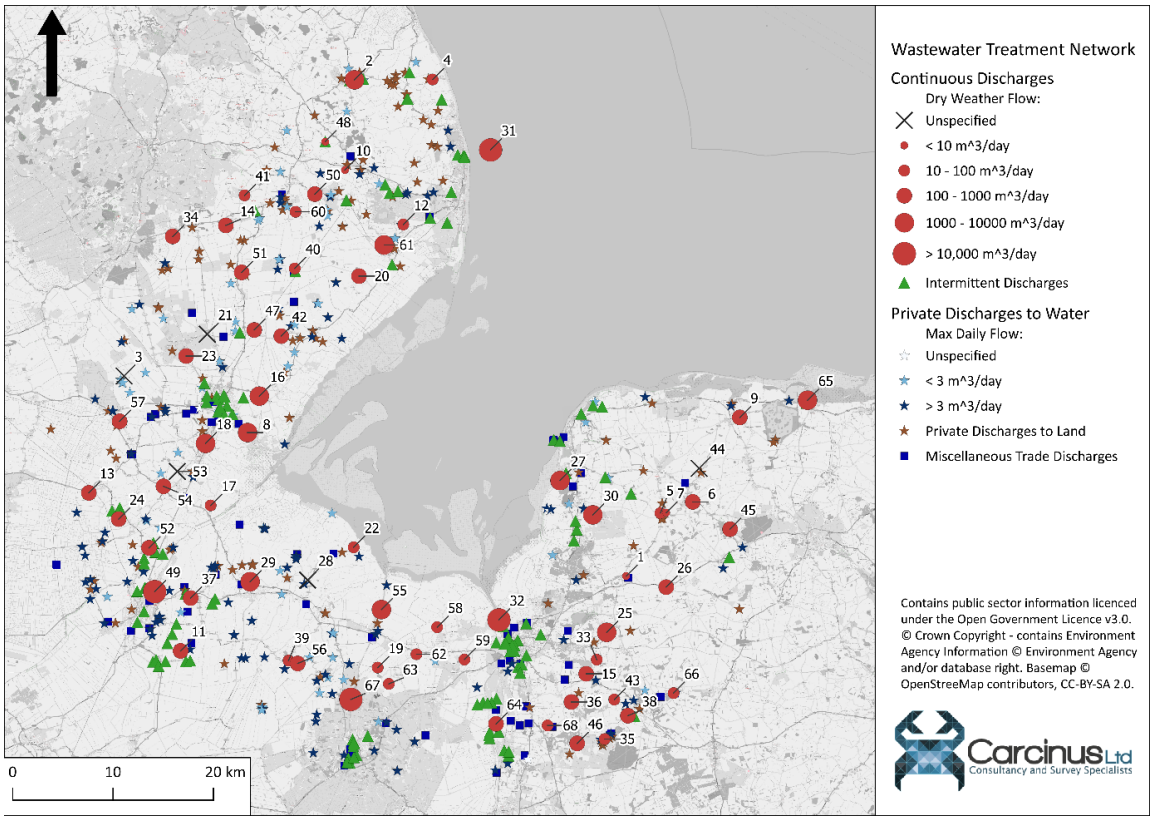

Figure 3.2 Locations of all consented discharges within 20 km of a Classification Zone in The Wash BMPA. Labels refer to continuous discharges, details of which can be found in Table 3.1.

Table 3.1 Details of all continuous discharges within 20 km of The Wash BMPA. All discharges that have decreases to consented DWFs are highlighted in green., those that have had increases are highlighted in red.

ID	Sewage Works	NGR	TREATMENT	DWF (m^3/day)
1	ABBEY ROAD WATER RECYCLING CENTRE	TF7321026590	BIOLOGICAL FILTRATION	2.25
2	ALFORD STW	TF4615175973	BIOLOGICAL FILTRATION	1150
3	AMBER HILL STW	TF2320046500	UNSPECIFIED	UNSPECIFIED
4	ANDERBY WATER RECYCLING CENTRE	TF5393076010	PACKAGE TREATMENT PLANT	90
5	BIRCHAM FRING ROAD STW	TF7662032860	PACKAGE TREATMENT PLANT	26
6	BIRCHAM NEWTON (MONKS CLOSE) WRC	TF7984033970	BIOLOGICAL FILTRATION	143
7	BIRCHAM TOFTS (STOCKS CLOSE) WRC	TF7720032900	BIOLOGICAL FILTRATION	9
8	BOSTON STW	TF3550040870	BIOLOGICAL FILTRATION	10000
9	BURNHAM MARKET WATER RECYCLING CTR	TF8453042380	UV DISINFECTION	780

10	CANDLESBY STW	TF4520067000	SEPTIC TANK	10
11	COWBIT STW	TF2883019140	BIOLOGICAL FILTRATION	350
12	CROFT STW	TF5101061580	BIODISC	17
13	DONINGTON WATER RECYCLING CENTRE	TF1969334870		410
14	EAST KIRKBY STW	TF3334061490	BIOLOGICAL FILTRATION	200
15	EAST WINCH STW	TF6923016860	UNSPECIFIED	159
16	FISHTOFT STW	TF3667044500	BIOLOGICAL FILTRATION	2050
17	FOSDYKE(BELL LANE) STW	TF3182033620	PACKAGE TREATMENT PLANT	74.25
18	FRAMPTON STW	TF3132039790	BIOLOGICAL FILTRATION	1600
19	FRENCH'S ROAD STW	TF4846017480	UNSPECIFIED	13
20	FRISKNEY STW	TF4660056440	BIOLOGICAL FILTRATION	205
21	FRITHVILLE STW	TF3148050660	UNSPECIFIED	UNSPECIFIED
22	GEDNEY DROVE END STW	TF4607029450	BIOLOGICAL FILTRATION	18
23	GIPSEY BRIDGE STW	TF2938248488	BIODISC	169
24	GOSBERTON STW	TF2266032260	BIOLOGICAL FILTRATION	400
25	GRIMSTON WATER RECYCLING CENTRE	TF7127020990	CHEMICAL - PHOSPHATE STRIPPING	1295
26	HARPLEY WATER RECYCLING CENTRE	TF7720025490	ACTIVATED SLUDGE	272
27	HEACHAM WATER RECYCLING CENTRE	TF6662036090	UNSPECIFIED	4500
28	HOLBEACH GEDNEY DYKE STW	TF4148026180	PACKAGE TREATMENT PLANT	UNSPECIFIED
29	HOLBEACH WATER RECYCLING CENTRE	TF3575026030	BIOLOGICAL FILTRATION	1910
30	INGOLDISTHORPE WRC	TF6989032680	CHEMICAL - PHOSPHATE STRIPPING	1400
31	INGOLDMELLS WRC	TF5971069000	BIOLOGICAL FILTRATION	18062
32	KINGS LYNN WRC	TF6053522225	ACTIVATED SLUDGE	21600
33	LEZIATE WATER RECYCLING CENTRE	TF7028218269	PACKAGE TREATMENT PLANT	45.5
34	MAREHAM LE FEN STW	TF2804060390	BIOLOGICAL FILTRATION	185
35	MARHAM STW	TF7107010370	UNSPECIFIED	29
36	MIDDLETON(NORFOLK) STW	TF6776014060	ACTIVATED SLUDGE	260
37	MOULTON STW	TF2983024400	BIOLOGICAL FILTRATION	720
38	NARBOROUGH STW	TF7338012690	UNSPECIFIED	250
39	NEEDHAM DRIVE	TF3958218177		17
40	NEW LEAKE(EASTVILLE) STW	TF4020057200	ACTIVATED SLUDGE	41
41	OLD BOLINGBROKE STW	TF3520064480	PACKAGE TREATMENT PLANT	50

42	OLD LEAKE (SKIPMARSH) STW	TF3886050470	HIGH RATE BIOLOGICAL	475
43	PENTNEY STW	TF7203014300	UNSPECIFIED	36
44	PREMISES REAR 1 STATION ROAD	TF8048037310	BIODISC	UNSPECIFIED
45	SCULTHORPE STW	TF8356031250	CHEMICAL - PHOSPHATE STRIPPING	300
46	SHOULDHAM STW	TF6832709940	BIOLOGICAL FILTRATION	170
47	SIBSEY WATER RECYCLING CENTRE	TF3617051080	BIOLOGICAL FILTRATION	315
48	SKENDLEBY STW	TF4324069820	SCREENING	8
49	SPALDING STW	TF2625025040	ACTIVATED SLUDGE	15720
50	SPILSBY STW	TF4220064600	BIOLOGICAL FILTRATION	858
51	STICKNEY STW	TF3491056810	BIOLOGICAL FILTRATION	395
52	SURFLEET STW	TF2568029400	BIOLOGICAL FILTRATION	186
53	SUTTERTON ROPERS LN STW	TF2850037000	BIOLOGICAL FILTRATION	UNSPECIFIED
54	SUTTERTON/WIGTOFT STW	TF2712035520	BIOLOGICAL FILTRATION	350
55	SUTTON BRIDGE STW	TF4883023250	PACKAGE TREATMENT PLANT	3247
56	SUTTON ST JAMES STW	TF4049017890	OXIDATION DITCH	178
57	SWINESHEAD STW	TF2276041990	ACTIVATED SLUDGE	660
58	TERRINGTON ST CLEMENT	TF5438021500	UNSPECIFIED	11
59	TILNEY ALL SAINTS STW	TF5710018280	SCREENING	23
60	TOYNTON ST. PETER WATER RECYC. CNTR	TF4028062840	PACKAGE TREATMENT PLANT	49
61	WAINFLEET STW	TF4910059540	BIOLOGICAL FILTRATION	1200
62	WALPOLE ST. ANDREW STW	TF5232018810	UNSPECIFIED	20
63	WALPOLE ST. PETER STW	TF4957015860	UNSPECIFIED	11
64	WATLINGTON STW	TF6025011880	ACTIVATED SLUDGE	1000
65	WELLS-NEXT-THE-SEA STW	TF9128044090	UV DISINFECTION	1125
66	WEST ACRE WATER RECYCLING CENTRE	TF7793014940	PACKAGE TREATMENT PLANT	14.6
67	WISBECH(WEST WALTON)STW	TF4578814311	ACTIVATED SLUDGE	14421
68	WORMEGAY STW	TF6539011720	UNSPECIFIED	17

In addition to the continuous discharges, the original sanitary survey identified a total of 38 intermittent discharges within 2 km of the estuary. All these discharges are currently still active. Intermittent discharges comprise Combined Storm Overflows (CSOs), storm tank overflows and pumping station emergency overflows. No spill event monitoring was

available to the authors of the original sanitary survey. Spill event monitoring data is available for 6 intermittent discharges within the near vicinity of the BMPA, however only one of these drains directly to the estuary, and data is only available for one year. As patterns of rainfall have remained similar (see Section 5), the frequencies of spill events are predicted to have remained similar. As such, the impact on bacterial loading as a result spills is not expected to have changed, particularly as consultation with the LA and EA did not indicate any upgrades to the wastewater treatment network.

Finally, the original sanitary survey identified 7 private discharges with consented flows of more than 5 m^3/day. Whilst there are some additional private discharges currently consented, most are relatively low volumes and unlikely to pose an additional significant risk to the bacteriological health of the shellfish waters.

No significant changes or upgrades to the wastewater treatment network have occurred since the publication of the original sanitary survey; there remain no wastewater treatment works continually discharging to the waters of the Wash, and most bacteriological contamination from the wastewater treatment network will be carried down the four main watercourses into the shellfish waters. As such, the recommendations made in the original sanitary survey to capture this source of pollution remain valid.

3.3 Agricultural Sources

Despite the fact that very little of the catchment area is reserved for pasture, a significant amount of livestock rearing takes place, which potentially represents a significant risk of contamination of the shellfishery through land-run off. The original sanitary survey provides livestock data based on the 2010 agricultural census. Updated data at the same spatial scale were not freely available to the authors of this review, however livestock data for the Local Authority Districts that fall within or partially within the catchment of The Wash were available for 2013 and 2016 (DEFRA, 2018). As only a small proportion of some of the districts falls within the catchment, the livestock data have been adjusted to reflect the percentage of each district that falls within the catchment. This assumes that livestock are distributed uniformly throughout the district and therefore, some inaccuracies may be present. Aggregate adjusted livestock population change data are shown in Figure 3.3 and Table 3.2.

There are 41 Local Authority Districts contained wholly or partially within The Wash's catchment. Overall, livestock populations within the catchment increased by 10.55% between 2013 and 2016, although there are significant differences between both districts and species. Most of the districts saw an increase in livestock populations, although more than half had very little change, with populations changing by less than 2%. The largest increases were in Newark and Sherwood; Norwich and South Norfolk, and Melton, which saw increases of 107.44%, 204.92% and 350.54% respectively. Across all districts, poultry and sheep populations increased by 11.42% and 7.14% respectively, whereas cattle and pig populations decreased by 3.45% and 12.79% respectively. In terms of dominant species, poultry remain the most populous, although biomass data were not available. The livestock

density remains high and has increased to 28.31 animals per hectare between 2013 and 2016.

The principal route of contamination of coastal waters by livestock is surface run-off carrying faecal matter to coastal waters. The original sanitary survey reported the presence of cattle grazing on saltmarsh adjacent to embayment. Any faecal deposition by these animals on the saltmarsh would have been carried directly to the shellfishery. Recently compiled (2018) land cover maps do not indicate the presence of any other areas of pasture adjacent to the embayment (Figure 3.3), although it is likely that some cattle still graze on the saltmarsh. Periods of high rainfall, particularly during spring tides and following extended dry periods, are highest-risk in terms of the chances of contamination. Land cover maps indicate that most of the land surrounding the embayment comprises arable farmland. Application of organic fertilisers to this land may carry contamination to the shellfishery, although without specific data as to the nature, timing and extent of any fertiliser application it is not possible to comment on any potential effects on the BMPA.

Despite the fact that livestock populations have increased significantly since the original sanitary survey, and that livestock densities are relatively high, the overall risk of contamination posed by faecal deposition from livestock remains low given that limited land around the embayment is reserved for pasture. The extent of cattle grazing on saltmarsh is not predicted to have increased in volume or changed locations significantly, and as such the recommendations made in the original sanitary survey to capture this source of pollution remain valid.

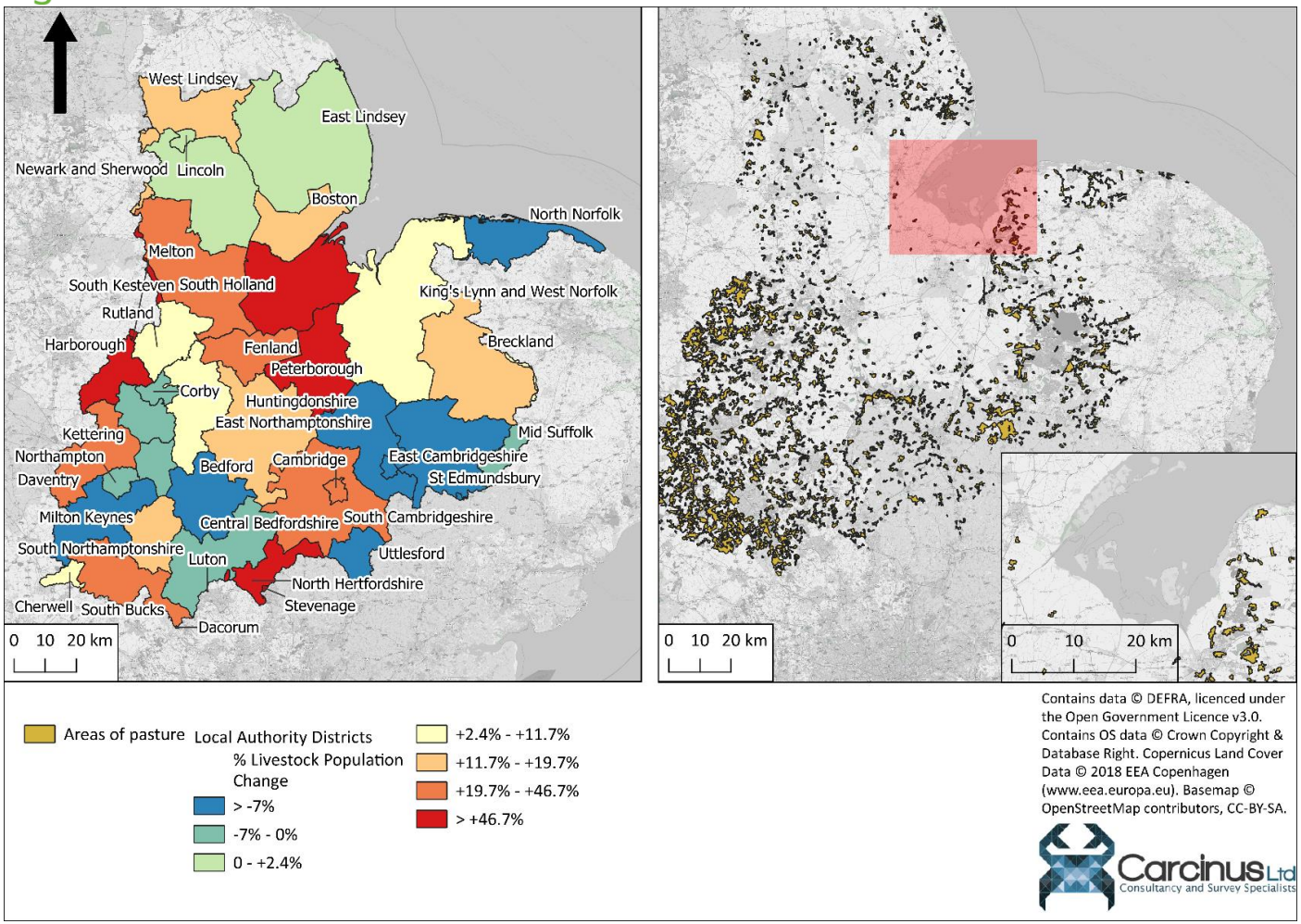

Figure 3.3 Livestock population change between 2013 and 2016 (left) and areas of pasture within the Blackwater catchment, based on 2018 Copernicus land cover data (right).

Table 3.2 Livestock data for the catchment for The Wash between 2013 and 2016.

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
Bedford	47,640.83	47,666.08	100.00%	2.78%	4,705	4,002	-14.93%	18,544	21,999	18.63%	11,717	11,707	-0.09%	578,755	535,025	-7.56%
Boston	39,779.27	39,793.69	100.00%	2.32%	5,399	5,455	1.04%	4,010	3,204	-20.12%	5,767		-100.00%	347,824	398,891	14.68%
Breckland	130,511.66	91,819.11	70.35%	5.35%	15,816	14,078	-10.99%	38,587	42,039	8.95%	285,392	258,785	-9.32%	6,510,405	7,591,960	16.61%
Cambridge	4,069.88	4,071.00	100.00%	0.24%	352	320	-9.16%	539	618	14.74%	188	167	-11.39%	7,178	9,417	31.19%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
South Cambridgeshire	90,168.72	87,377.20	96.90 %	5.09%	7,794	7,080	- 9.16%	11,932	13,691	14.74 %	4,165	3,690	- 11.39 %	159,030	208,630	31.19 %
Cherwell	58,874.12	6,612.92	11.23 %	0.39%	20,271	18,836	- 7.08%	58,704	60,650	3.32%	7,953	8,923	12.19 %	1,169,937	1,260,269	7.72%
Dacorum	21,247.64	59.99	0.28%	0.00%	5,026	3,868	- 23.04 %	5,326	7,565	42.04 %	46		- 100.00 %	34,730	31,147	- 10.32 %
Daventry	66,560.05	47,135.95	70.82 %	2.75%	22,872	20,640	- 9.76%	122,057	129,456	6.06%	7,365	12,196	65.60 %	58,509	113,738	94.39 %
East Cambridgeshire	65,172.04	63,864.07	97.99 %	3.72%	5,217	6,144	17.77 %	4,807	7,078	47.24 %	4,311	4,360	1.14%	304,490	231,445	- 23.99 %

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
East Lindsey	183,085.72	150,304.94	82.10%	8.75%	42,812	38,367	-10.38%	40,640	43,632	7.36%	51,477	43,505	-15.49%	3,978,336	4,051,236	1.83%
East Northamptonshir	50,978.73	51,006.74	100.00%	2.97%	9,151	8,353	-8.72%	30,145	31,721	5.23%	1,590	4,774	200.30%	83,437	91,205	9.31%
Fenland	54,735.54	54,752.88	100.00%	3.19%	3,020	3,192	5.69%	1,783	2,105	18.08%	9,313	6,821	-26.75%	380,146	823,453	116.61%
Harborough	59,269.20	25,686.62	43.34%	1.50%	36,263	38,833	7.09%	121,112	120,510	-0.50%	7,397	9,956	34.60%	286,150	776,550	171.38%
Huntingdonshire	91,254.58	91,294.29	100.00%	5.32%	9,094	9,194	1.10%	12,015	9,114	-24.15%	4,131	5,447	31.85%	446,280	515,492	15.51%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
Ipswich & Babergh	61,164.01	401.19	0.66%	0.02%	4,291	3,481	-18.87%	15,804	16,026	1.40%	8,450	8,787	3.99%	118,007	73,502	-37.71%
Corby	8,028.09	8,032.94	100.00%	0.47%	1,593	1,384	-13.12%	6,350	7,137	12.38%	287	410	43.00%	10,940	10,198	-6.78%
Kettering	23,348.99	23,363.55	100.00%	1.36%	4,632	4,024	-13.12%	18,469	20,756	12.38%	835	1,194	43.00%	31,817	29,659	-6.78%
King's Lynn and West	152,690.08	143,433.38	93.94%	8.35%	9,187	8,811	-4.09%	21,378	25,720	20.31%	110,788	107,194	-3.24%	432,503	491,018	13.53%
Lincoln	3,569.03	3,571.06	100.00%	0.21%	234	236	0.59%	785	997	26.94%	1,179	1,452	23.19%	168,384	172,082	2.20%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
North Kesteven	92,247.14	90,223.22	97.81 %	5.25%	5,917	5,951	0.59%	19,839	25,184	26.94 %	29,785	36,691	23.19 %	4,254,247	4,347,669	2.20%
Luton	4,335.25	5.51	0.13%	0.00%	500	460	-8.13%	999	1,234	23.46 %	239	252	5.65%	15,218	14,897	-2.11%
Central Bedfordshire	71,566.53	63,113.77	88.19 %	3.68%	8,261	7,589	-8.13%	16,494	20,364	23.46 %	3,941	4,164	5.65%	251,223	245,927	-2.11%
Melton	48,138.05	3,535.17	7.34%	0.21%	26,106	26,665	2.14%	56,274	58,642	4.21%	17,239	19,046	10.48 %	363,412	1,597,909	339.70%
Mid Suffolk	87,107.06	13,449.06	15.44 %	0.78%	8,692	7,664	-11.83 %	6,318	9,054	43.30 %	189,989	106,401	-44.00 %	3,864,580	3,682,404	-4.71%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
Milton Keynes	30,862.68	30,881.56	100.00%	1.80%	5,000	5,168	3.37%	11,991	13,909	16.00%	1,033	27	-97.38%	860	2,213	157.33%
Newark and Sherwood	65,183.53	5,023.05	7.71%	0.29%	16,709	15,698	-6.05%	25,363	26,865	5.92%	31,719	27,989	-11.76%	2,919,132	3,462,037	18.60%
North Norfolk	98,999.10	37,182.35	37.56%	2.17%	11,677	10,685	-8.49%	17,133	17,837	4.11%	71,502	64,222	-10.18%	1,921,740	1,669,571	-13.12%
Northampton	8,077.19	8,082.49	100.00%	0.47%	838	829	-1.01%	2,375	2,728	14.87%	0	23	N/A	142,695	136,096	-4.62%
Wellingborough	16,303.65	16,313.56	100.00%	0.95%	1,691	1,674	-1.01%	4,795	5,507	14.87%	0	47	N/A	288,026	274,706	-4.62%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
Norwich & South Norfolk	90,890.65	1,556.41	1.71%	0.09%	24,669	24,232	-1.77%	16,969	15,954	-5.98%	89,870	68,259	-24.05%	3,186,695	3,528,692	10.73%
Peterbor-ough	34,343.79	34,359.31	100.00%	2.00%	1,563	1,676	7.21%	2,352	8,724	270.91%	8,040	4,418	-45.05%	320,188	391,810	22.37%
Rutland	39,374.89	34,306.93	87.13%	2.00%	6,228	6,618	6.25%	58,180	58,317	0.24%	2,453	3,685	50.22%	69,057	74,498	7.88%
South Bucks	156,494.91	45,087.94	28.81%	2.63%	2,451	2,632	7.39%	1,028	1,024	-0.44%	2,129	793	-62.76%	16,189	26,692	64.88%
South Holland	81,550.37	81,579.92	100.00%	4.75%	4,398	4,821	9.61%	8,444	8,610	1.97%	3,756	5,498	46.38%	1,031,357	1,616,255	56.71%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
South Kesteven	94,258.58	92,997.47	98.66 %	5.42%	11,776	11,553	-1.90%	34,592	35,305	2.06%	13,914	13,267	-4.65%	778,218	956,640	22.93 %
South Northamptonshir	63,402.32	47,956.24	75.64 %	2.79%	22,348	22,945	2.67%	108,718	110,433	1.58%	8,638	14,724	70.45 %	2,076,521	1,910,729	-7.98%
St Edmunds-bury	103,467.58	83,119.63	80.33 %	4.84%	1,863	1,990	6.82%	9,825	13,970	42.19 %	91,588	82,718	-9.68%	1,093,109	549,499	-49.73 %
Stevenage	2,596.92	294.24	11.33 %	0.02%	183	219	19.87 %	220	646	192.92%	330	242	-26.85 %	299	790	163.79%

Local Authority District	Total LA Area (Ha)	Area LA within Catchment (Ha)	Proportion LA within Catchment	Proportion of Catchment Area	Population (Adjusted)											
					Cattle			Sheep			Pigs			Poultry		
					2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff	2013	2016	% Diff
North Hertfordshire	37,538.23	22,289.03	59.38 %	1.30%	2,647	3,173	19.87 %	3,186	9,333	192.92%	4,777	3,494	-26.85 %	4,328	11,417	163.79%
Uttlesford	64,118.29	18,622.42	29.04 %	1.08%	3,031	2,907	-4.09%	4,842	4,776	-1.36%	5,987	5,773	-3.56%	140,250	129,022	-8.01%
West Lindsey	115,765.21	46,728.76	40.37 %	2.72%	20,345	19,561	-3.85%	32,202	32,269	0.21%	63,176	62,724	-0.71%	3,588,319	4,118,372	14.77 %
TOTAL	**2,618,770.12**	**1,716,955.65**	**65.56 %**	**100.00%**	**394,619**	**381,008**	**-3.45%**	**975,128**	**1,044,703**	**7.14%**	**1,162,454**	**1,013,825**	**-12.79 %**	**41,432,523**	**46,162,761**	**11.42 %**

3.4 Wildlife

The Wash encompasses significant areas of intertidal mudflat, sand flat and saltmarsh (which are all Priority Habitats), as well as several other important habitats that support internationally important populations of wildlife such as overwintering birds and seals. As a consequence, the entire area is designated as a Ramsar Site; Site of Special Scientific Importance (SSSI); Special Area of Conservation (SAC) and as a Special Protection Area (SPA).

As described in the original sanitary survey, the most significant wildlife aggregation in terms of its contribution to faecal contamination of the shellfishery is overwintering birds. The Wash supports the largest overwintering population of waterbirds of any estuary/embayment in the UK (Frost *et al.*, 2020). The original sanitary survey reported that in the five winters to 2010/2011, an average of 379,164 waterbirds were spotted in the embayment. In the five winters to 2018/2019 (the most recent for which data are available, this had increased to 381,498 (an increase of 0.61%). Figure 3.4 indicates the areas of core bird feeding activity, based on EIFCA surveys of disturbance in the Wash and North Norfolk Coast SAC in 2019. Their summary report (EIFCA, 2019a) indicates that the areas of the embayment where bird feeding most frequently overlaps areas of activity (i.e. harvesting of shellfish) are at Black Buoy, Butterwick, Roger and Toft Sands. CZs in these areas are therefore at the greatest risk of contamination from direct faecal deposition when feeding. However, as described in the original sanitary survey, the precise distribution of avian species will be driven by the distributions of their prey, and so it remains challenging to define RMP locations that will reliably capture this source of pollution.

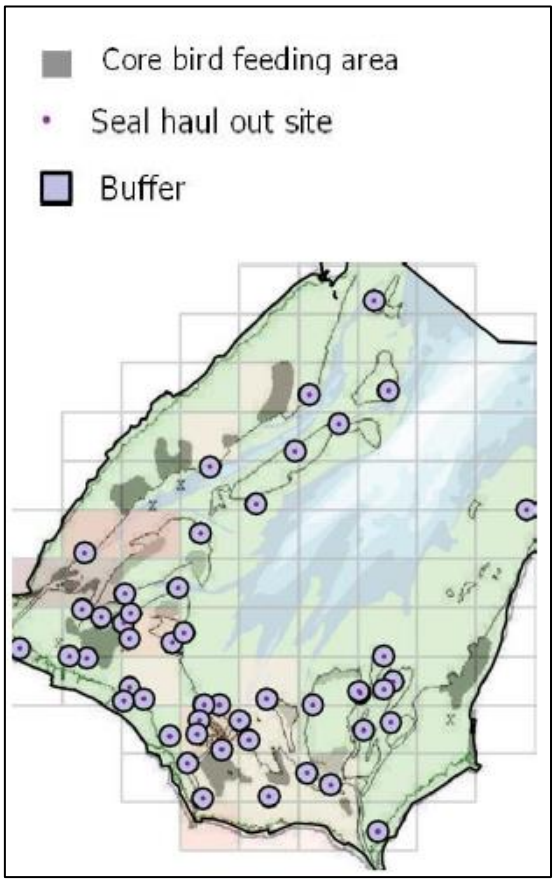

Figure 3.4 Seal haul-out sites (with 600 m buffer) and core bird feeding areas within the Wash. After EIFCA (2019a).

In addition to the overwintering waterbirds, The Wash supports the largest common/harbour seal (*Phoca vitulina*) colony in the UK, with 7% of the national population (JNCC, 2015). The most recent Special Committee on Seals (SCOS) report (SCOS, 2019) indicates that harbour seal populations in The Wash have remained stable since the original sanitary was published. Figure 3.4 indicates that seals hall out relatively evenly across the south-western edge of the embayment, although their precise distributions will vary year-to year. Because of the spatio-temporal variation in both seal aggregations and shellfish (particularly cockles) distributions, it is difficult to define RMPs that will reliably capture this source of pollution. It should be noted however that where the distributions overlap, there may be significant influences on shellfish hygiene, though this was also the case during the original sanitary survey.

Overall, bird and marine mammal populations have remained stable since the original sanitary survey. Due to the variability of both the shellfish distributions and contaminating influences both seasonally and spatially, it remains challenging to define RMP locations to accurately account for this source of pollution in any updated sampling plan. The recommendations made in the original sanitary survey with respect to wildlife in The Wash remain valid.

3.5 Boats and Marinas

The discharge of sewage from boats is a potential significant source of bacterial contamination of shellfisheries within the North Kent Coast BMPA. Boating activities within the area have been derived through analysis of satellite imagery and various internet sources and compared to that described in the original sanitary survey. Their geographical distributions are presented in Figure 3.5.

No changes to the main boating activities within The Wash were identified through this review. The four commercial ports remain in operation, as do the recreational sailing and Yacht clubs. The boating infrastructure in the area remains in the estuaries and rivers that drain into the main embayment, and there are no mooring areas in the central areas.

There have been no changes to the legislation governing overboard discharges from vessels, with restrictions placed on commercial vessels against overboard discharges within three nautical miles of land and guidance given to pleasure craft users to follow the same advice (RYA, 2020). Vessels large enough to contain onboard toilets are liable to make occasional overboard discharges, particularly when transiting through the main navigational routes of the estuary or when moored overnight. Peak activity levels are likely to remain in the summer months, and the associated risk of contamination is therefore also highest at these times.

The main areas at risk of contamination from overboard discharges have not changed significantly, and consultation with the LA did not indicate a significant increase in the extent of shipping activity. The original sanitary survey was not able to make concrete recommendations about RMP locations to capture this source of pollution due to the lack of specific data. The same is true for this review, and as such this source of contamination does not carry any additional weighting for consideration in any updated sampling plan.

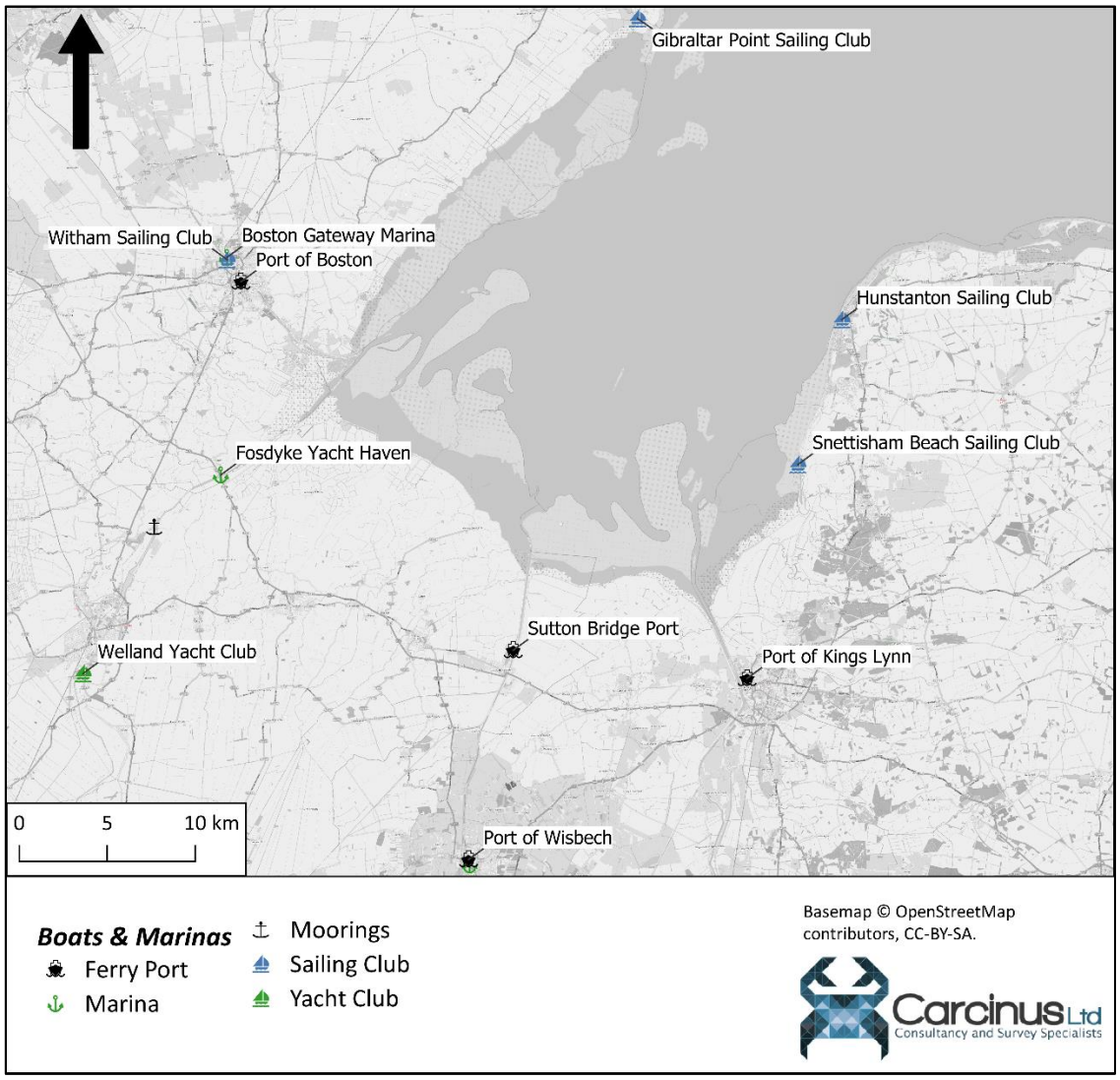

Figure 3.5 Locations of moorings, marinas and other boating activities in The Wash.

3.6 Other Sources of Contamination

As described in Section 3.1, urban fabric in the catchment is mostly located a significant distance from the coastline. However, there are some settlements near to the coast (e.g. Hunstanton), and these represent a potential source of diffuse contamination via utility misconnections and dog fouling. As the geographical extent of these coastal settlements has not increased significantly, the risk that these settlements pose is considered to be broadly similar.

Several coastal paths run along the shoreline of the embayment, and whilst it is unlikely to represent a significant source of pollution, some impact of dog fouling may be present in the nearshore zone. There is no evidence that the use of these paths or the extent of the pollution has changed since the original sanitary survey.

No evidence of significant changes to these sources of contamination exists. Therefore, it can be assumed that the RMP location recommendations made in the original sanitary survey will still capture the influence of these sources.

4 Hydrodynamics/Water Circulation

Whilst the precise locations of sandbanks and drainage channels in The Wash may have changed slightly, it is considered unlikely that the bathymetry presented in the original sanitary survey (Figure IX.1, p 93) has changed significantly since that document was published. The embayment receives freshwater input from four main rivers; Witham, Welland, Nene and Great Ouse and consequently the embayment shows some estuarine characteristics. Contamination from shoreline sources will be carried to the wider embayment down the main drainage channels (the Boston Deeps and Lynn Deeps), before being dispersed over the wider area.

The patterns of circulation are considered unlikely to have changed since the original sanitary survey was published, and as such the consideration given to this factor in choosing RMP locations in the original sanitary survey remains valid.

5 Rainfall

The original sanitary survey presented rainfall data from two weather stations, Heacham weather station and Robin Hood at Boston weather station. Updated data were only available from the National River Flow Archive (NRFA, 2021) for the Heacham weather station (NGR: TF685374), and rainfall data from 2010 – 2013 (pre sanitary survey) and 2014 – 2017 (post sanitary survey) were used to determine whether any changes in rainfall patterns had occurred since the original sanitary survey (data were accessed using the rnrfa package (Vitolo, 2020) for R (R version 3.6.3)). Figure 5.1 shows the average daily rainfall totals for each month at the Heacham monitoring station. Whilst rainfall has increased slightly since the publication of the original sanitary survey, two-sample t-tests indicated that there was no significant difference ($p = 0.240$) between the mean daily rainfall per month between the 2010 – 2013 and 2014 – 2017 periods. Table 5.1 summarises the rainfall at the Heacham monitoring station for the two periods.

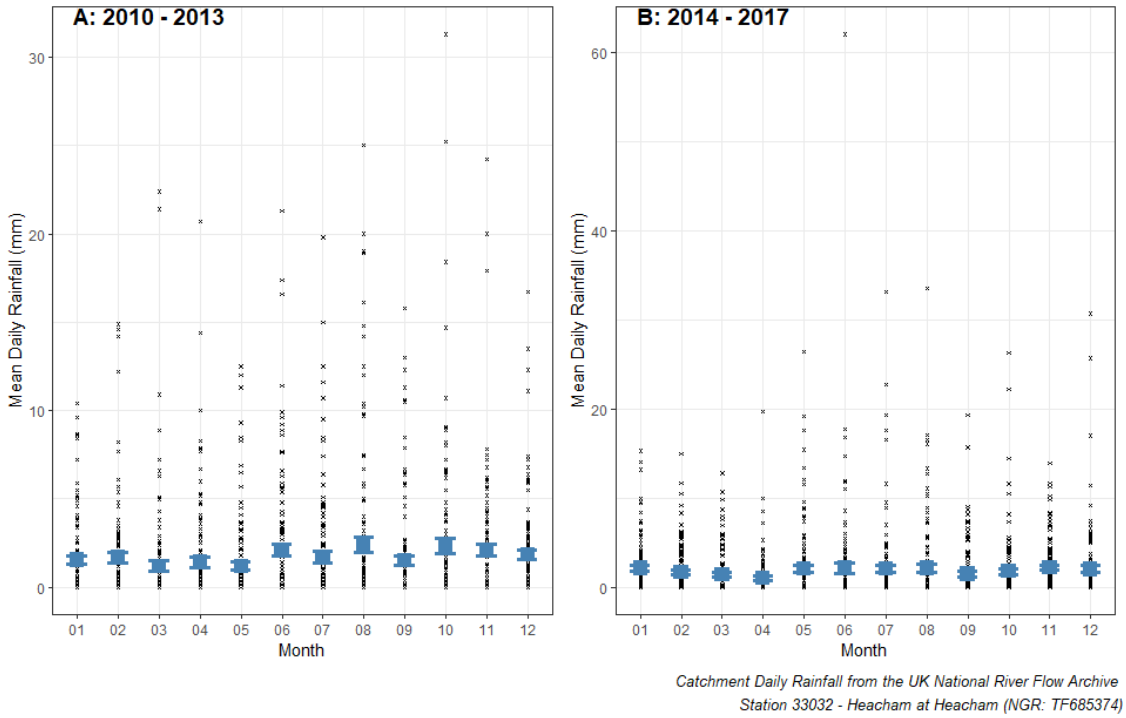

Figure 5.1 Mean daily rainfall (mm) per month for the Heacham at Heacham monitoring station (NGR: TF685374) for the period (A) 2010 – 2013 and (B) 2014 – 2017.

Table 5.1 Summary statistics for rainfall before and after the original sanitary survey.

Period	Mean Annual Rainfall (mm)	% Dry Days	% Days > 10 mm	% Days > 20 mm
2010 - 2013	641.20	44.15	26.01	15.95
2014 - 2017	678.58	43.26	26.42	16.91

Rainfall leads to increased faecal loading through two factors; elevated levels of surface runoff and spill events from intermittent discharges. However, as the rainfall patterns have remained consistent across the two time periods, significantly increased bacterial loading due to these factors are unlikely and as such RMP recommendations made in the original sanitary survey to capture the influence of runoff and spill events remain valid.

6 Microbial Monitoring Results

6.1 Summary Statistics and geographical variation

There are a total of 10 RMPs that have been sampled within The Wash since the original sanitary survey; 6 for cockles (*Cerastoderma edule*) and 4 for mussels (*Mytilus edulis*). Of these RMPs, three were sampled prior to the original sanitary survey being published. Sampling at six of the remaining RMPs began in May and July 2014, with the final RMP (River Ouse (B04AR)) starting in February 2015. Sampling at both the Firskney (B003B) and

River Ouse (B04AR) RMPs was suspended in April 2016, although it is not clear what prompted this action. All other RMPs are actively sampled. Consultation with the LEA and EIFCA indicated that the Nene Mouth (B014AL) RMP has been moved ~200 m north as there were no stocks in the original location. The geometric mean results of Official Control monitoring for all RMPs sampled since the original sanitary survey are presented in Figure 6.1, and summary statistics are presented in Table 6.1. All data have been taken directly from the Cefas datahub[1] and have been taken at face value.

Relative to other BMPAs around the country, mean levels of *E. coli* are low, with all RMPs having a mean value of less than 2,200 MPN/100 g and more than half having a mean value of less than 600 MPN/100 g. No RMPs have ever returned a value of > 46,000 MPN/100 g, although all but two have returned results that exceed 4,600 MPN/100 g. Generally, those RMPs closer to the main watercourses have returned higher levels of *E. coli* than those farther out into the embayment; the highest *E. coli* results occurred at Ouse Mouth (B04AM), Black Buoy (B04AO) and Welland Wall (B003M). An exception to this trend is the River Ouse (B04AR) RMP, although only seven samples were collected from this RMP. There are only two examples of where RMPs from two species are co-located, which prevents a thorough comparison, although there does not appear to be any real differences by species.

Table 6.1 Summary statistics of E. coli (MPN/100 g) from RMPs sampled from 2003 onwards (data cut off at February 2021).

Site (Species)	NGR	Species	No.	First Sample	Last Sample	*E. coli* MPN/100 g					
						Geometric Mean	Min Value	Max Value	% > 230	% > 4,600	% > 46,000
Firskney (C) - B003B	TF51604930	Cockle	23	05/01/2003	26/04/2016	211.22	20	2,400	17.39	0.00	0.00
Welland Wall (M. sp) - B003M	TF39903920	Mussel	199	26/02/2003	02/02/2021	1,917.03	40	17,000	81.91	11.06	0.00
Toft (M. sp) - B003V	TF44234098	Mussel	69	28/07/2014	01/02/2021	470.96	18	4,900	50.72	1.45	0.00
North Lays (C. ed) - B003W	TF42534217	Cockle	69	28/07/2014	01/02/2021	548.09	18	4,900	37.68	1.45	0.00
Hunstanton - Holmeside (M. sp) - B004L	TF67504200	Mussel	213	20/01/2003	12/01/2021	542.31	18	18,000	44.13	0.47	0.00
Nene Mouth (C. ed) - B04AL	TF50052801	Cockle	72	29/07/2014	01/02/2021	1,329.96	18	24,000	58.33	8.33	0.00
Ouse Mouth (C. ed) - B04AM	TF58272800	Cockle	75	29/07/2014	01/02/2021	2,168.68	20	35,000	65.33	8.00	0.00
Black Buoy (C. ed) - B04AO	TF41423976	Cockle	72	28/07/2014	01/02/2021	1,949.78	20	17,000	75.00	12.50	0.00
Stubborn Sand (C. ed) - B04AP	TF65963701	Cockle	82	13/05/2014	12/01/2021	556.44	18	7,900	37.80	1.22	0.00
River Ouse (M) - B04AR	TF60252334	Mussel	7	24/02/2015	05/04/2016	490.00	270	780	100	0.00	0.00

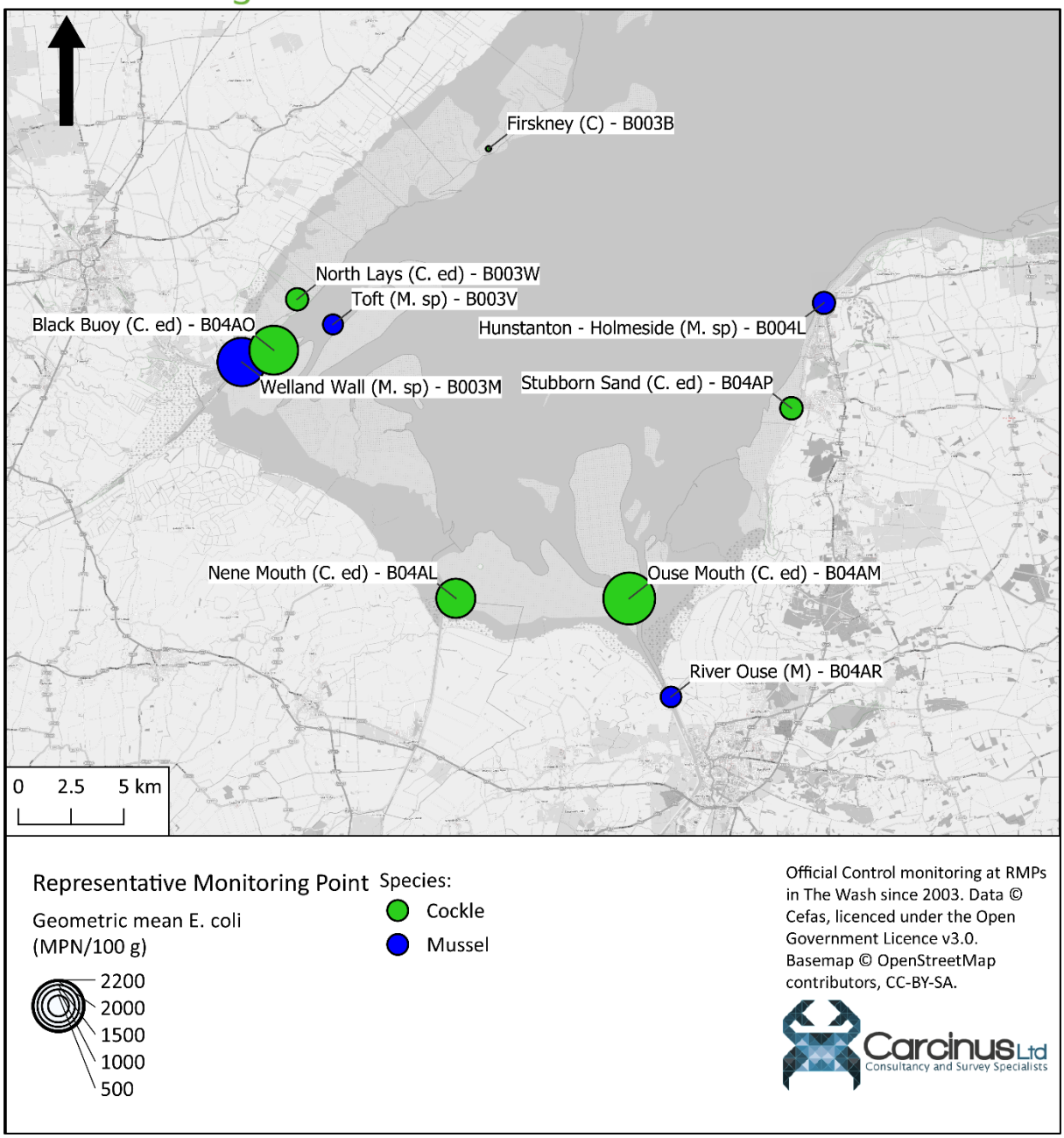

Figure 6.1 Geometric mean E. coli results from Official Control monitoring at bivalve RMPs within The Wash BMPA.

Figure 6.2 and Figure 6.3 present boxplots of *E. coli* monitoring results for RMPs sampled for cockle (Figure 6.2) and mussels (Figure 6.3). One-way analysis of variance (ANOVA) tests (performed in R version 3.6.3) indicated that results from Ouse Mouth (B04AM) were significantly greater than those from Stubborn Sand (B04AP) and North Lays (B003W) ($p < 0.05$). It is not clear from the contamination sources identified through this review what may be causing the elevated results at Ouse Mouth (B04AM). No other significant differences between cockle RMPs were found. Variation in results was quite large at all cockle RMPs, but was greatest at three RMPs with the highest median values. Within mussel

RMPs (Figure 6.3), results from Welland Wall (B003M) were significantly greater than those from Toft (B003V) and Hunstanton – Holmeside (B004L) ($p < 0.0001$), which may be caused by Welland Wall's proximity to continuous discharges near to the embayment.

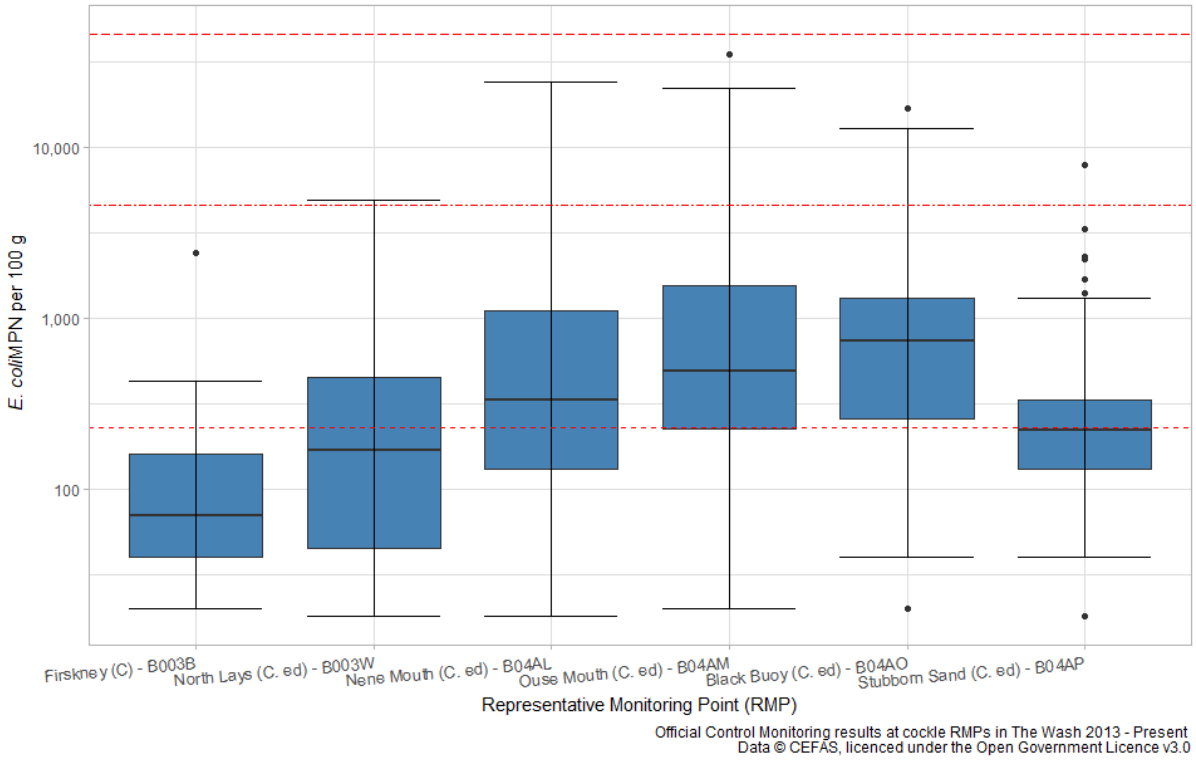

Figure 6.2 Boxplots of E. coli levels at cockle RMPs sampled within The Wash BMPA 2013 Present. Central line indicates median value, box indicates lower – upper quartile range and whisker indicates minimum/maximum value excluding outliers (points > 1.5 x interquartile range).

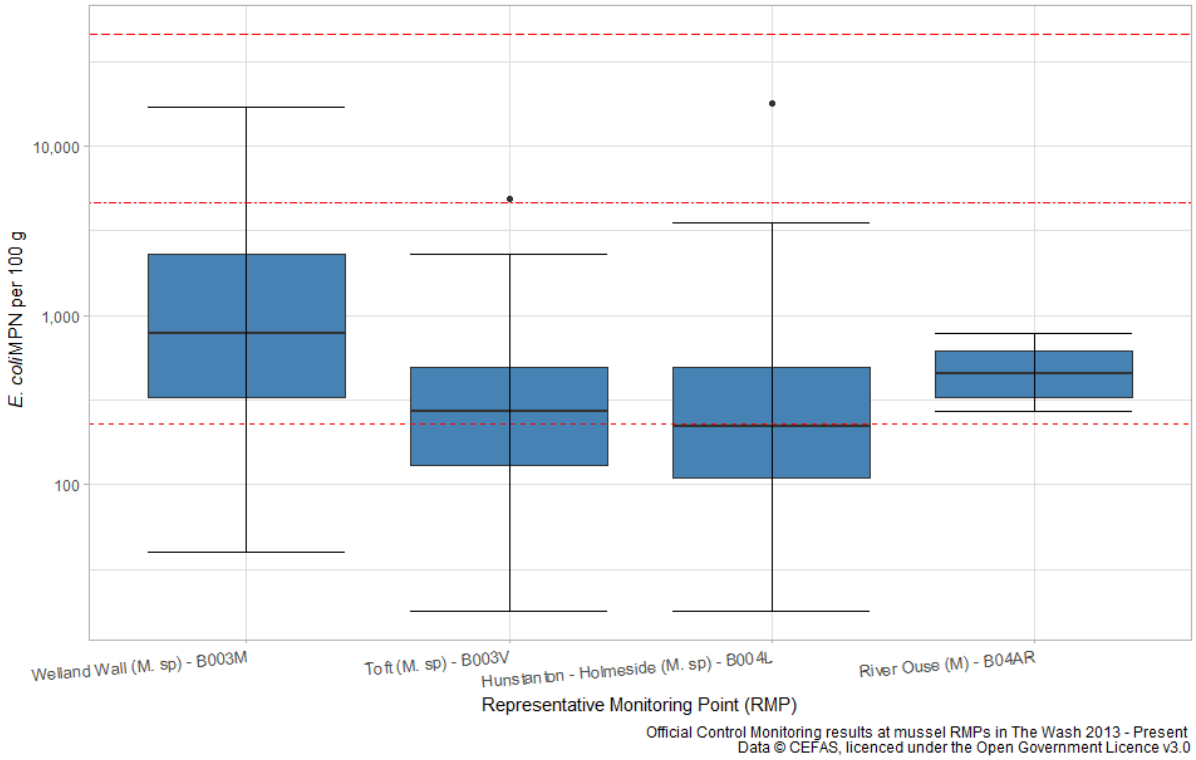

Figure 6.3 Boxplots of E. coli levels at mussel RMPs sampled within The Wash BMPA 2013 Present.

6.2 Overall temporal pattern in results

The overall temporal pattern in shellfish flesh monitoring results for cockle RMPs is shown in Figure 6.4 and those for mussel RMPs is shown in Figure 6.5.

The loess models fitted to the *E. coli* monitoring data from cockle RMPs indicate that levels of *E. coli* have been broadly stable, with North Lays (B003W) and Stubborn Sand (B04AP) sitting around the lower threshold of 230 MPN/100 g (required for Class A), and the rest sitting between the 230 MPN/100 g threshold and the middle threshold of 4,600 MPN/100 g (required for Class B). In recent years, there is a trend of decreasing *E. coli* results from Black Buoy (B04AO), Stubborn Sand (B04AP) and North Lays (B003W). However, the trend from the remaining RMPs (Nene Mouth (B04AL) and Ouse Mouth (B04AM)) have indicates increasing levels of *E. coli*. It is not clear from the review process undertaken here what is causing these trends.

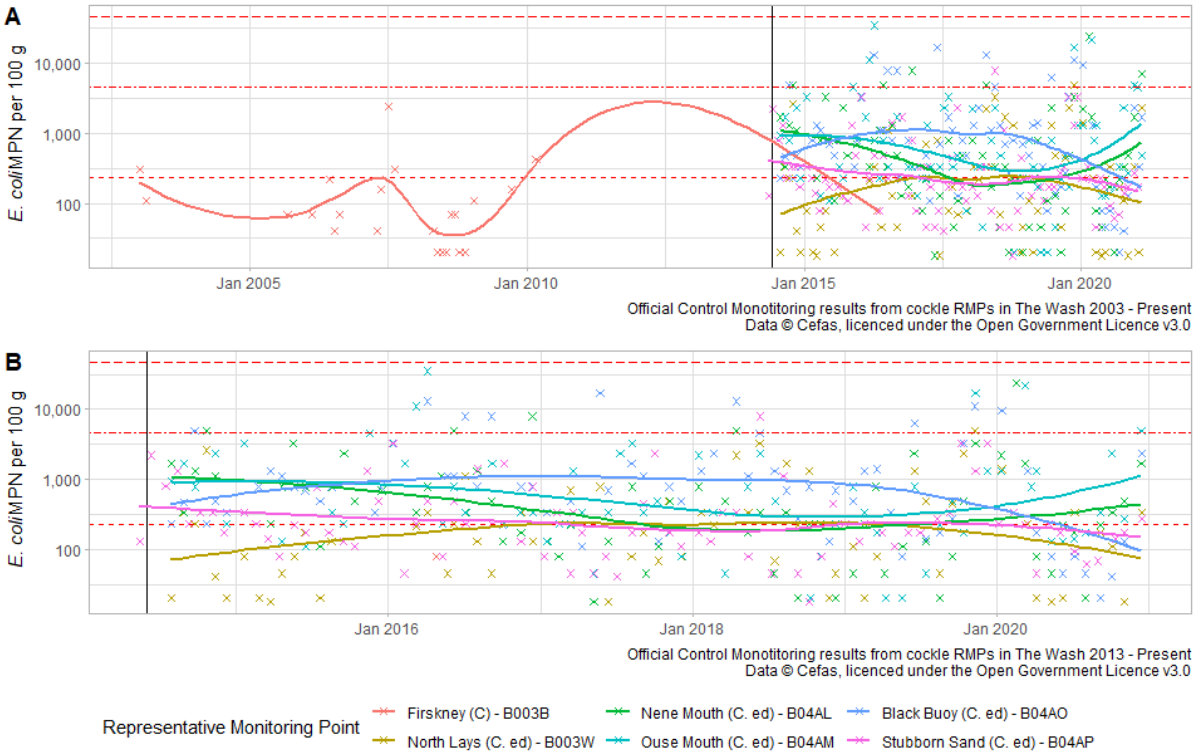

Figure 6.4 Timeseries of E. coli levels at cockle RMPs sampled within The Wash BMPA (A) 2003 – Present and (B) 2013 – Present. Scatter plots are overlaid with a loess model fitted to the data.

The loess models fitted to the *E. coli* monitoring data from mussels indicates a similar level of stability, with two RMPs (Hunstanton – Holmeside (B004L) and Toft (B003V)) having trend lines that sit around the Class A threshold of 230 MPN/100 g and the other sitting between the lower threshold and the Class B threshold of 4,600 MPN/100 g. Toft (B003V) and Welland Wall (B003M) show a slight downward trend in the last 12 months, whereas Hunstanton – Holmeside (B004L) shows a slight upward trend. None of the trends are stark enough to warrant further consideration in this review, as the trend level is not approaching the level of the next highest classification threshold.

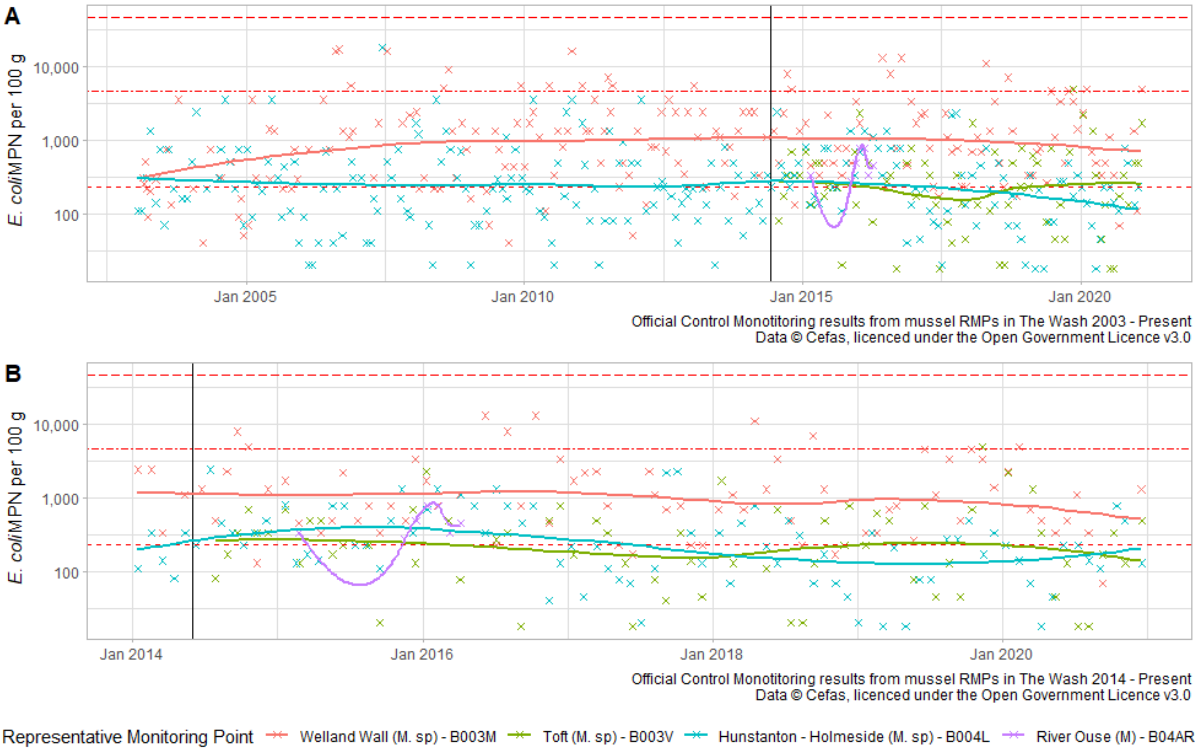

Figure 6.5 Timeseries of E. coli levels at mussel RMPs sampled within The Wash BMPA (A) 2003 – Present and (B) 2013 – Present. Scatter plots are overlaid with a loess model fitted to the data.

6.3 Seasonal patterns of results

The seasonal patterns of *E. coli* levels at the various RMPs within The Wash BMPA were investigated and are presented in Figure 6.6 (cockles) and Figure 6.7 (mussels). The data for each year were averaged into the four seasons, with Winter comprising data from January – March, Spring from April – June, Summer from July – September and Autumn from October – December. Two-way ANOVA testing was used to look for significant differences in the data, using both season and RMP as independent factors (i.e. pooling the database across RMP and season respectively), as well as the interaction between them (i.e. exploring seasonal differences within a given RMP). Significance has been taken at the 0.05 level.

There are some visual differences in the data, particularly at Toft (B003V) (Figure 6.7). two-way ANOVA tests did not indicate any significant differences in seasonal levels of *E. coli* when data were pooled or within individual RMPs for either of the sampled species ($p > 0.05$), indicating that seasonal classifications are not appropriate for any of the currently classified CZs in The Wash.

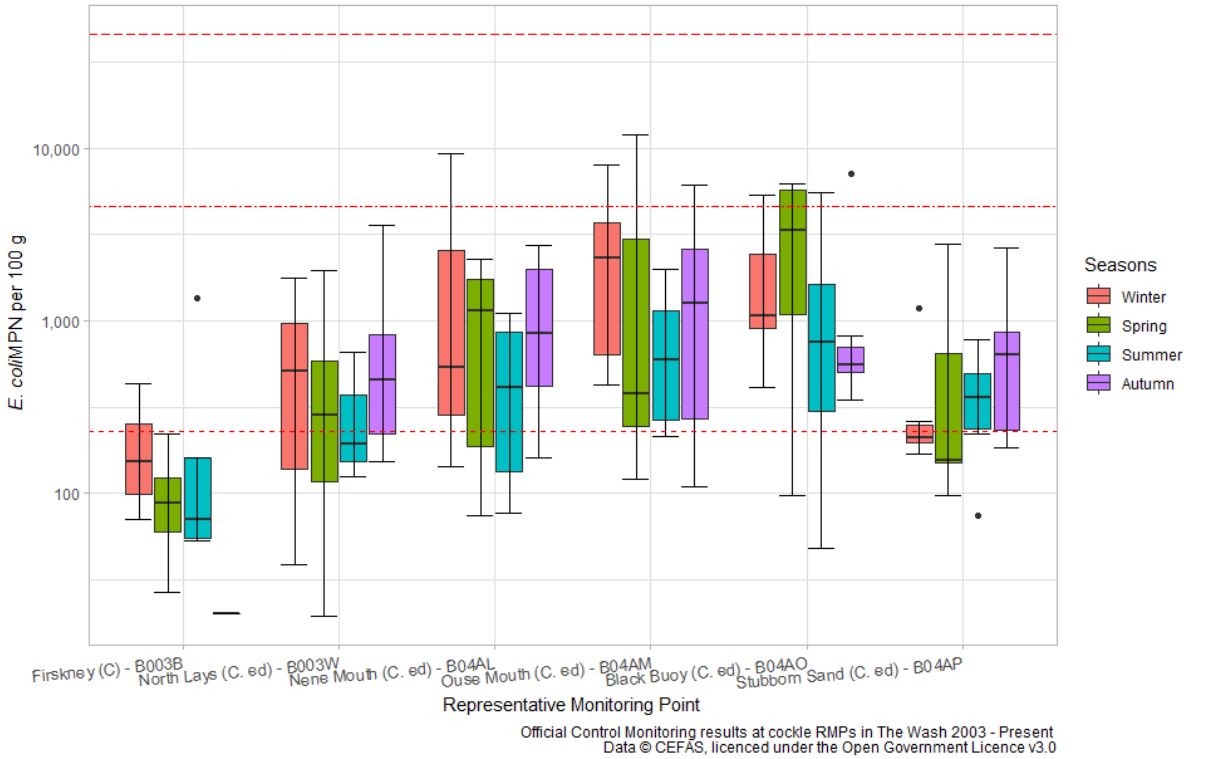

Figure 6.6 Boxplots of E. coli levels per season at cockle RMPs sampled within The Wash BMPA 2003 - present.

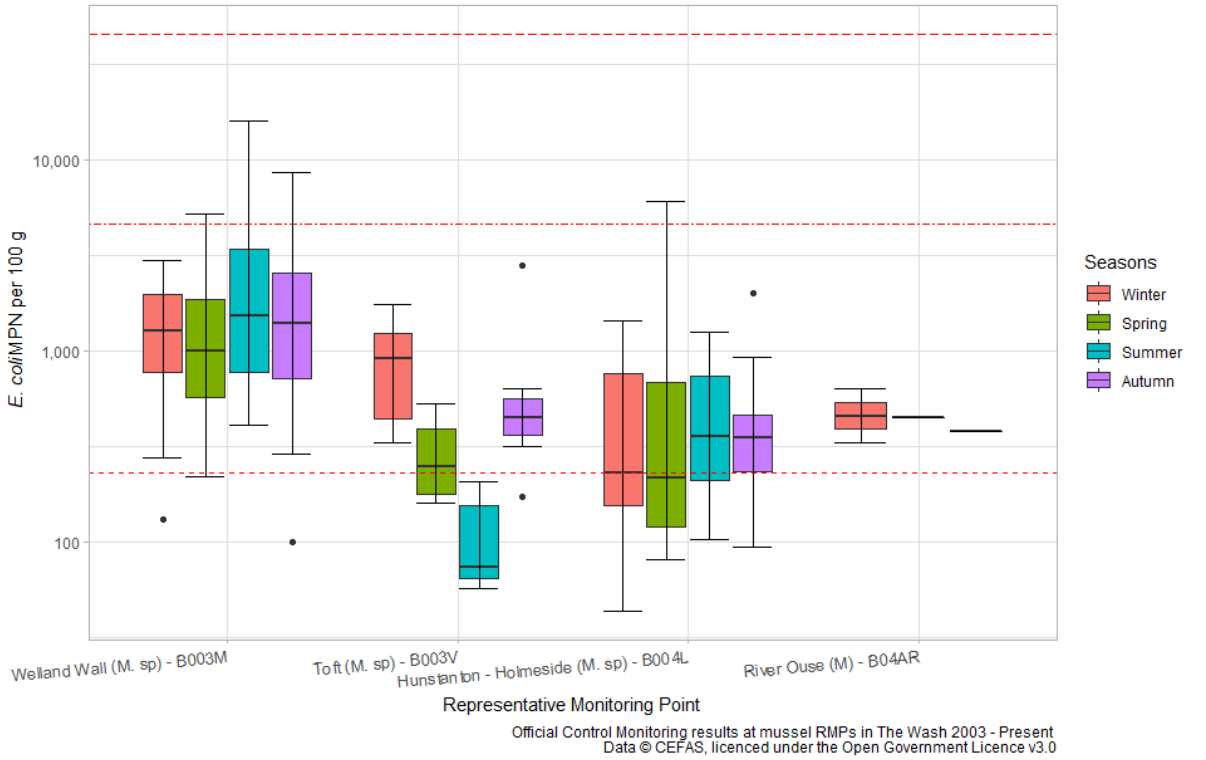

Figure 6.7 Boxplots of E. coli levels per season at mussel RMPs sampled within The Wash BMPA 2003 - present.

7 Conclusion and overall assessment

The Wash supports an actively managed cockle and mussel fishery. Much of the embayment is controlled by the Wash Fishery Order 1992, which is implemented by the Eastern Inshore Fisheries and Conservation Authority. EIFCA indicated during initial consultation that 3,531 tonnes of cockles were landed in 2020, and that whilst the mussel fishery has declined significantly in recent years, it remains active. There are currently 11 Classification Zones in the BMPA, 5 for cockles and 6 for mussels. All these zones were recommended in the original sanitary survey, and no other changes to CZs have occurred since then.

No updated population data was available at the time of this review, though the UK government predict that the national population will increase 6.6% between 2011 and 2021 (when the next full census is scheduled to occur). Most of the population density will continue to be centred a significant distance from the embayment, and the smaller conurbations of Boston, Hunstanton and Kings Lynn have not increased in size significantly, based on land cover maps compiled in 2012 and 2018. Most of the catchment remains rural though population increases will almost certainly have led to increases in sewage discharges and associated urban runoff through misconnections and other urban factors in those conurbations closest to the embayment.

Consultation with the Local Authority did not indicate that any significant upgrades to the wastewater treatment network have occurred since the original sanitary survey was published. There have been some changes to the consented discharge volumes, although the main hotspots of contamination will likely have remained the same, and no continuous discharges discharge directly to the embayment. As such, the loading experienced by the estuary is not expected to have changed significantly since the original sanitary survey.

The total livestock population of The Wash's catchment increased by 10.55% between 2013 and 2016 (the most recent year for which data are available), and an average livestock density of 28.31 animals per hectare. However, recent land cover maps indicate that very little of the land around the embayment is reserved for pasture, and so there is little pathway for direct connectivity with the shellfishery. The pollution from up-estuary livestock populations will contribute to the background level of contamination in the BMPA.

The Wash supports the largest population of overwintering waterbirds in the UK and is home to ~7% of the nation's harbour seals. However, population numbers have remained stable since the original sanitary survey was published, and the spatio-temporal variability of these contaminating influences continues to make it hard to accurately define RMP locations to capture it.

The Wash continues to be popular with both recreational and commercial boaters, with several commercial ports and sailing clubs distributed throughout the embayment. Commercial fishing activity remains at a constant level year-round, and recreational activity will be greatest in summer months. The commercial vessels are prevented from making

overboard discharges within 3 nautical miles of shore, but recreational vessels of a sufficient size to contain on-board toilets may make occasional overboard discharges.

A total of 10 RMPs have been sampled in The Wash since the original sanitary survey was published in 2013, of which three were sampled prior. In the 8 RMPs currently sampled, those closest to the main freshwater sources tend to have the highest mean *E. coli* levels. Relative to other BMPAs in England and Wales, monitoring results are fairly good, with more than half having mean values of <600 MPN/100 g. Given the apparent dominance of shoreline/freshwater courses in driving patterns of contamination, a general approach of selecting RMPs at the shoreline edge of CZs should be taken.

No statistically significant seasonal variation in *E. coli* levels was found at any of the RMPs, both within a given RMP and between RMPs of a certain species. Seasonal classifications are therefore not appropriate for RMPs in this BMPA.

Based on the information available, there do not appear to have been any significant changes to the sources of contamination to this BMPA since the original sanitary survey was published. The authors of this review have not identified any knowledge gaps that would justify a full shoreline survey.

Having reviewed the recommendations of the 2021 report and compared with the findings of the 2013 sanitary survey review for the Wash, the FSA are content that the level of risk posed by the findings is low and therefore does not warrant a further review of the existing shoreline assessment.

8 Recommendations

During initial consultations with EIFCA, the authors of this review were made aware of the need to place RMPs in locations that can be safely accessed by the sampling team (i.e. not requiring sampling officers to travel long distances through soft mud), and that overall sampling effort required should not exceed the current level. Where possible, these recommendations have taken this into account but continue to take a precautionary approach to choosing RMP locations that are most representative of likely patterns of contamination.

There are several instances of Classification Zones that have the same name, but different boundaries for the two harvested species within the BMPA. As a general rule, we would recommend slightly re-naming the CZs to reflect the species harvested there. This change has been reflected in Sections 8.1 and 8.2, as well as in Table 8.1.

8.1 Cockles

The original sanitary survey recommended the classification of five classification zones for cockle harvesting in The Wash, all of which are currently active. Recommendations for these CZs are described in the following paragraphs and are summarised in Table 8.1.

Freiston to Wainfleet

This zone covers an area of 175.9 km^2 and is the most north-easterly CZ for cockle harvesting. It meets the *Heacham & Hunstanton (Cockles)* CZ at its eastern edge, and the *Witham and Welland Outer (Cockles)* and *Nene Mouth (Cockles)* CZs on its southern edge. The original sanitary survey identified that the main contaminating influences to the zone were the Rivers Welland and Witham and recommended that an RMP at North Lays (Witham Bank), in the southwestern corner, be used. This RMP (B003W) is still in use, and it is recommended that the RMP be retained as it is still representative of the main sources of contamination.

Heacham & Hunstanton (Cockles)

This CZ only includes areas that are inside the Le Strange private fishery, and in total covers an area of 194.14 km^2. As such, it is recommended that the boundaries remain the same. It meets the *Freiston to Wainfleet* CZ along its western edge and the *Ouse Mouth (Cockles)* CZ on its southern boundary. The original sanitary survey identified that the main contaminating influences to this zone would drain through the Heacham River, with some background contamination from the Ouse and Nene rivers. It recommended using an RMP at Stubborn Sand, near the mouth of the River Heacham. This RMP (B04AP) has been used since then, and it is recommended that this RMP be retained as it will likely capture contamination from the Heacham Water Recycling Centre. Careful analysis of any deterioration at the Hunstanton – Holmeside (B004L) mussel RMP should be undertaken, as this is likely to be caused by spill events from the intermittent discharges near that RMP.

Nene Mouth (Cockles)

This zone covers an area of 80.63 km^2, and sits between the *Ouse Mouth (Cockles)* and *Witham and Welland Outer (Cockles)* CZs. The *Freiston to Wainfleet* CZ meets this one at the northern boundary. The original sanitary survey identified that the main cockle stocks were at the mouth of the River Nene, and recommended that an RMP be placed here as this was likely the main source of contamination. This RMP (B04AL) has been used continually, although EIFCA indicated during initial consultation that it has been moved 200 m north of its original location due to a lack of stock in the original position. The current position is NGR TF 50740 28381. It is recommended that this RMP (in its new position) should be retained as it is still representative of the main contaminating influence on this zone, the River Nene. As the sampling tolerance is 100 m, this move is not considered to be consequential and does not need to be moved closer to its original location.

Ouse Mouth (Cockles)

This zone covers the area south of the *Heacham and Hunstanton (Cockles)* CZ, and meets the *Nene Mouth (Cockles)* CZ on its western edge. This zone is also classified for mussel harvesting, although this is the only one where the cockle CZ and the mussel CZ have the same boundaries. The main contaminating influence on this zone likely remains up-catchment sources that will discharge out from the mouth of the River Ouse and it is recommended that the current RMP (Ouse Mouth, B04AM) be retained.

Witham and Welland Outer (Cockles)

This zone is larger than the mussel CZ of the same name, and extends farther out into the embayment. The original sanitary survey recommended using an RMP at Black Buoy (B04AO) to capture the contamination draining to the zone from the combined mouths of the Rivers Witham and Welland. It is recommended that this RMP be retained as it is representative of the main sources of contamination to this zone.

8.2 Mussels

Heacham & Hunstanton (Mussels)

This CZ is smaller than the cockle CZ of the same name, covering an area of 130.50 km^2. It meets the *Ouse Mouth (Mussels)* at its southern boundary and the *Mare Tail, Gat and Toft* CZ at its western boundary. The positions of these are the same as the cockle CZ, although the northern boundary does not extend as far out into the embayment. Like the cockle CZ, the shellfish of this zone are within the Le Strange private fishery. The original sanitary survey recommended retaining an existing RMP, Hunstanton – Holmeside (B004L), as this was considered to be the south eastern extent of the mussel beds. If stocks exist farther south, it is recommended that the RMP be moved to better capture the dominant sources of pollution which originate from the Heacham River, such as the continuous sewage discharge there, provided that there are no issues with the intermittent discharges to the north.

Mare Tail, Gat and Toft

This zone covers an area of 119.46 km^2 and sits between the *Heacham & Hunstanton (Mussels)* and *Welland & Witham Outer (Mussels)* CZs. The *Nene Mouth* CZ is located to the south. The zone will receive contamination from the ebb plumes of both the Witham/Welland & Nene rivers, although probably to a lesser extent than the *Nene Mouth (Mussels)* and *Witham & Welland Outer (Mussels)* CZs. It is currently classified using samples from the Lays at Toft (B003V) RMP. It is recommended that this continue, although should any significant deterioration at either of the neighbouring CZs occur, this should be investigated for any potential connectivity with this zone.

Nene Mouth (Mussels)

This zone is almost half the size of the cockle CZ of the same name; its east and west boundaries are the same but this one does not extend as far north. The original sanitary survey recommended using the cockle RMP (mentioned above: B04AL), as the cockle beds were closer to the outfall than the mussel beds. If the same pattern of stock remains, it is recommended that this cockle RMP continue to be used.

Ouse Mouth (Mussels)

This is the only zone classified for both harvested species with the same boundaries, and is the most south-easterly zone in the embayment. The original sanitary survey recommended placing an RMP at the mouth of the Ouse. The zone is currently classified using cockle samples from the Ouse Mouth (B04AM) RMP. It is recommended that this RMP be retained.

Witham and Welland Inner

This zone was set to capture the mussel bed at Welland Wall and is situated at the mouth of the Welland/Witham Rivers. It is the smallest zone in the BMPA, only covering 12.24 km^2. The original sanitary survey recommended using an existing RMP at Welland Wall (B003M) to classify the zone. This RMP is still in use, and it is recommended that be retained, provided that it is on the confluence of both drainage channels. If this is not the case, the availability of sampling stock nearer this point should be investigated as this would be more representative of the contamination to this zone.

Witham and Welland Outer (Mussels)

The western edge of this zone meets the seaward edge of the *Witham and Welland Inner* CZ. The main contaminating influences are the same as the *Inner* CZ, although will most likely be felt to a lesser extent as it this CZ is further out into the embayment. The mussel CZ is about half the size of the cockle CZ of the same name, although they are both classified using the Black Buoy (B04AO), and it is recommended that this RMP be retained.

8.3 General Information

8.3.1 Location Reference

Production Area	The Wash (Boston) & The Wash (King's Lynn)
Cefas Main Site Reference	M003 & M004
Ordnance survey 1:25,000	Explorer 249, 250, 261 & 174
Admiralty Chart	1200

8.3.2 Shellfishery

Species	**Culture Method**	**Seasonality of Harvest**
Cockles (*Cerastoderma edule*)	Wild	Year Round
Mussels (*Mytilus edulis*)	Wild	Year Round

8.3.3 Local Enforcement Authority(s)

Name	**Boston Borough Council** Municipal Buildings, West Street, Boston, Lincolnshire PE21 8QR

Website	https://www.mybostonuk.com/environmental-health/
Telephone number	01205 314200
E-mail address	info@boston.gov.uk
Name	**King's Lynn & West Norfolk Borough Council** Kings Court Chapel Street King's Lynn Norfolk PE30 1EX
Website	https://www.west-norfolk.gov.uk/info/20096/environmental_health.
Telephone number	01553 616200
E-mail address	N/A
Name	**Fenland District Council** Fenland Hall County Road, March, Cambridgeshire, PE15 8NQ
Website	https://www.fenland.gov.uk/environment
Telephone number	01354 654321
E-mail address	info@fenland.gov.uk.

*Table 8.1 Proposed sampling plan for The Wash BMPA. Suggested changes are given in **bold red** type. Corrections to the existing Nene Mouth (B04AL) RMP position are given in underlined type.*

Classification Zone	***RMP***	***RMP Name***	***NGR (OSGB 1936)***	***Lat/Long (WGS 1984)***	***Species Represented***	***Growing Method***	***Harvesting Technique***	***Sampling Method***	***Sampling Species***	***Tolerance***	***Frequency***
Freiston to Wainfleet	B003W	North Lays	TF 4253 4217	52°57.482'N 00°07.225'E	*C. edule*	Wild	Hand or dredge	Hand	*C. edule*	100 m	Monthly
Heacham & Hunstanton (Cockles)	B04AP	Stubbon Sand	TF 6596 3701	52°54.29'N 00°27.97'E	*C. edule*	Wild	Hand or dredge	Hand	*C. edule*	100 m	Monthly
Heacham & Hunstanton (Mussels)	B004L	Hunstanton Holmeside	TF 6750 4200	52°56.95'N 00°29.50'E	*M. edulis*	Wild	Hand or dredge	Hand	*M. edulis*	100 m	Monthly
Mare Tail, Gat and Toft	B003V	Toft	TF 4423 4098	52°56.81'N 00°08.71'E	*M. edulis*	Wild	Hand or dredge	Hand	*M. edulis*	100 m	Monthly
Nene Mouth (Cockles)	B04AL	Nene Mouth	TF 5074 2838	52° 49.912'N 00° 14.167'E	*C. edule, M. edulis*	Wild	Hand or dredge	Hand	*C. edule*	100 m	Monthly

Classification Zone	*RMP*	*RMP Name*	*NGR (OSGB 1936)*	*Lat/Long (WGS 1984)*	*Species Represented*	*Growing Method*	*Harvesting Technique*	*Sampling Method*	*Sampling Species*	*Tolerance*	*Frequency*
Ouse Mouth (Cockles)	B04AM	Ouse Mouth	TF 5827 2800	52°49.58'N 00°20.86'E	*C. edule, M. edulis*	Wild	Hand or dredge	Hand	*C. edule*	100 m	Monthly
Witham and Welland Inner	B003M	Welland Wall	TF 3990 3920	52°55.92'N 00°04.80'E	*M. edulis*	Wild	Hand or dredge	Hand	*M. edulis*	100 m	Monthly
Witham and Welland Outer (Cockles) / (Mussels)	B04AO	Black Buoy	TF 4142 3976	52°56.197'N 00°06.172'E	*C. edule, M. edulis*	Wild	Hand or dredge	Hand	*C. edule*	100 m	Monthly

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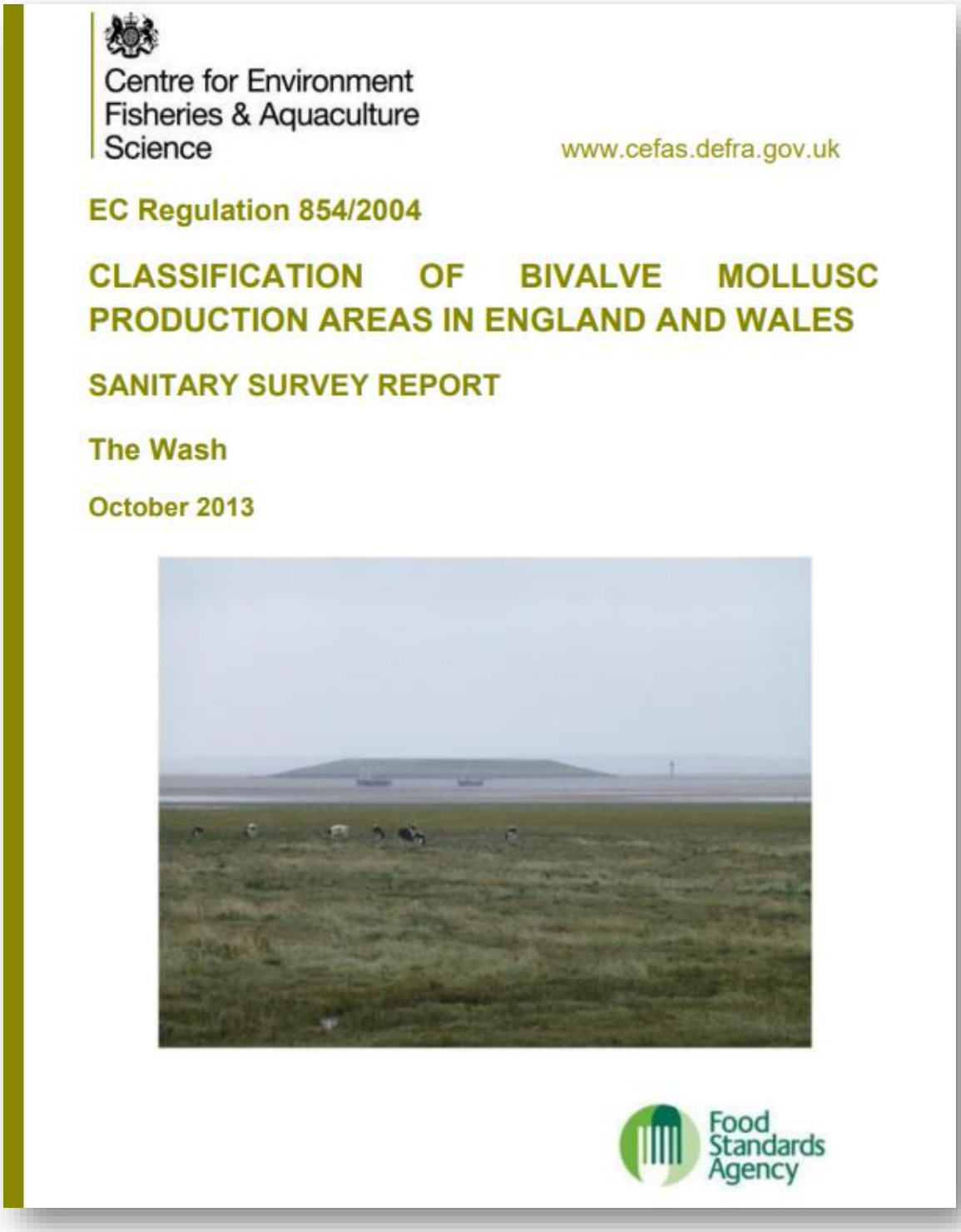
Appendices

Appendix I. The Wash Sanitary Survey Report 2013



Centre for Environment
Fisheries & Aquaculture
Science

www.cefas.defra.gov.uk

EC Regulation 854/2004

CLASSIFICATION OF BIVALVE MOLLUSC PRODUCTION AREAS IN ENGLAND AND WALES

SANITARY SURVEY REPORT

The Wash

October 2013

Food Standards Agency

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Environmental Consultancy

Carcinus provides environmental consultancy services for both freshwater and marine environments. Our freshwater and marine environmental consultants provide services that include scoping studies, Environmental Impact Assessment (EIA) for ecological and human receptors, Habitats Regulations Appraisal (HRA), Water Framework Directive (WFD) assessments, project management, licensing and consent support, pre-dredge sediment assessments and options appraisal, stakeholder and regulator engagement, survey design and management and site selection and feasibility studies.

Ecological and Geophysical Surveys

Carcinus delivers ecology surveys in both marine and freshwater environments. Our staff are experienced in the design and implementation of ecological surveys, including marine subtidal and intertidal fish ecology and benthic ecology, freshwater fisheries, macro invertebrate sampling, macrophytes, marine mammals, birds, habitat mapping, River Habitat Surveys (RHS), phase 1 habitat surveys, catchment studies, water quality and sediment sampling and analysis, ichthyoplankton, zooplankton and phytoplankton.

In addition, we provide aerial, topographic, bathymetric and laser scan surveys for nearshore, coastal and riverine environments.

Our Vision

"*To be a dependable partner to our clients, providing robust and reliable environmental advice, services and support, enabling them to achieve project aims whilst taking due care of the sensitivity of the environment*"