Sanitary Survey- Review

Morecambe Bay & Duddon Estuary – 2023

Document No. – *J0591/22/09/20*

Carcinus Ltd, Wessex House, Upper Market Street, Eastleigh, Hampshire, SO50 9FD.
Tel. 023 8129 0095
https://www.carcinus.co.uk/

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Document QA and Approval

	Name	Role	Date
Author	Joshua Baker	Senior Consultant	24 February 2023
Checked	Matthew Crabb	Director	24 February 2023
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Initial Consultation

Consultee	Date of consultation
North West Inshore Fisheries & Conservation Authority (NW-IFCA	August 2022
South Lakeland District Council	August 2022
Barrow Borough Council	August 2022
Environment Agency	August 2022
Lancaster City Council	October 2022

Consultation on draft report

Consultee	Date of consultation
South Lakeland District Council	December 2022
Lancaster City Council	January 2023
Barrow Borough Council	January 2023
Environment Agency	January 2023

Sanitary surveys relevant to the bivalve mollusc beds in Morecambe Bay & Duddon Estuary were undertaken in 2014 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 provides for appropriate hygiene classification zoning and monitoring plan based on the best available information with detailed supporting evidence. In line with regulatory requirements 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, Barrow Borough Council, South Lakeland District Council and Lancaster City Council. The report is publicly available via the Carcinus Ltd. Website.

Recommended Bibliographic Citation:

Carcinus Ltd., 2022. Review of the Morecambe Bay & Duddon Estuary 2014 Sanitary Surveys. 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

The Food Standards Agency is responsible for carrying out sanitary surveys in classified production and relay areas in accordance with Article 58 of retained (EU) Regulation 2019 627 and the EU Good Practice Guide (European Commission, 2021). In line with these requirements, sanitary surveys must be reviewed to ensure public health protection measures continue to be appropriate. Carcinus is contracted to undertake reviews on behalf of the Food Standards Agency.

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 surveys were 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 the outcome of the desktop report and identified risks. The desktop assessment is completed through analysis and interpretation of publicly available information, in addition to consultation with stakeholders.

1.2 Morecambe Bay & Duddon Estuary Review

This report reviews information and makes recommendations for a revised sampling plan for existing mussel (*Mytilus* spp.), cockle (*Cerastoderma edule*) and Pacific oyster (*Crassostrea gigas*) classification zones in Morecambe Bay & Duddon Estuary (Figure 1.1). The previous sanitary surveys considered the Duddon Estuary and Morecambe Bay in two separate reports, in line with the designated Bivalve Mollusc Production Areas (BMPA). This review considers the pollution sources collectively, given the connectivity between the two waterbodies via the Walney Channel (which is itself considered part of the Morecambe Bay BMPA). This review explores any changes to the main microbiological contamination sources that have taken place since the original sanitary surveys were conducted. Data for this review was gathered through a desk-based study and consultation with stakeholders.

An **initial consultation** with Local Authorities (LAs), Inshore Fisheries and Conservation Authority (IFCA) and the Environment Agency (EA) responsible for the production area was undertaken in August 2022 (n.b. Lancaster City Council were consulted in October 2022). 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 December and January 2023. 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 sampling plans and assessments originally conducted in 2014, as necessary and should read in conjunction with these previous surveys.

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 surveys. A summary of the changes is presented in section 6.4 and recommendations for an updated sampling plan are described in section 8.

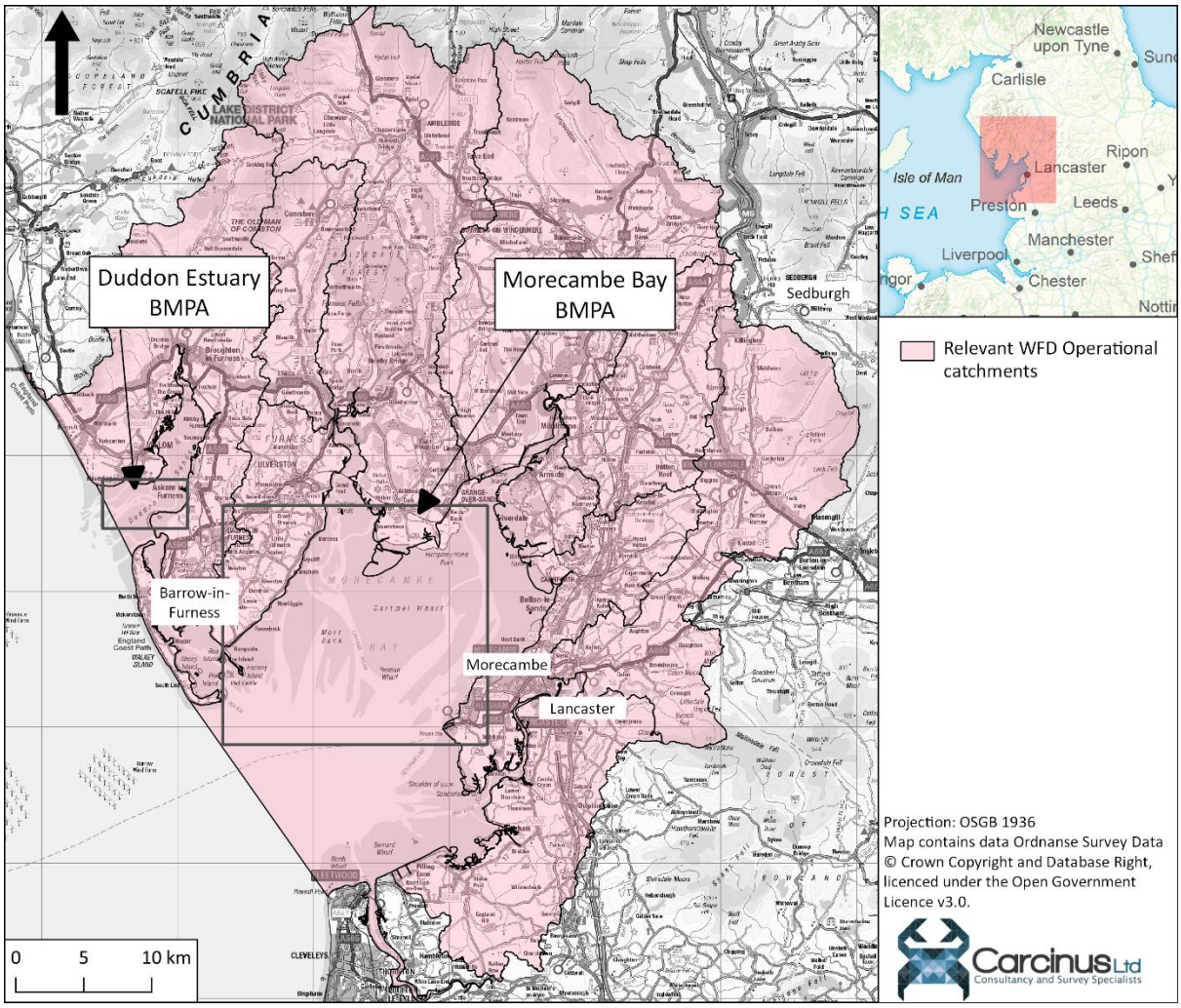

Figure 1.1 Location of Morecambe Bay & Duddon Estuary.

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 September 2022;
- 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 September 2022 have been used within this review. Any subsequent samples have not been included.

2 Shellfisheries

2.1 Description of Shellfishery

2.1.1 Morecambe Bay

Morecambe Bay is the second largest embayment in the UK, after the Wash in North Norfolk. It is characterised by large intertidal sand flats which are exposed at low tide, with several significant rivers draining to it. It is hydrologically connected to the Duddon Estuary via the Walney Channel, which separates Walney Island from the mainland. The Morecambe Bay BMPA does not include the section of the embayment at the southern end, around the Lune and Wyre estuaries, as these are home to separate production areas.

Morecambe Bay is situated within the NW-IFCA district, and harvesting of shellfish is regulated under Byelaw 3, which allows permit holders to collect mussels and cockles on a commercial basis from designated commercial beds, and also gives rights for "The Authority [to] close any cockle or mussel bed, or part thereof for the following purposes:

a) To control the rate of exploitation with regard to cockles or mussels;
b) For the recovery of any cockle or mussel bed from exploitation;
c) For the protection of immature shellfish; and
d) For the protection of a protected feature."[2]

For food hygiene purposes, the BMPA is under the jurisdiction of three different Local Enforcement Authorities (LEAs)s. These are Barrow-in-Furness Borough Council, Lancaster City Council and South Lakeland District Council. The authors of this review were advised that from April 2023, Barrow BC and South Lakeland DC will be merged into a new LEA, Westmorland & Furness.

[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] NW-IFCA Byelaw 3. Available at: https://www.nw-ifca.gov.uk/app/uploads/NWIFCA-Byelaw-3-Permit-to-Fish-for-Cockles-and-Mussels.pdf.

This section describes the current status of the shellfishery for each of the harvested species.

Cockles

The original sanitary survey recommended the creation of nine classification zones for cockles within the BMPA, though at the time of these reports all beds were closed. There are currently four active classification zones in the Morecambe Bay BMPA (*Newbiggin*, *Central West*, *Central East* and *Aldingham*). Those historic beds on the far east side of the bay (*Morecambe/Heysham*, *Keer* and *Silverdale*), and those within the Walney Channel (*Snab Sands* and *Roosecote Sands*), do not have an active classification. Furthermore, commercial harvesting of all species is prohibited from the *Aldingham* zone due to official control monitoring results above the maximum class C limit.

Cockles are subject to wild harvest from the designated beds within the Morecambe Bay BMPA, and the fishery is open from 01 September to 30 April. NW-IFCA makes a decision during the closed season on whether commercial beds can be opened the following year, depending on the outcome of its annual survey results and the viability of stock. Figure 2.1 shows the results of the 2022 cockle stock survey of the shellfish beds within the Morecambe Bay BMPA, and suggests that the densest aggregations of cockles are in the *Newbiggin* and *Aldingham* CZs. At the time of writing (October 2022) all commercial cockle beds within Morecambe Bay (Flookburgh/Leven, Newbiggin and Aldingham) remained closed under Paragraph 15 of Byelaw 3, due to a lack of stock to open a sustainable fishery.

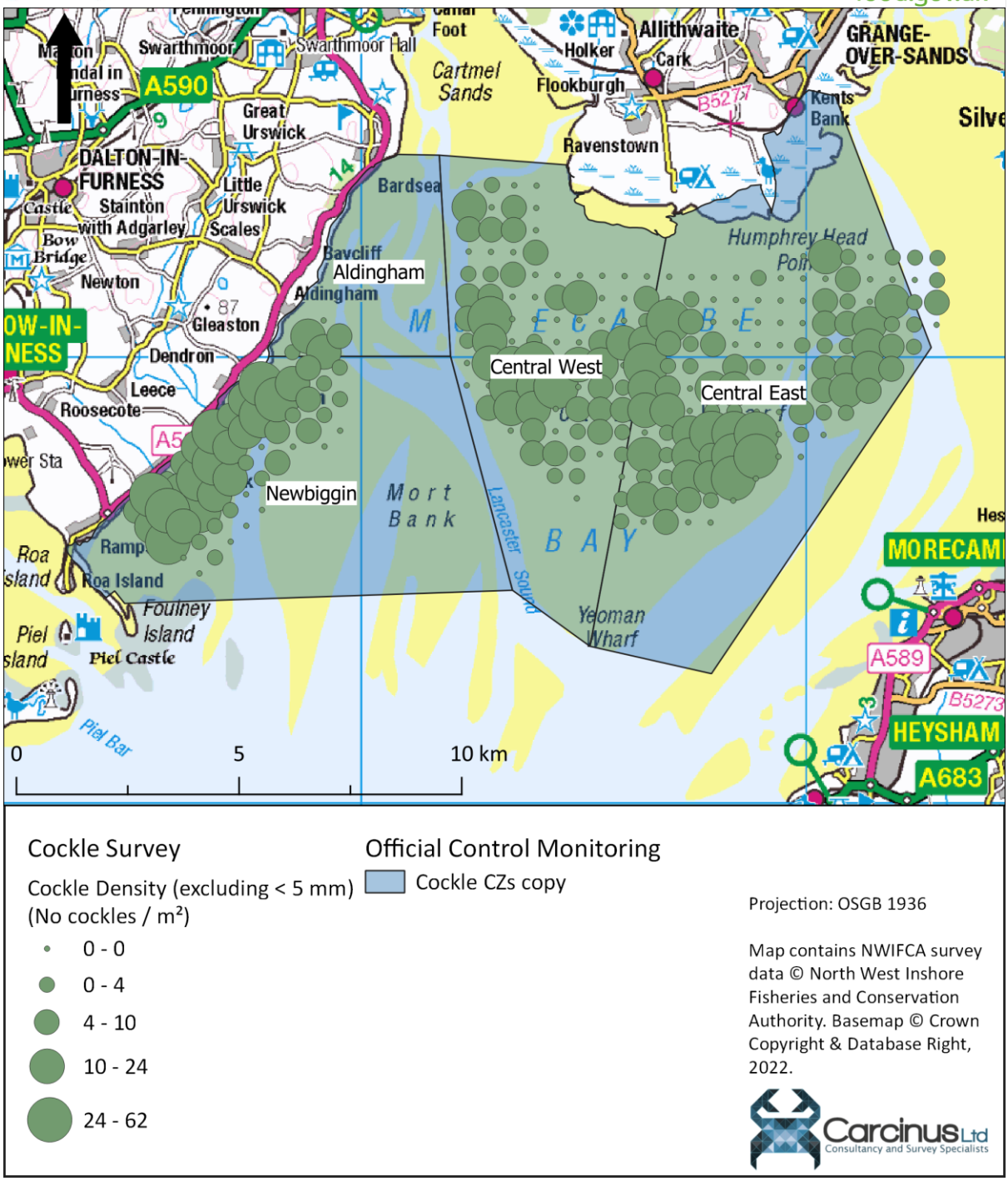

Figure 2.1 Results from the 2022 NW IFCA cockle stock survey, overlaid on existing Classification Zones.

During initial consultations, Barrow BC provided recent landing statistics for cockle beds in the BMPA. These are summarised in Table 2.1. No landing statistics for previous years were available to the authors of this review, although it is understood that there was lower activity in 2021 than previous years due to difficulties exporting shellfish to European markets following the UK's departure from the EU.

Table 2.1 Recent landing statistics from Cockle beds in the Morecambe Bay BMPA.

Bed Name (approximate CZ)	2021 Landings (kg)	2022 Landings (kg)*
Flookburgh (*Central West & Central East*)	33,972	0
Newbiggin (*Newbiggin & Aldingham*)	1,364	0
*All cockle beds in Morecambe Bay closed for 2022/23 season.		

Mussels

The original sanitary survey recommended the creation of six classification zones for mussels, two near Morecambe/Heysham, one within the Walney Channel and three around the Foulney area. Currently, Foulney is the only active mussel zone, though the size of this zone has reduced since the original sanitary survey.

Mussels are also subject to wild harvest within the BMPA and those of size can be harvested year round. There is also a seed mussel fishery, although these beds are opened on a bed by bed basis under Paragraph 15 of Byelaw 3. Figure 2.2 shows the location of mussel beds as estimated from the 2022 NW IFCA survey. The Foulney mussel bed is open, with a minimum landing size of 45 mm across the longest part of the shell. The South America seed mussel Bed is currently subject to a closure due to changes in the bed rendering it no longer compliant with the Habitat Regulations Assessment (HRA) required for a 'plan or project' (of which the opening of a mussel bed is classed) within a European Designated Site (NW-IFCA, 2022). No estimate of mussel stock within the Walney Channel is provided by the annual IFCA stock assessments.

The Local Authority advised that there has been a marked reduction in landings from Foulney Mussel zone, with more than 340,000 kg of mussels landed in 2021, but only 71,000 kg landed as of September 2022.

In May 2022, the FSA received an application from Barrow Borough Council to classify an area south of the Jubilee Bridge within the Walney Channel for mussel harvesting. The application specified that this fishery would be hand harvest of wild mussels in the intertidal areas of the channel. A Classification Zone Assessment for this zone was produced (Carcinus, 2022), although no formal classification was ever awarded. The LEA advised during initial consultation that this was because the harvesters intended use could not be considered either a 'production' or 'relay' area.

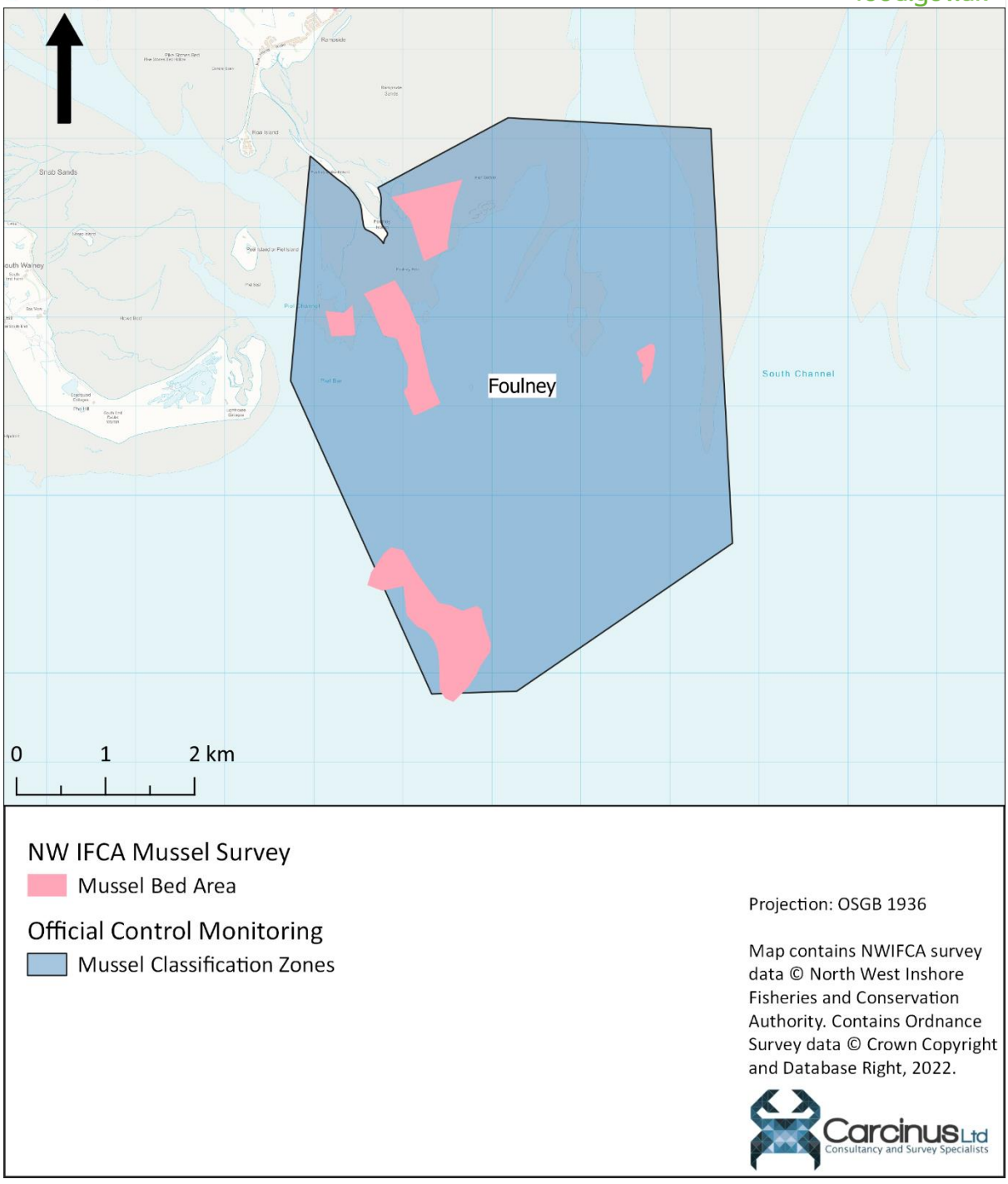

Figure 2.2 Morecambe Bay mussel beds as estimated from the 2022 NW IFCA mussel stock survey, overlaid on existing Classification Zones.

Pacific oysters

Pacific oysters within the Morecambe Bay BMPA are cultured year-round within a single classification zone (*Roosebeck*), to the south of the Walney Channel (Figure 2.3). NW IFCA do not impose any byelaws on the harvest of this species. The FBO advised during secondary

consultation that over 38,000 kg of oysters were sent to market in 2021, and in 2022 nearly 30,000 kg of oysters were sent to market.

2.1.2 Duddon Estuary

The Duddon Estuary is a small estuary north of Morecambe Bay. The BMPA covers the entirety of the inlet, but does not include the Walney Channel that links it to Morecambe Bay.

The BMPA is also found within the NW-IFCA District. Harvesting of shellfish is subject to the same byelaws as Morecambe Bay. The LEA responsible for the BMPA for food hygiene purposes is Barrow-in-Furness BC.

The original sanitary survey made recommendations for the creation of three classification zones, two for cockles and one for mussels. A temporary closure of this bed was imposed by the local authority due to high biotoxin levels, although the bed has since been reopened. On 03 November 2022, the bed was upgraded from Class C to Class B, which caused renewed commercial interest in the bed. Barrow BC stated at secondary consultation that NW-IFCA officers confirmed that there is currently very little mussel left on the bed, and stocks are not expected to improve in coming weeks. At the time of writing (February 2023), declassification has been requested by the Local Authority and actioned in the February 2023 interim update.

2.2 Classification History

2.2.1 Morecambe Bay

The original sanitary survey made recommendations for the creation of sixteen (16 no.) Classification Zones, each with their own Representative Monitoring Point (RMP). Nine of these were for cockles, six for mussels and one for Pacific oysters. Currently, there are five classification zones within the production area, three for cockles and one each for mussels and Pacific oysters (Table 2.2). The cockle zones in the Walney Channel (*Snab Sands* and *Roosecote Sands*) were declassified in 2018, the mussel zones in the southern region of Morecambe Bay (*Heysham* and *Bare Ayre)* declassified in 2020 and the mussel zones in Walney Channel (*Roa Island* and *Bass Pool*) declassified in 2017. All zones were declassified due to lack of commercial interest.

The locations of these zones, with their associated RMPs, are shown in Figure 2.3. A summary of the classification status of these zones (as of 10 November 2022) is presented in Table 2.2

Table 2.2 Classification status of all Classification Zones within the Morecambe Bay.

Classification Zone	Species	Classification Status
Newbiggin	*C. edule*	B
Central West	*C. edule*	B-LT
Central East	*C. edule*	Seasonal A/B Class A 01/01 → 31/05, Class B at all other times
Aldingham	*C. edule*	Prohibited for all species

Classification Zone	Species	Classification Status
Keer Channel	*C. edule*	Declassified
Foulney	*Mytilus* spp.	Seasonal A/B Class A 01/01 → 31/05, Class B at all other times
Roosebeck	*C. gigas*	Seasonal A/B Class A 01/01 → 30/06, Class B at all other times

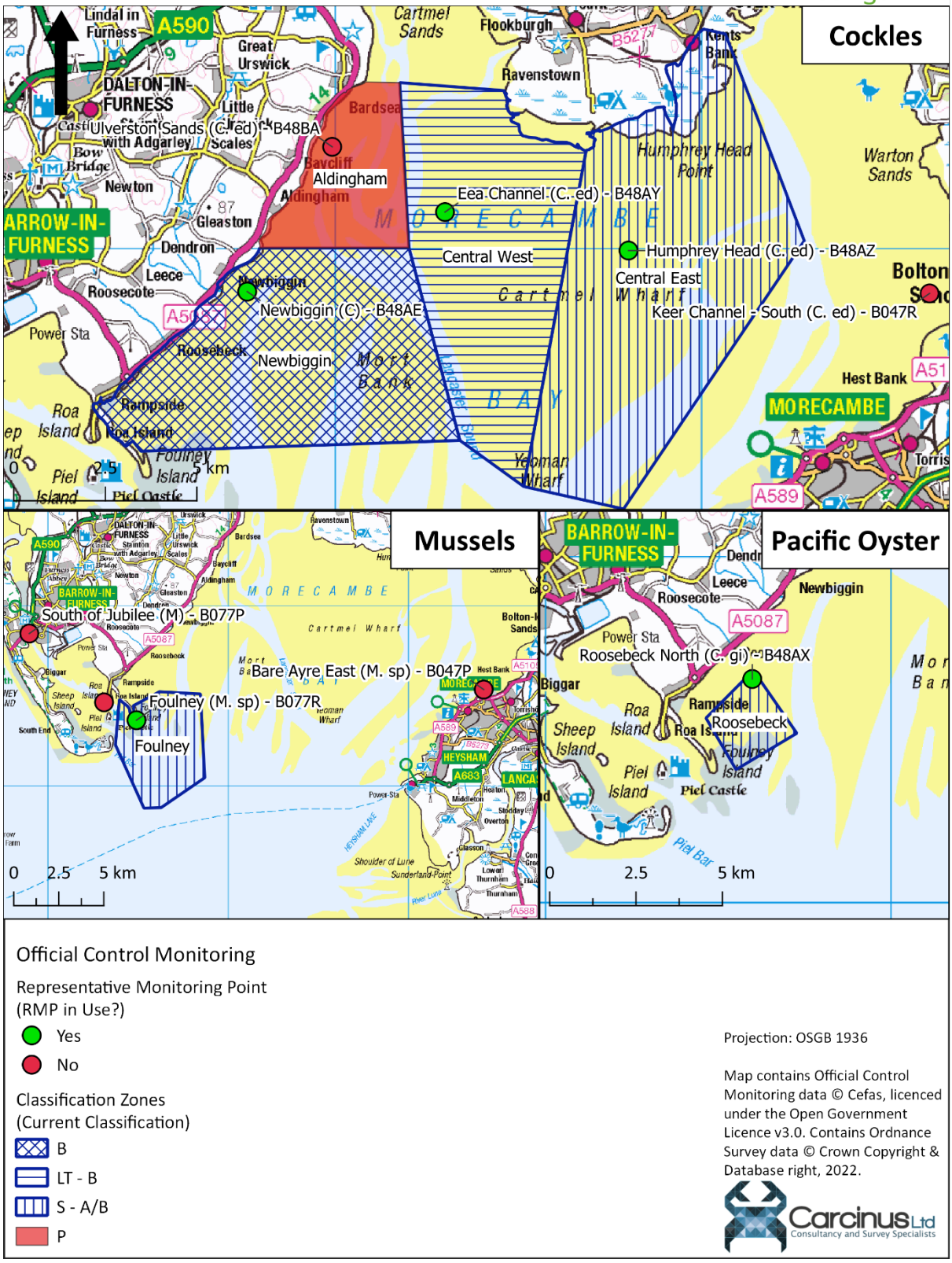

Figure 2.3 Current Classification Zones and associated Representative Monitoring Points in the Morecambe Bay BMPA.

2.2.2 Duddon Estuary

The original sanitary survey recommended the creation of three classification zones, two for cockles and one for mussels. None of the cockle zones have been awarded a full Classification since the original sanitary survey was published. The mussel zone, *Duddon Sands* held a Class B up prior to its declassification in February 2023 (it was previously declassified between 2016 and 2021 due to a lack of stock.

The location of the only active CZ within the Duddon Estuary (prior to its declassification in February 2023), along with its RMP, is shown in Figure 2.4.

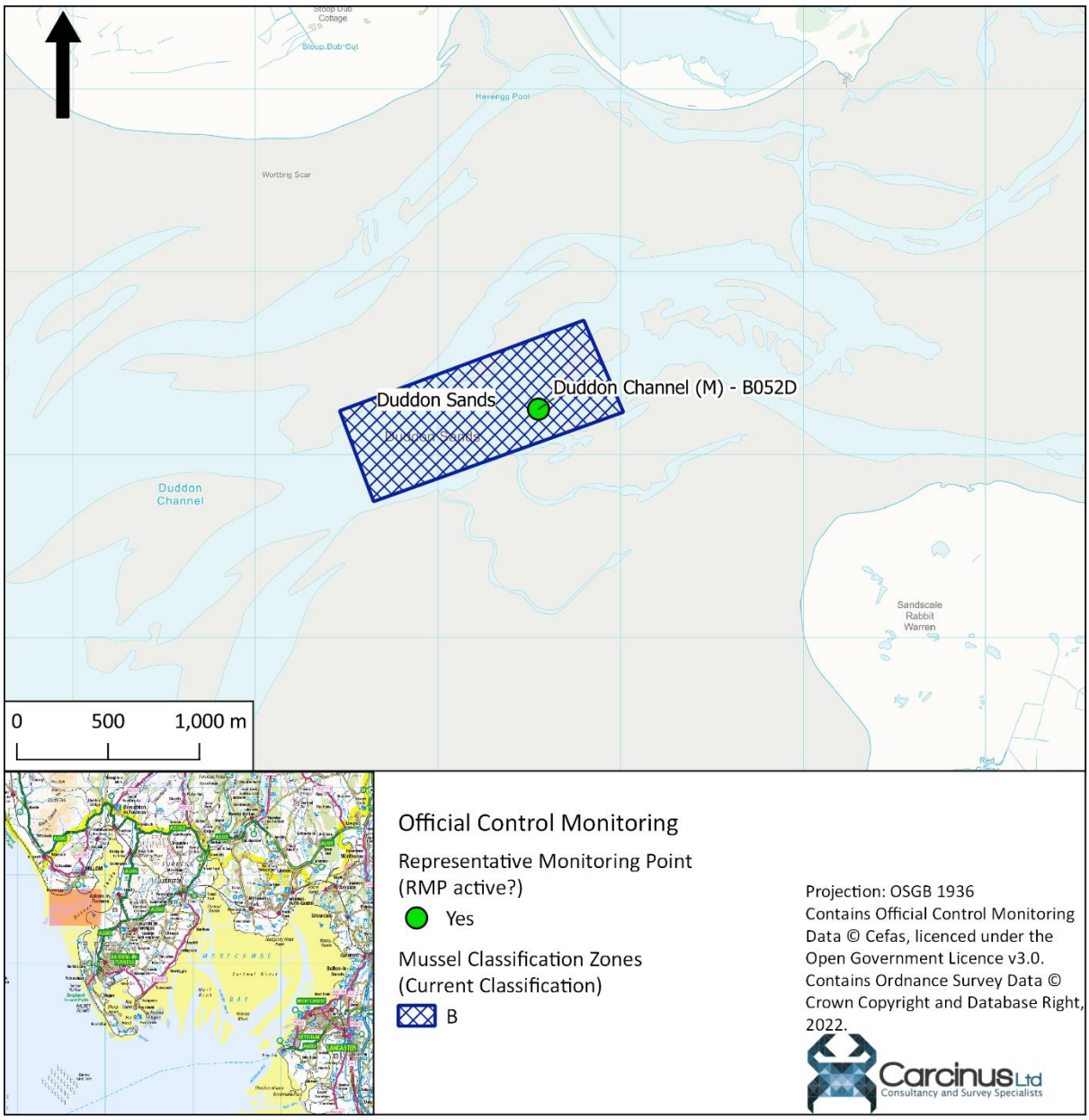

Figure 2.4 Current Classification Zones (at December 2022) and associated Representative Monitoring Points in the Duddon Estuary BMPA.

3 Pollution sources

3.1 Human Population

The original sanitary surveys of both the Duddon Estuary and Morecambe Bay cite population data from the 2011 Census of the United Kingdom. No updated census data for the catchment are available; the next full Census took place in March 2021, but the data is not yet available. The Morecambe Bay survey report reported a population within that catchment of 229,614, and the Duddon survey report a population of 50,840, giving a total population in the combined catchments of 280,454. The UK government estimates that the national population will have increased by 6.79% between 2011 and 2022 (ons.gov.uk, 2022). An increase of this proportion would see the approximate population living in the combined catchments increase to almost 300,000 people.

The largest population centre in the vicinity of the Duddon is Barrow-in-Furness, though only the north-west part of this conurbation is in the catchment of the Duddon Production Area (the rest falls within the Morecambe Bay catchment). On the south west of the estuary, the town of Millom, is the only other population centre that is larger than a village. The Morecambe Bay catchment is much larger than that of the Duddon, and consequently has a higher number of conurbations: Barrow-in-Furness and Ulverston on the north-west side of the bay, Morecambe on the south-east, and the towns of Kendal, Windermere and Ambleside in the upper reaches of the catchment. Figure 3.1 shows how land cover has changed within the two catchments between 2012 and 2018 (no more recent land cover data are available) and indicates that the sizes of these settlements have remained similar, although there is slightly more urban-associated land types in the upper catchments. Consultation with the LEAs for both production areas did not indicate any significant housing developments since the original sanitary surveys were published. A data search for all applications containing the word 'dwellings' was made to the Barrow Borough Council's planning portal in November 2022[3]. This search returned 96 applications that had either been approved or approved with conditions between 2022 and 2015. A search of South Lakeland Council's planning portal[4] also indicates a large number of planning applications in areas adjacent to Morecambe Bay in recent years, although the exact number is unknown. These applications will almost certainly be in response to a growing population in the area, and any increase in population would almost certainly lead to an increase in loading to the wastewater treatment network (WWTN) which, without upgrades to assets on the network, would in turn increase faecal loading to coastal waters. The greatest potential for urban runoff to the Duddon estuary remains the towns of Barrow-in-Furness and Millom, and similarly the greatest risk to Morecambe Bay remains Barrow-in-Furness, Ulverston and Morecambe. This is due to the size of these conurbations and also their proximity to the Classification Zones of the respective BMPAs.

[3] Barrow Borough Council Planning Hub. Available at: https://webapps.barrowbc.gov.uk/webapps/f?p=BARROWPLANNINGHUB:HOME:6971227030970::NO:

[4] South Lakeland Council Planning Hub. Available at: https://my.southlakeland.gov.uk/mysouthlakeland.aspx.

Approximately 35% of both catchments (considered collectively) falls within the Lake District National Park (similarly 37% of the area of this Park is within the two catchments), and the Morecambe Bay sanitary survey reported that there were 14.8 million visitors to the National Park in 2012. More recent (2018) estimates put this at 19.38 million visitors (Lake District National Park, 2022). It is likely that the numbers of tourists (and the associated faecal loading) in the area will be greatest in summer months, although No information was received during initial consultation to suggest the existing capacity of the network is not sufficient to handle this increase.

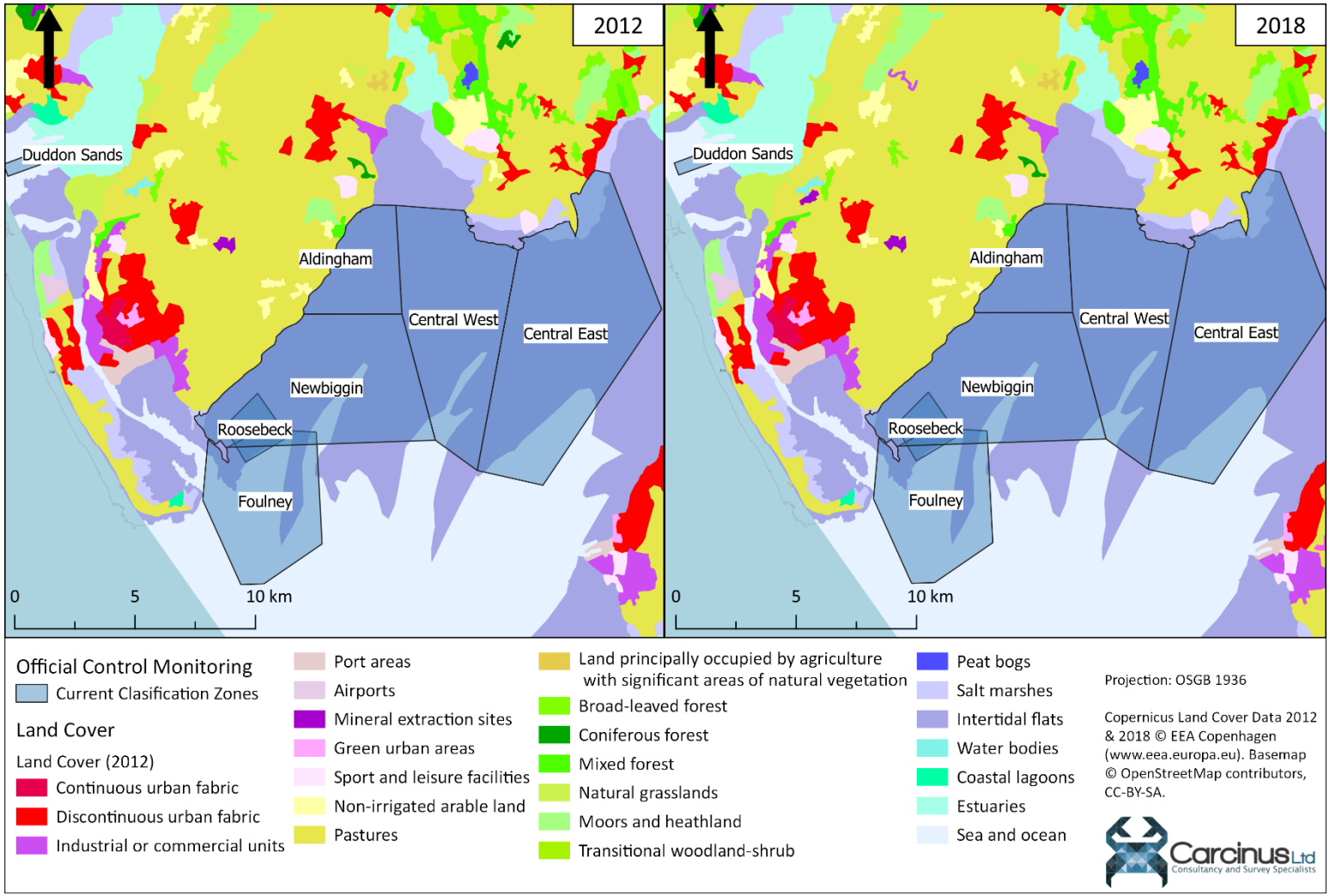

Figure 3.1 Land cover change around the Duddon Estuary and Morecambe Bay between 2012 and 2018.

No updated census information is available to the authors of this report, although it is likely that the resident and seasonal population of the catchment has increased slightly since the original sanitary survey was published. However, the size of the main urban centres has not increased significantly since the original sanitary survey and as such the recommendations made in the original sanitary survey to account for the risk urban runoff remain valid.

3.2 Sewage

Details of all consented discharges in the catchments for both Morecambe Bay and the Duddon Estuary were taken from the most recent update to the Environment Agency's national permit database at the time of this report (October 2022). The locations of those discharges closest to the Classification Zones of Morecambe Bay and the Duddon Estuary are shown in Figure 3.2. Continuous discharges in the entire catchment are summarised in Table 3.1.

Table 3.1 Continuous discharges within the catchments of the Morecambe Bay and Duddon Estuary BMPAs.

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
1	NEWBIGGIN (LEVEN) WWTW NEWBG	17370051	SD 26750 68940	UV DISINFECTION	710	2.366588
2	WAINGATE BRIDGE STW	17470052	SD 15790 79520	BIOLOGICAL FILTRATION	Unspecified	3.311094
3	ROANHEAD STW	17470019	SD 20070 75550	BIOLOGICAL FILTRATION	Unspecified	3.894751
4	MILLOM WASTEWATER TREATMENT WORKS	17470048	SD 19263 79298	UV DISINFECTION	2799	4.302322
5	ULVERSTON WWTW	17370179	SD 31430 77300	UV DISINFECTION	9315	5.227729
6	ASKHAM-IN-FURNESS WWTW ASKAM	17470136	SD 21180 78600	UV DISINFECTION	1036	5.477974
7	GRANGE OVER SANDS WWTW GRNGS	17370128	SD 39250 75060	UV DISINFECTION	3462	5.622911
8	GREENSCOE STW	17470018	SD 22030 76590	BIOLOGICAL FILTRATION	Unspecified	5.804203

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
9	ROA ISLAND WASTEWATER TREATMENT WKS	17470160	SD 23180 64600	BIOLOGICAL FILTRATION	38	5.855292
10	SILECROFT WWTW	EPRBP3620XR	SD 13860 81650	PACKAGE TREATMENT PLANT	57	5.911089
11	LOPPERGARTH STW	17370042	SD 26330 77310	BIOLOGICAL FILTRATION	Unspecified	6.206532
12	MARTON LAKE ENDS STW	17380239	SD 24200 76900	BIOLOGICAL FILTRATION	Unspecified	7.389645
13	MARTON STW	17470045	SD 24250 76970	BIOLOGICAL FILTRATION	25	7.394863
14	SOUTERGATE WWTW SOUTE SOUTE	17470020	SD 22050 81370	UV DISINFECTION	1112	7.754228
15	BARROW-IN-FURNESS WWTW	17470166	SD 20190 66600	UV DISINFECTION	27500	8.239319
16	THE GREEN (MILL PARK)STW	17470021	SD 17940 84580	BIOLOGICAL FILTRATION	Unspecified	8.514124
17	ARRAD FOOT STW	17370040	SD 30890 80890	UNSPECIFIED	Unspecified	8.659222
18	CARNFORTH WWTW	17370081	SD 48340 70780	UV DISINFECTION	5260	9.459855
19	BROUGHTON BECK STW	17370041	SD 28690 82060	BIOLOGICAL FILTRATION	Unspecified	9.863232
20	SKELLOW CRAG END	17470181	SD 20940 85060	UNSPECIFIED	Unspecified	9.997773
21	MORECAMBE WWTW	17280350	SD 38400 58350	UV DISINFECTION	13820	11.11462

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
22	NETHER KELLET WTW NETHK	17370074	SD 50180 68160	BIOLOGICAL FILTRATION	173	11.27944
23	BROUGHTON-IN-FURNESS WWTW	17470187	SD 20300 86810	BIOLOGICAL FILTRATION	799	11.32676
24	HALTON WEST LUNE WWTW	17270003	SD 49335 64438	BIOLOGICAL FILTRATION	330	11.50809
25	LINDALE WASTEWATER TREATMENT WORKS	17370073	SD 42330 80670	BIOLOGICAL FILTRATION	763	11.71829
26	FIELD BROUGHTON STW	17370046	SD 38550 81170	UNSPECIFIED	Unspecified	11.7363
27	MIDDLETON OVERTON WWTW MIDDL	17270051	SD 43040 57960	OXIDATION DITCH	1359	12.18706
28	HALTON EAST STW	17270002	SD 50530 64610	BIOLOGICAL FILTRATION	292	12.52764
29	LANCASTER WWTW LANCA	17270050	SD 45700 58710	UV DISINFECTION	38731	12.67092
30	OVER KELLET WWTW	17370075	SD 51640 70240	BIOLOGICAL FILTRATION	208	12.69132
31	HIGH NEWTON STW	17370047	SD 39880 82900	BIOLOGICAL FILTRATION	Unspecified	13.48931
32	AYSIDE STW	17370044	SD 38990 83620	BIOLOGICAL FILTRATION	Unspecified	14.17936
33	CATON WASTEWATER TREATMENT WORKS	17270001	SD 52770 65250	BIOLOGICAL FILTRATION	Unspecified	14.42113
34	HAVERTHWAITE STW	17370080	SD 33990 83320	BIOLOGICAL FILTRATION	Unspecified	14.74894

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
35	BEETHAM STW	17370064	SD 49670 80000	BIOLOGICAL FILTRATION	Unspecified	15.02906
36	CRAKE VALLEY WWTW	EPRFP3828GS	SD 31420 82890	BIOLOGICAL FILTRATION	151	15.4286
37	MILNTHORPE STW	17370083	SD 48780 81570	ACTIVATED SLUDGE	2071	15.5965
38	HOLME WWTW	17370138	SD 51719 78504	BIOLOGICAL FILTRATION	1018	15.6384
39	BOUTH STW	17370033	SD 32900 85070	BIOLOGICAL FILTRATION	Unspecified	16.77081
40	SPARK BRIDGE WWTW	17380262	SD 30810 84560	BIOLOGICAL FILTRATION	80	17.18625
41	CLAUGHTON STW	17270010	SD 56440 66820	BIOLOGICAL FILTRATION	Unspecified	17.66458
42	FARLETON STW	17270011	SD 57230 67080	BIOLOGICAL FILTRATION	Unspecified	18.41123
43	LOWICK GREEN NO1 STW	17370036	SD 29890 85660	UNSPECIFIED	Unspecified	18.59406
44	COCKERHAM STW	17260072	SD 45200 51400	BIOLOGICAL FILTRATION	72	19.09496
45	OXEN PARK STW	17380241	SD 31700 87100	BIOLOGICAL FILTRATION	Unspecified	19.10239
46	HUTTON ROOF STW	17370069	SD 57030 77860	PACKAGE TREATMENT PLANT	27	19.92385
47	CROOKLANDS STW	17370066	SD 53480 83540	BIOLOGICAL FILTRATION	Unspecified	20.22995

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
48	FORTON STW	17260052	SD 49820 52250	SAND FILTRATION	390	20.33554
49	PILLING WASTEWATER TREATMENT WORKS	17260137	SD 40580 48960	BIOLOGICAL FILTRATION	289	20.55546
50	ENDMOOR STW	17370067	SD 54170 84640	BIOLOGICAL FILTRATION	Unspecified	21.49409
51	WINDERMERE WWTW	17370032	SD 38464 91360	UV DISINFECTION	5559	21.92811
52	BRIGSTEER STW	17370062	SD 47850 89590	BIOLOGICAL FILTRATION	Unspecified	22.01937
53	WHITTINGTON STW	17270101	SD 60920 75560	BIOLOGICAL FILTRATION	Unspecified	22.7862
54	LOW PARK STW	17370070	SD 54620 86630	BIOLOGICAL FILTRATION	Unspecified	23.24569
55	SATTERTHWAITE STW	17370034	SD 33550 92350	BIOLOGICAL FILTRATION	Unspecified	23.54699
56	UNDERBARROW(HILL GARTH)STW	17370063	SD 46420 92090	BIOLOGICAL FILTRATION	Unspecified	23.84439
57	KIRKBY LONSDALE STW	17270006	SD 61520 77880	BIOLOGICAL FILTRATION	Unspecified	24.07694
58	KENDAL WASTEWATER TREATMENT WORKS	17370100	SD 51551 90761	CHEMICAL - PHOSPHATE STRIPPING	16000	24.75608
59	CASTERTON WWTW	17270014	SD 61750 79560	BIOLOGICAL FILTRATION	80	24.92617
60	FAR SAWREY STW	17370025	SD 37860 94720	BIOLOGICAL FILTRATION	Unspecified	25.30798

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
61	ST JOHN'S VIEW STW	17370071	SD 55620 88520	BIOLOGICAL FILTRATION	Unspecified	25.32289
62	NEAR SAWREY WWTW NEARS	17370030	SD 36600 95110	UV DISINFECTION	79	25.78335
63	FERRY HOUSE WWTW	17390102	SD 39020 95590	BIOLOGICAL FILTRATION	25	26.15362
64	TORVER STW	17370039	SD 28260 93960	BIOLOGICAL FILTRATION	16	26.76426
65	HAWKSHEAD STW	17370028	SD 35767 97609	BIOLOGICAL FILTRATION	368	28.35577
66	CONISTON WWTW	17370035	SD 30680 97110	BIOLOGICAL FILTRATION	542	28.89211
67	BOWSTON STW	17370057	SD 49950 96510	BIOLOGICAL FILTRATION	Unspecified	29.21431
68	STAVELEY WWTW	17370061	SD 48300 98030	BIOLOGICAL FILTRATION	754	30.07677
69	OUTGATE WASTEWATER TREATMENT WORKS	17370031	SD 35683 99826	BIOLOGICAL FILTRATION	13	30.56924
70	GRAYRIGG STW	17370058	SD 57590 96830	BIOLOGICAL FILTRATION	Unspecified	33.12257
71	TROUTBECK WWTW	17390292	NY 41130 03110	BIOLOGICAL FILTRATION	17	33.74502
72	AMBLESIDE WWTW	17370024	NY 37210 03950	UV DISINFECTION	1843	34.56178
73	LANGDALE WASTEWATER TREATMENT WORKS	17380300	NY 33820 03680	CHEMICAL & BIOLOGICAL	Unspecified	34.63285

ID	Discharge Name	Permit Number	NGR	Treatment	Dry Weather Flow	Distance to nearest CZ (km)
74	GRASMERE WWTW	17370027	NY 33920 06840	CHEMICAL - PHOSPHATE STRIPPING	4409	37.74807

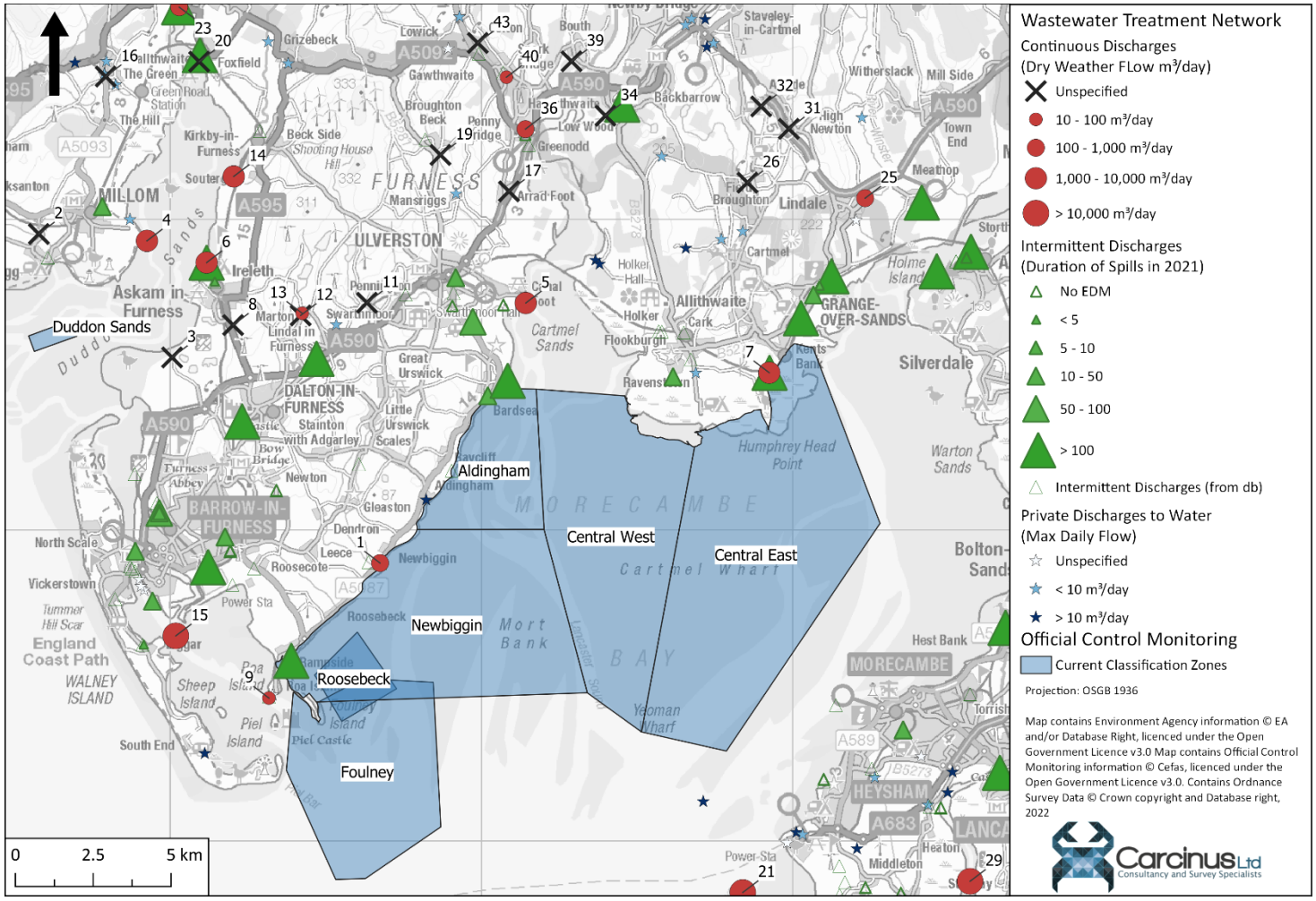

Figure 3.2 Locations of all consented discharges in the vicinity of the Morecambe BMPA. Labels refer to continuous discharges, details of which can be found in Table 3.1.

The 2014 sanitary survey of Morecambe Bay (Appendix II) identified a total of 52 continuous water company discharges within the catchment). It identified that eight of these discharged to saline waters (i.e., those closest to CZs) and that the largest volume of discharge originated from the Barrow STW, but the use of UV disinfection meant that the overall bacteriological contamination was small. During initial consultations, the EA stated that no upgrades to water company assets in the area had occurred since 2013, meaning that no changes to the continuous discharges have occurred since the original sanitary survey was published. In addition to Barrow STW (No. 15 in Table 3.1), Roa Island WWTW (No. 9), Newbiggin (Leven) WWTW (No. 1), Ulverston WWTW (No. 5) and Grange-over-sand WWTW (No. 7) are the most relevant discharges to the bacteriological health of the BMPA given their proximity (within 5km). No changes to the consented discharge volumes from these discharges have occurred and so the risk they pose to the bacteriological health of the Morecambe Bay BMPA remains unchanged.

The 2014 sanitary survey of the Duddon identified a much smaller number of continuous water company discharges, only 11 (Appendix II). This is mainly due to the much smaller catchment of the BMPA. It identified that the three largest sewage works all provided effective UV disinfection. All continuous discharges in the area are located at least 4 km upstream of the only CZ in the BMPA, and whilst some contamination will be carried over the bed on an ebbing tide, a degree die off will occur. It should be noted that the Bank House Kirkby discharge is no longer in use, although this was adjudged to have minimal impact. No changes to any of the other discharges have occurred since the original sanitary survey was published, and so the risk they pose is also unchanged. The most significant discharges in terms of the contamination they cause are likely to be Millom STW (No. 4) and Askham-in-Furness WWTW (No. 6), located 4.3 and 5.4 km from the *Duddon Sands* CZ respectively.

In addition to the continuous discharges, the original sanitary survey of Morecambe Bay identified a significant number of intermittent discharges in the catchment draining to the BMPA. Intermittent discharges comprise Combined Storm Overflows (CSOs), Storm Tank Overflows (STOs) and Pumping Station Emergency Overflows (PSs). During AMP6 and AMP7, Event Duration Monitoring (EDM) was installed at several of the discharges within the catchment, and summary data for 2020 was published by the Environment Agency in March 2021 and for 2021 in March 2022 (Environment Agency, 2022). Details of the EDM data from 2021 for those discharges in the catchments of Morecambe Bay and the Duddon Estuary are presented in Appendix I.

The 2014 Morecambe survey identified a total of 126 intermittent discharges, and presented EDM data for 38 of these. Intermittent discharges near to or within Classification Zones represent the greatest risk to the bacteriological health of a shellfishery, as discharges are often untreated when they do occur. There are several intermittent discharges with EDM data reported in the original sanitary survey, and the 2020 and 2021 reporting years. The data suggest that spill events are occurring more frequently in general, and so

additional consideration should be given to the presence of intermittent discharges within or near to a CZ, particularly as the EA stated that no upgrades to storage capacity or treatment have occurred, or are planned for any of the assets in the area. Discharges that have spilled more frequently include the Rampside Pumping Station, near the *Newbiggin* CZ, Cooper Lane Pumping Station near the *Aldingham* CZ, and the Grange-over-Sands WWTW near the *Central East* CZ. During initial consultations, the LEA advised there have been reported high levels (i.e., high frequency) of wastewater outflows from the River Duddon, River Leven (from Lake Windermere) and from Walney. This would support the finding that intermittent discharges are spilling more frequently and should be given additional weighting. Outflows from the Duddon would impact the *Duddon Estuary* CZ, outflows from the Leven would primarily impact the *Aldingham* and *Central West* CZs and outflows from the Walney would primarily impact the *Foulney* mussel CZ, *Newbiggin* cockle CZ and *Roosebeck* Pacific oyster CZ. However, the EA stated during secondary consultation that all the Bathing Waters in Windermere and Walney were classified as excellent in the latest annual classifications (Environment Agency, 2023).

The 2014 Duddon survey only presents EDM data for two assets, and comparison of this data with that from 2020 and 2021 suggests that assets are spilling less frequently. It should also be noted that, like the continuous discharges, there are none within 4 km of the mussel? CZ and so any impacts will be mitigated to a degree by die off/dilution of FIOs in the water column.

In addition to the water company owned discharges, the original sanitary survey identified a large number of private sewage discharges within the catchment (315 in the Morecambe Bay catchment, 8 in the Duddon catchment), although most were small, spilling less than 10 m^3/day, and discharged to watercourses throughout the catchment. Many such discharges remain (Figure 3.2), although those in the direct vicinity of the BMPAs continue to be small and so do not require additional consideration within the sampling plan as the water company owned discharges will be of much greater significance. Limited information about the specific details (location and discharge volumes) of private discharges can be provided due to data protection requirements.

No upgrades to water company assets in the catchments of Morecambe Bay and the Duddon estuary have occurred since 2013, and none are planned for the near future. The consented discharge volumes remain the same. Comparison of EDM data suggests that spills from intermittent discharges in the immediate vicinity of CZs within the Morecambe BMPA are occurring more frequently, although the opposite is true for assets in the Duddon BMPA. Additional consideration should therefore be given to the presence of an intermittent discharges when determining any new sampling plan.

3.3 Agricultural Sources

The 2014 sanitary survey of Morecambe presented livestock population information based on the 2013 livestock census of Morecambe Bay and Duddon estuary sub-catchments, with the 2014 survey of the Duddon citing the results of the 2010 livestock census for the

catchment. Livestock data of the same spatial scale was not freely available to the authors of this review, and so a data request was made to the Farming Statistics Office of the Department for Environment, Food and Rural Affairs (DEFRA) for livestock populations within the catchments presented in Figure 1.1. This data was made available under the Open Government Licence v3.0. Figure 3.3 presents the changes in livestock populations within the catchments of Morecambe Bay and the Duddon between 2013 and 2021.

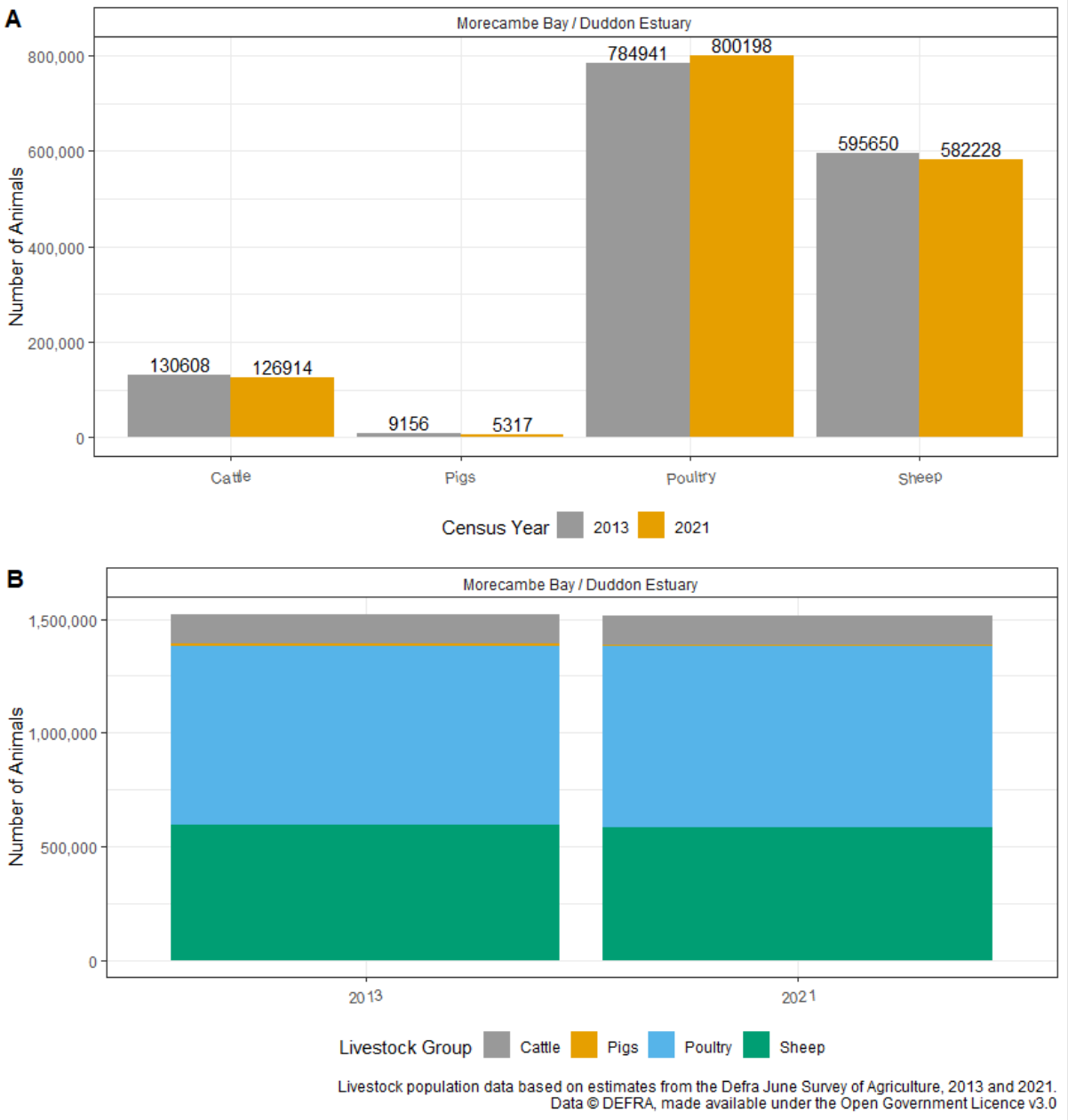

Figure 3.3 Changes in livestock populations within the Morecambe Bay / Duddon catchment. Panel A shows populations broken down by different livestock group, and panel B shows the aggregated population.

The data presented in Figure 3.3 A show that the dominant livestock group in terms of population size for both census years is poultry, followed by sheep. Pig populations are an

order of magnitude smaller than the other three groups considered. Livestock populations have remained very similar, with a slight decrease (0.38%) from 2013 to 2021. It should be noted that the June survey[5] represents a snapshot of livestock populations in a single day, but populations will vary throughout the year, with highest numbers in spring, following the birthing season, and lowest in autumn and winter when animals are sent to market.

The principal route of contamination of coastal waters by livestock is surface runoff carrying faecal matter. The land cover map presented in Figure 3.1 suggests that a significant proportion of the land cover surrounding both the Morecambe and Duddon BMPAs is reserved for pasture, as well as saltmarsh used for grazing, which would mean that runoff is a potentially significant source of contamination to this shellfishery and should be taken into consideration in any updated sampling plan. However, there has been no change in the area of these pastures, and so the risk is considered to have remained similar to the original sanitary survey. The main CZs at risk of contamination from runoff in the Morecambe Bay BMPA are the *Newbiggin* and *Aldingham* CZs. The *Duddon Sands* CZ is not at great risk of contamination from this source given it sits >1 km offshore.

Another potential route of contamination from livestock-associated factors is slurry spreading. The spreading of slurry to fields is controlled under the Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018, known as the Farming Rules for Water (FRfW), which came into force in April 2018. This legislation lays out a set of rules that require good farming practice, so that farmers manage their land both to avoid water pollution and benefit their business. Rules include requiring farmers to judge when it is best to apply fertilisers, where to store manures and how to avoid pollution from soil erosion. Furthermore, silage and slurry storage for agricultural purposes is subject to The Water Resources (Silage, Slurry and Agricultural Fuel Oil) (England) Regulations 2010 (SSAFO). All farmers must comply with the SSAFO regulations when building new slurry stores, or substantially altering (e.g. enlarging) existing ones. All stores must be built at least 10m from any watercourse, including field drains or ditches, and be built or altered to last for at least 20 years with proper maintenance. Since 2021, the EA now has ART (Agricultural Regulatory Taskforce) Officers that have all been assigned a catchment and will engage, inspect, advise and if necessary, enforce the Silage, Slurry and Agricultural Fuel Oil regulations and the new (2018) Farming Rules for Water. In theory, these legislative changes should have reduced the pollution that this activity causes to shellfish beds. During initial consultation, the EA did not indicate that there were any problems associated with slurry use in this area. During secondary consultation, the EA stated that the ART in the area has not yet had a full year in operation, but that they are aware that in many cases slurry storage is not sufficient and slurry will be spread in Autumn and Winter. The EA also noted

[5] June Survey of Agriculture and Horticulture. Further information available at: https://www.gov.uk/guidance/structure-of-the-agricultural-industry-survey-notes-and-guidance#june-survey-of-agriculture-and-horticulture-in-england.

some mis-management of farms which has been dealt with through farm action plans. The EA did not provide further details of this but did characterise it as minor.

Livestock populations, and pasture areas have remained very similar since the original sanitary surveys were published. The recommendations in those reports to account for those forms of pollution therefore remain valid.

3.4 Wildlife

Morecambe Bay, and to a lesser extent, the Duddon Estuary, contain a large variety of intertidal and coastal habitats that support a significant diversity of wildlife. The group of animals most likely to contribute notable levels of faecal contamination to the shellfishery is overwintering waterbirds (both wildfowl and waders), as they tend to forage (and therefore defecate) directly on intertidal shellfish beds.

Morecambe Bay contains the second highest over-wintering count of waterbirds (gulls, waders and waterfowl) of any bay/estuary in the UK, after the Wash. In the five winters to 2014/15, the average count of waterbirds was 240,320 (Frost *et al.*, 2016). The average count in the five winters to 2019/20 was 211,623 (Frost *et al.*, 2021), but despite this fall the Bay still contains nationally and internationally significant populations of over 25 species. The Duddon contains far fewer, but still large numbers of waterbirds, with an average of nearly 30,000 waterbirds in the five winters to 2019/20. This number is also an increase on the five winters to 2014/15 and still contains nationally significant populations. As concluded in the original sanitary surveys, waterbirds 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.

Both original sanitary surveys identify seals as another potential source of faecal contamination from wildlife. The 2021 Special Committee on Seals (SCOS) report (SCOS, 2022) identifies that the main haul out sites for grey seals in the area is on the seaward side of Walney Island. It is probable that grey seals use the waters of the BMPAs for foraging from time to time. However, this species forages over a wide area and so any faecal contamination will be highly spatially and temporally variable and would have a very minor influence on the bacteriological health of the BMPA, requiring no additional consideration in any updated sampling plan.

No other wildlife species of significance are noted.

3.5 Boats and Marinas

The discharge of sewage from boats in the vicinity of the Morecambe and Duddon BMPAs is a potentially significant source of contamination. Boating activities in the area have been derived through analysis of satellite imagery and various internet sources, and compared to that described in the original sanitary survey reports. Their geographical positions are presented in Figure 3.4.

3.5.1 Morecambe Bay

The 2014 sanitary survey of Morecambe Bay describes that, due to the shallow nature and constantly changing bathymetry of the inner reaches of Morecambe Bay, boating activities are severely restricted. As a consequence, most of the boating activity in the bay is restricted to the Walney Channel, which connects Morecambe bay to the Duddon estuary. The Port of Barrow is located within the Walney Channel, and handles 110,000 tonnes of freight annually and can receive vessels of up to 150 m Length Overall (LOA) (Associated British Ports, 2022). The commercial shipping Port of Heysham is located on the eastern side of Morecambe bay, which acts as a significant ferry terminal connecting the north-west of England with the Isle of Mann and Ireland. The legislation governing the discharge of sewage from commercial vessels has not changed since the original sanitary survey was published, as vessels of this type are still prohibited from making overboard discharges within three nautical miles of land[6]. Parts of the CZs within the Morecambe Bay BMPA are not within 3 nm of land, although as the shipping channel does not pass over these zones, there are not expected to be any impacts from commercial vessels on the bacteriological health of this BMPA.

There is a small fishing fleet that operates in Morecambe Bay, with 13 vessels of <10 m listing the Port of Barrow as their home port (no vessels >10 m) (gov.uk, 2022). Some discharges from these vessels are to be expected, although as described in the original sanitary survey, most are probably too small to contain onboard toilets.

Satellite imagery suggests that there are a few sailing clubs and free swinging moorings throughout the study area. Vessels of a sufficient size to contain on board toilets are likely to make occasional overboard discharges, particularly when moored at night (away from marina/harbour settings as this is considered unsociable) or moving through the main navigational channels. As a result of this, the main area at risk from this source of pollution is likely to be the Walney Channel, and the peak time the summer months, although without firm information as to the precise timing, nature and extent of any discharges it is difficult to define RMPs that would reliably capture this form of pollution.

[6] The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008.

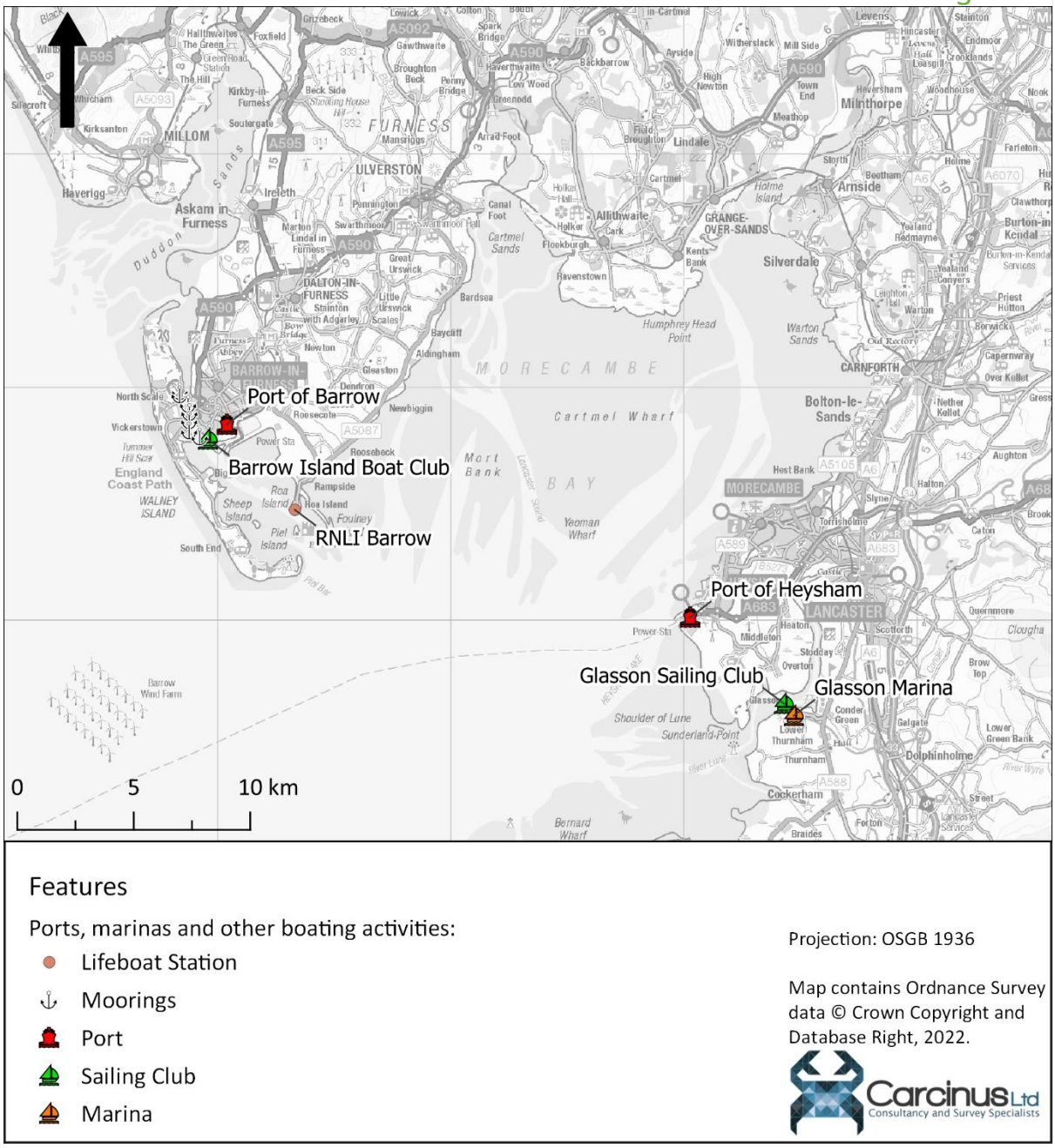

Figure 3.4 Locations of moorings, marinas and other boating activities in the vicinity of Morecambe Bay and the Duddon estuary.

3.5.2 Duddon Estuary

The 2014 sanitary survey of the Duddon describes that there are no commercial ports within the estuary itself, the closest is the Port of Barrow, situated within the Walney Channel (approx. 15 km away), as described in the previous section. Satellite imagery suggests that there are some moorings and so there may be some recreational boat traffic originating from the Walney Channel. However, the risk of pollution from boats in the Duddon estuary is considered to be minimal, given the restricted water depths available in the estuary.

There may be some contamination carried from the Walney Channel on an ebbing tide, and so the hotspot of contamination (albeit minor) is likely to be at the mouth of the channel.

There is no evidence that boating activities in both Morecambe Bay and the Duddon Channel have changed significantly since the original sanitary surveys were published. The recommendations given in the original reports to account for this source of pollution remain valid.

3.6 Other Sources of Contamination

3.6.1 Morecambe Bay

Urban fabric around Morecambe bay remains the towns of Barrow-in-Furness on the western side of the bay, Ulverston on the north-west side of the bay, Morecambe on the south-east, and the towns of Kendal, Windermere and Ambleside in the upper reaches of the catchment. The only urban fabric immediately adjacent to a classification zone is Grange-over-Sands, near the *Central East* zone. Therefore, limited impact of contamination from any utility misconnections and/or urban runoff is expected, though this is no change from the situation described in the original sanitary survey. It is likely that some dog walking takes place along the shoreline, and so some minor diffuse impact from dog waste is expected.

3.6.2 Duddon Estuary

Urban fabric around the Duddon is even more limited than around Morecambe Bay, with the only real conurbations Millom on the north-west side of the estuary, Askam-in-Furness on the south-east side and Broughton-in-Furness at the head of the estuary. The only active classification zone in the Duddon BMPA is not situated adjacent to the shoreline, and so limited connectivity with any urban run-off or potential misconnections is expected.

Overall, the risk from these sources of contamination is considered to be similar to that described in the original sanitary survey and no update to the sampling plan is required on this basis.

4 Hydrodynamics/Water Circulation

4.1 Morecambe Bay

The 2014 sanitary survey describes that Morecambe Bay consists of an extensive area of constantly shifting intertidal sandflats, interspersed by inter- and subtidal drainage channels. The main freshwater inputs to the bay are the Leven and Kent estuaries at the northern end of the Bay. Shoreline sources of contamination will therefore be generally carried in a southerly / south-westerly direction on an ebbing tide, and northerly / north-easterly on a flood tide. Whilst the sandbanks and drainage channels are constantly shifting, the overall pattern of water movement will remain similar. Where contamination events occur on intertidal areas, dilution may be minimal until the next flood tide, but contamination will generally be carried a significant distance, mainly down the significant drainage channels, given the volume of water that moves in and out of the bay during each tidal cycle. This will impact all CZs in the BMPA as all are situated on intertidal sandbanks.

The recommendations given in the original sanitary survey to account for the patterns of circulation in the bay remain valid.

4.2 Duddon Estuary

The Duddon Estuary is broadly intertidal along its entire length, with only a small river channel remaining at low water. The estuary generally follows a south-westerly / north-easterly axis, and so contamination will be carried out in in a south-westerly direction on the ebb tide, and the reverse direction on a flood tide. There are some small drainage channels along the estuary length, although the precise position of these will be constantly changing. The only CZ in the estuary is positioned near its mouth, and so will receive contamination from upstream sources, as well as from the Walney channel that connects the estuary to Morecambe Bay. Following secondary consultation, no information was received on the location of other species in the area, so an assessment of the impact of hydronamics/water circulation on contamination of other species is not possible.

There is no evidence that the patterns of water circulation within the estuary will have changed since the original sanitary survey, and so the recommendations for the sampling location given in the original sanitary survey to account for the patterns of circulation in the bay remain valid.

5 Rainfall

Rainfall data for the Palace Nook TEL (telemetry) monitoring station (#588886) (NGR: SD 191 718) were requested from the Environment Agency for the period 2011 – present. This station was chosen as it was considered to represent both BMPAs given its geographical position near the town of Barrow-in-Furness. These data were subdivided into 2011 – 2014 (pre sanitary survey) and 2015 – 2022 (post sanitary survey) and processed in R (R Core Team, 2021). These data were used to determine whether any changes in rainfall patterns had occurred since the original sanitary surveys were published. Table 5.1 provides summary statistics for rainfall preceding and following the original sanitary surveys, and Figure 5.1 shows the mean daily rainfall per month for the periods preceding and following the publication of the original sanitary surveys.

Table 5.1 Summary statistics for rainfall for the period preceding and following the original sanitary survey from the Palace Nook TEL monitoring station.

Period	Mean Annual Rainfall (mm)	Percentage Dry Days	Percentage Days Exceeding 10 mm	Percentage Days Exceeding 20 mm
2011 - 2014	1073.98	39.22	34.98	22.45
2015 - 2022	952.33	41.11	31.99	20.40

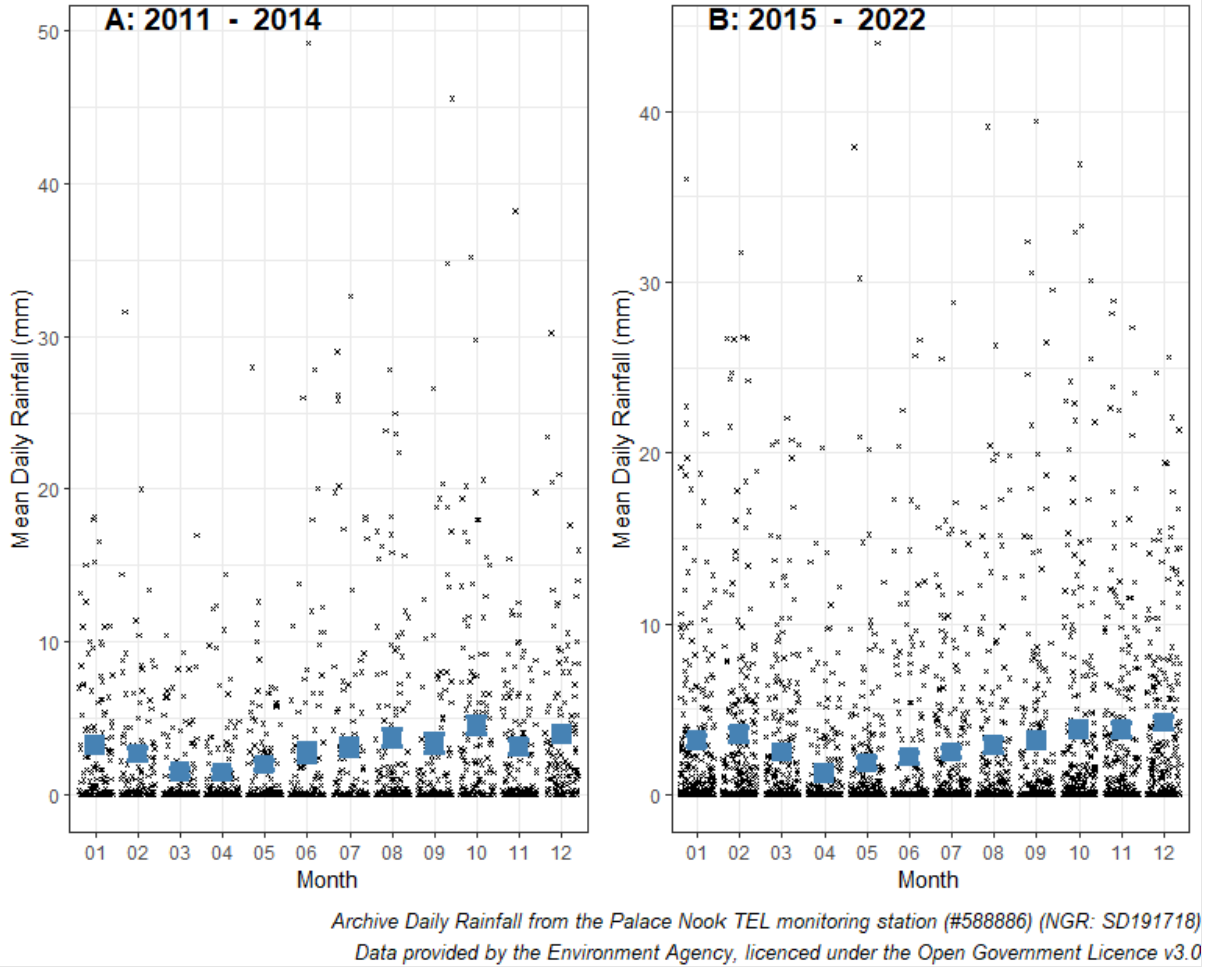

Figure 5.1 Mean daily rainfall per month for the Palace Nook TEL monitoring station (NGR: SD191718) for the periods (A) 2011 – 2014 and (B) 2015 – 2022.

These data show that rainfall in the vicinity of the BMPAs has reduced since the original surveys were published, with the total annual rainfall falling, percentage of dry days increasing and the percentage of days with heavy rain (>10 mm) falling. Two-sample t-tests indicated that there was no significant difference ($p>0.05$) in the mean daily rainfall per month for the 2011 – 2014 and 2015 – 2022 periods.

Rainfall leads to increased faecal loading through two factors, elevated levels of surface runoff and spill events from intermittent discharges, particularly during periods of heavy (>10 mm/day) or extremely heavy (>20 mm/day) rain. Rainfall levels during both periods were greatest in winter months (November – February), and so the levels of runoff etc. would be expected to be greatest during this time. However, as the rainfall patterns have remained (statistically) similar across the two time periods, significantly altered bacterial loading due to these factors is unlikely and as such RMP recommendations made in the original sanitary surveys to capture the influence of runoff and spill events remain valid.

6 Microbial Monitoring Results

6.1 Summary Statistics and geographical variation

The mean results of Official Control Monitoring for *E. coli* concentrations at all RMPs sampled in Morecambe Bay and the Duddon estuary since the original sanitary surveys were published are presented in Figure 6.1 and summary statistics are presented in Table 6.1.

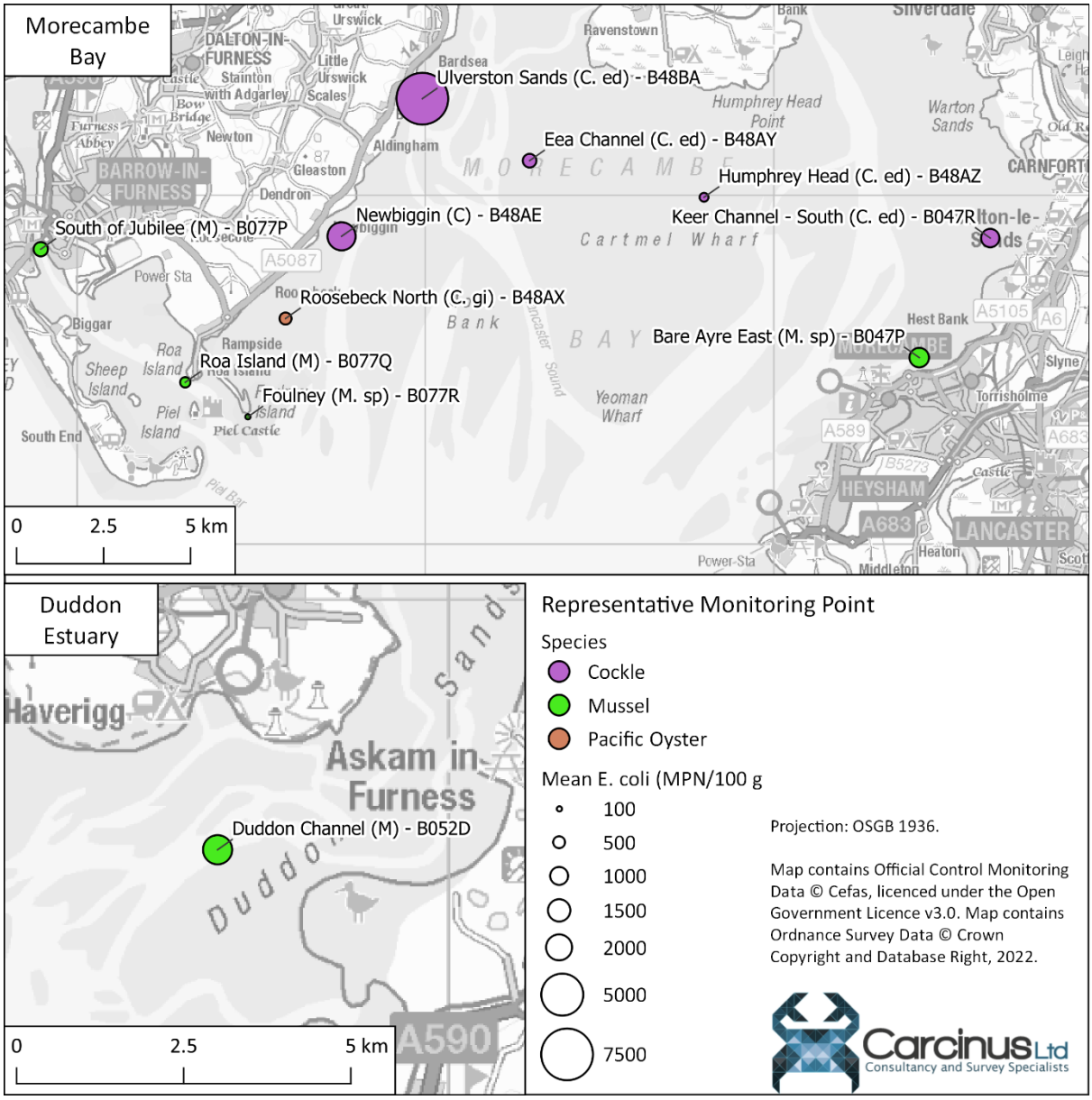

Figure 6.1 Mean E. coli results from Official Control Monitoring at bivalve RMPs in Morecambe Bay and the Duddon Estuary.

Table 6.1 Summary statistics of Official Control Monitoring for E. coli concentrations (MPN/100 g) at bivalve RMPs sampled since 2005 in the Morecambe Bay and Duddon Channel BMPAs. Data has been cut off at September 2022. Active RMPs are highlighted in yellow.

RMP (Species)	NGR	Species	No.	First Sample	Last Sample	Mean Value	Min Value	Max Value	% > 230	% > 4,600	% > 46,000
Morecambe Bay - East											
Bare Ayre East (M. sp) - B047P	SD44196535	Mussel	21	26/09/2016	26/02/2020	1165.619	78	7900	85.71	4.76	0.00
Keer Channel - South (C. ed) - B047R	SD46236878	Cockle	10	19/11/2019	23/06/2020	1046	130	3300	80.00	0.00	0.00
Morecambe Bay – Barrow											
South of Jubilee (M) – B077P	SD18966846	Mussel	17	19/08/2015	25/04/2017	669.3529	18	4900	64.71	5.88	0.00
Roa Island (M) – B077Q	SD23116464	Mussel	18	21/07/2015	02/05/2018	412.7222	18	3300	33.33	0.00	0.00
Foulney (M. sp) – B077R	SD24916365	Mussel	84	21/07/2015	14/09/2022	257.6905	18	2300	26.19	0.00	0.00
Morecambe Bay - Roosebeck											
Newbiggin (C) - B48AE	SD27606883	Cockle	108	05/10/2005	08/08/2022	2324.667	20	180000	55.56	1.85	0.93
Roosebeck North (C. gi) - B48AX	SD25996647	Pacific Oyster	86	21/07/2015	14/09/2022	509.5814	18	17000	32.56	1.16	0.00

RMP (Species)	NGR	Species	No.	First Sample	Last Sample	Mean Value	Min Value	Max Value	% > 230	% > 4,600	% > 46,000
Eea Channel (C. ed) – B48AY	SD33007100	Cockle	76	11/02/2016	08/08/2022	620.7895	18	7900	43.42	1.32	0.00
Humphrey Head (C. ed) - B48AZ	SD38016995	Cockle	78	11/02/2016	08/08/2022	341.859	18	3300	29.49	0.00	0.00
Ulverston Sands (C. ed) - B48BA	SD29927278	Cockle	29	05/08/2020	09/05/2022	7416.379	18	180000	65.52	13.79	3.45
				Duddon Estuary							
Duddon Channel (M) - B052D	SD16557625	Mussel	46	29/01/2014	14/09/2022	2504.087	78	54000	73.91	8.70	2.17

The data presented above have been taken directly from the Cefas datahub[1] and have been taken at face value. The datahub only presents data from RMPs where a sample has been taken in the last five years. Since the original sanitary surveys in 2014, Official Control monitoring samples have been taken from 10 RMPs in the Morecambe Bay BMPA and 1 in the Duddon Estuary BMPA. Of these, only one (Newbiggin (B48AE)) was sampled prior to the publication of the original sanitary surveys. Sampling at most of the others began in late 2015 or 2016, except for Ulverston Sands (B48BA) and Keer Channel - South (B047R) which began in 2020 and 2019 respectively. Four of the RMPs are not currently sampled: the two RMPs in the Walney Channel (South of Jubilee B077P and Roa Island B077Q) have not been sampled since 2018, and two RMPs on the eastern side (Keer Channel South B047R and Bare Ayre East B047P) have not been sampled since 2020. In all cases this was due to declassification and/or a lack of stock. The *Aldingham* CZ, which is classified based on samples from the Ulverston Sands B48BA) RMP, is currently prohibited. This occurred in December 2020 and the last sample from this RMP was collected in May 2022. During secondary consultation, South Lakeland council confirmed there was no commercial interest in this zone.

Generally, RMPs located farther up the bay and closer to shore have returned higher mean results, with the Ulverston Sands (B48BA) RMP having returned nearly 15% of its results above 4,600 MPN/100 g. Generally cockle RMPs have returned higher results than RMPs of other species, although as there are no instances of an RMP being collocated for more than one species, this is more likely a feature of contamination sources affecting a certain zone rather than anything else.

Figure 6.2 - Figure 6.4 present boxplots of *E. coli* monitoring results from the various mussel and cockle RMPs, respectively. One-way analyses of variance (ANOVA) tests were performed on the data to investigate the statistical significance of any differences between the monitoring results from the various RMPs. Comparisons are only appropriate between RMPs using the same species due to the differences in *E. coli* uptake between different species. Significance has been taken at the 0.05 level. All statistical analysis described in this section was undertaken in R ((R Core Team, 2021).

The median *E. coli* concentration at the Keer Channel (B047R) (declassified at the time of this report) is the highest of any cockle RMP (Figure 6.2). The Newbiggin (B48AE) and Ulverston Sands (B48BA) (prohibited) RMPs have returned the highest maximum value, even excluding the outlier samples at both RMPs. However, no significant differences were found in the data ($p > 0.05$).

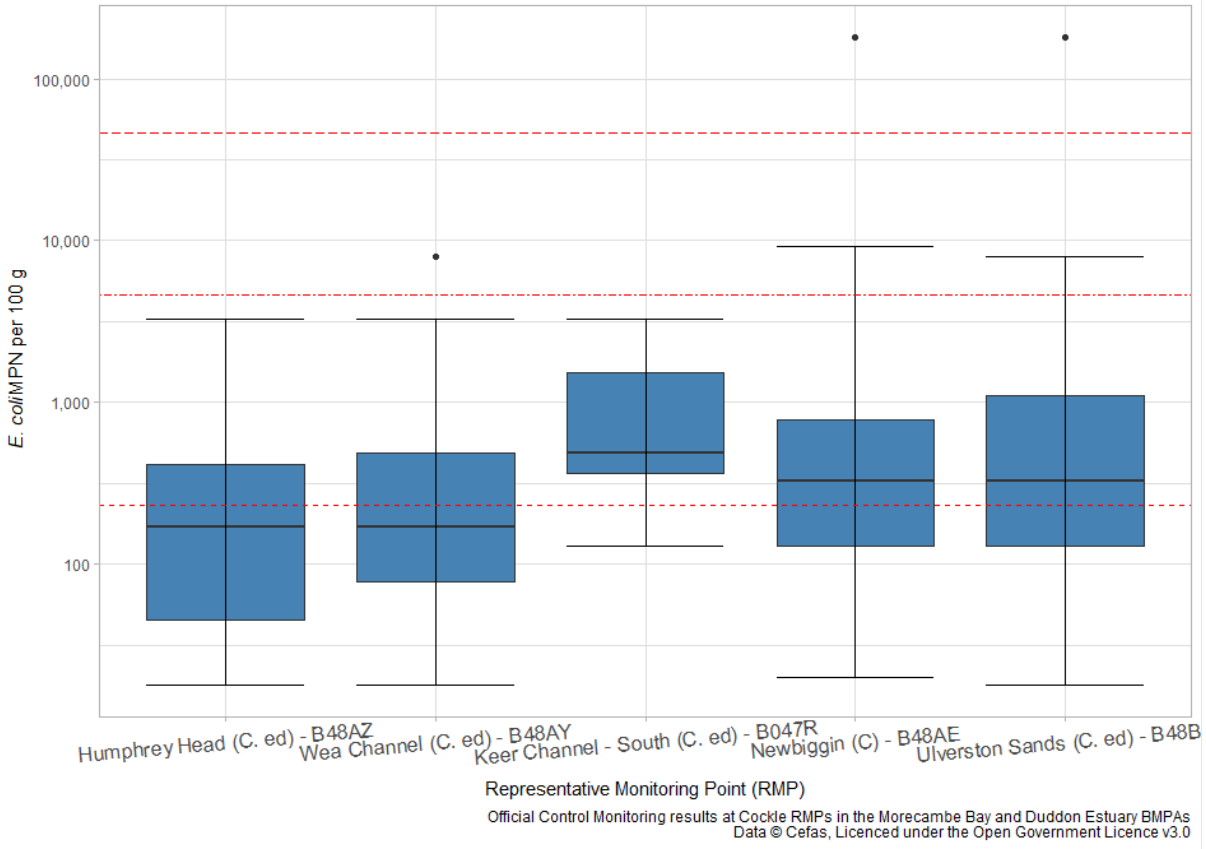

Figure 6.2 Boxplots of E. coli concentrations at cockle RMPs in the Morecambe and Duddon BMPAs since 2015. Central line indicates median value, box indicates lower-upper quartile range and whisker indicates minimum/maximum values, excluding outliers (points >1.5 x the interquartile range). Vertical dashed lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

Bare Ayre East (B047P) has the highest median value of any mussel RMP in either BMPA (Figure 6.3), although the Duddon Channel (B052D) RMP has a slightly higher maximum value. No significant differences were found in the data ($p > 0.05$).

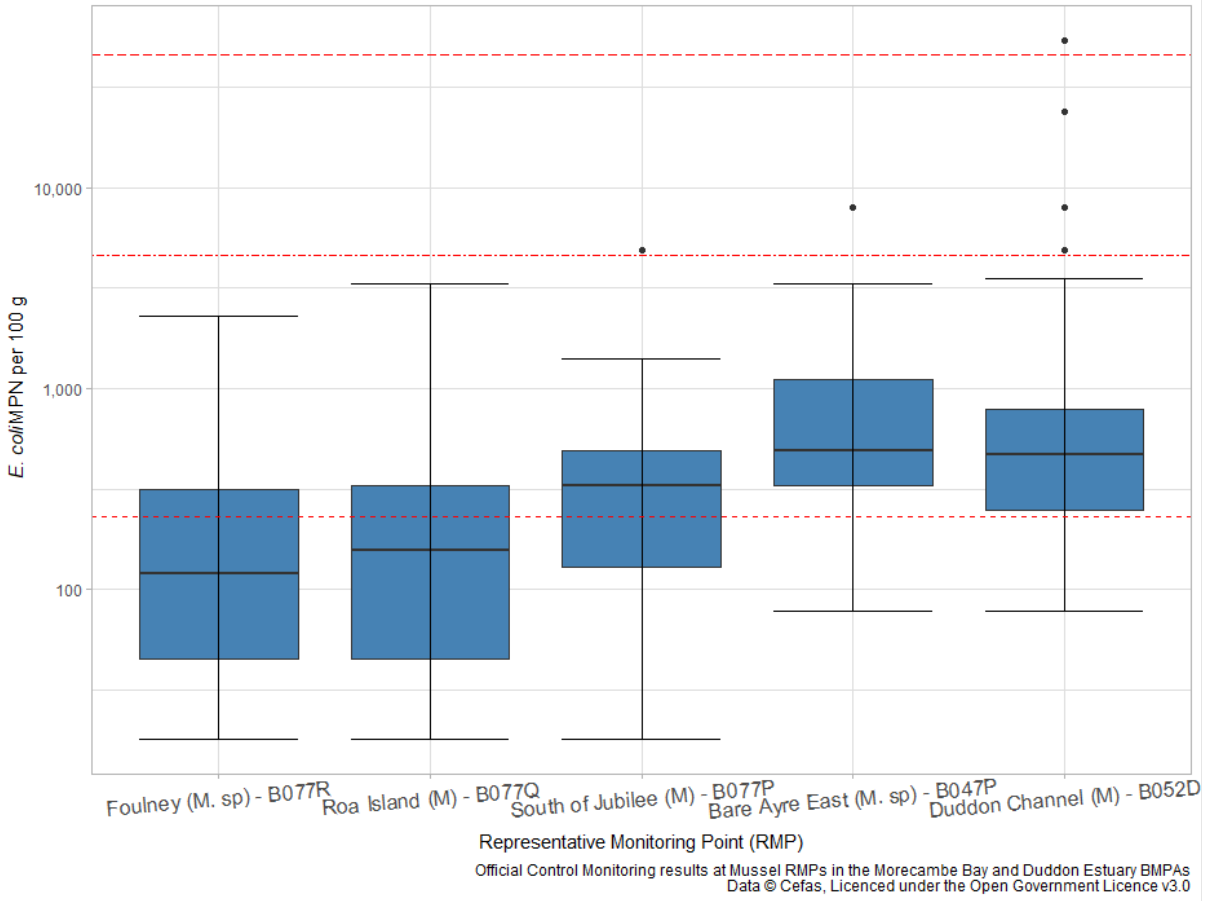

Figure 6.3 Boxplots of E. coli concentrations at mussel RMPs in the Morecambe and Duddon BMPAs since 2015. Central line indicates median value, box indicates lower-upper quartile range and whisker indicates minimum/maximum values, excluding outliers (points >1.5 x the interquartile range). Vertical dashed lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

No comparison of Pacific oyster monitoring results is possible as there is only one RMP for this species (Roosebeck North B48AX), and it is inappropriate to compare between different species due to the differences in rates of *E. coli* uptake and clearance.

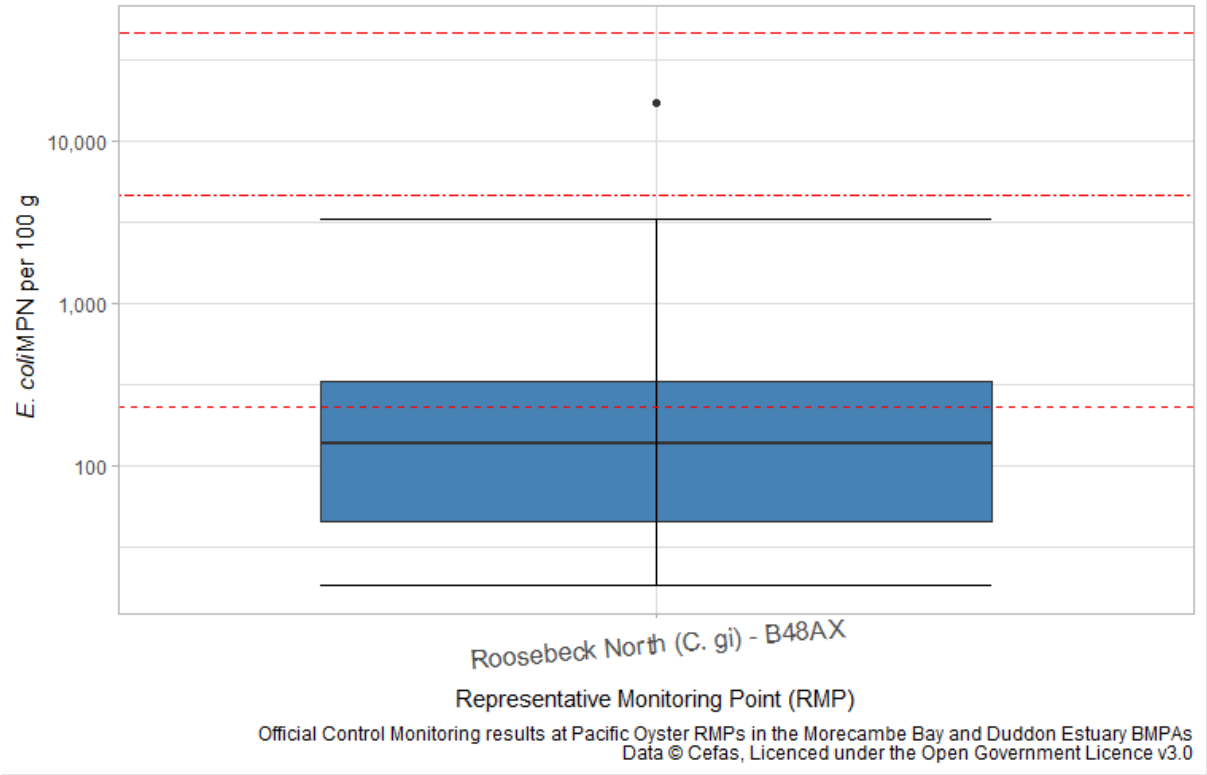

Figure 6.4 Boxplots of E. coli concentrations at Pacific oyster RMPs in the Morecambe and Duddon BMPAs since 2015. Central line indicates median value, box indicates lower-upper quartile range and whisker indicates minimum/maximum values, excluding outliers (points >1.5 x the interquartile range). Vertical dashed lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

6.2 Overall temporal pattern in results

The overall temporal pattern in shellfish flesh monitoring results for RMPs sampled within the Morecambe Bay and Duddon Estuary BMPAs are shown in Figure 6.5 - Figure 6.7 for cockles, mussels and Pacific oysters respectively.

The models fitted to the cockle data (Figure 6.5) suggest that, aside from Keer Channel South and Ulverston Sands, water quality has been broadly consistent, with the models falling at or around the 230 MPN/100 g threshold. The data also suggest that water quality has been improving since mid-2021, with loess models trending downwards for all RMPs except Newbiggin (B48AE).

It is harder to draw inference from the models fitted to mussel data (Figure 6.6), as the Duddon Channel RMP was not sampled between April 2015 and September 2021, and most of the other RMPs were only sampled for a short time. The loess model from Duddon Channel (B052D) does also suggest that water quality is improving.

Monitoring data from the single Pacific oyster RMP (Figure 6.7) suggests that water quality is generally stable in this position, with the model constantly falling below the 230 MPN/100 g threshold.

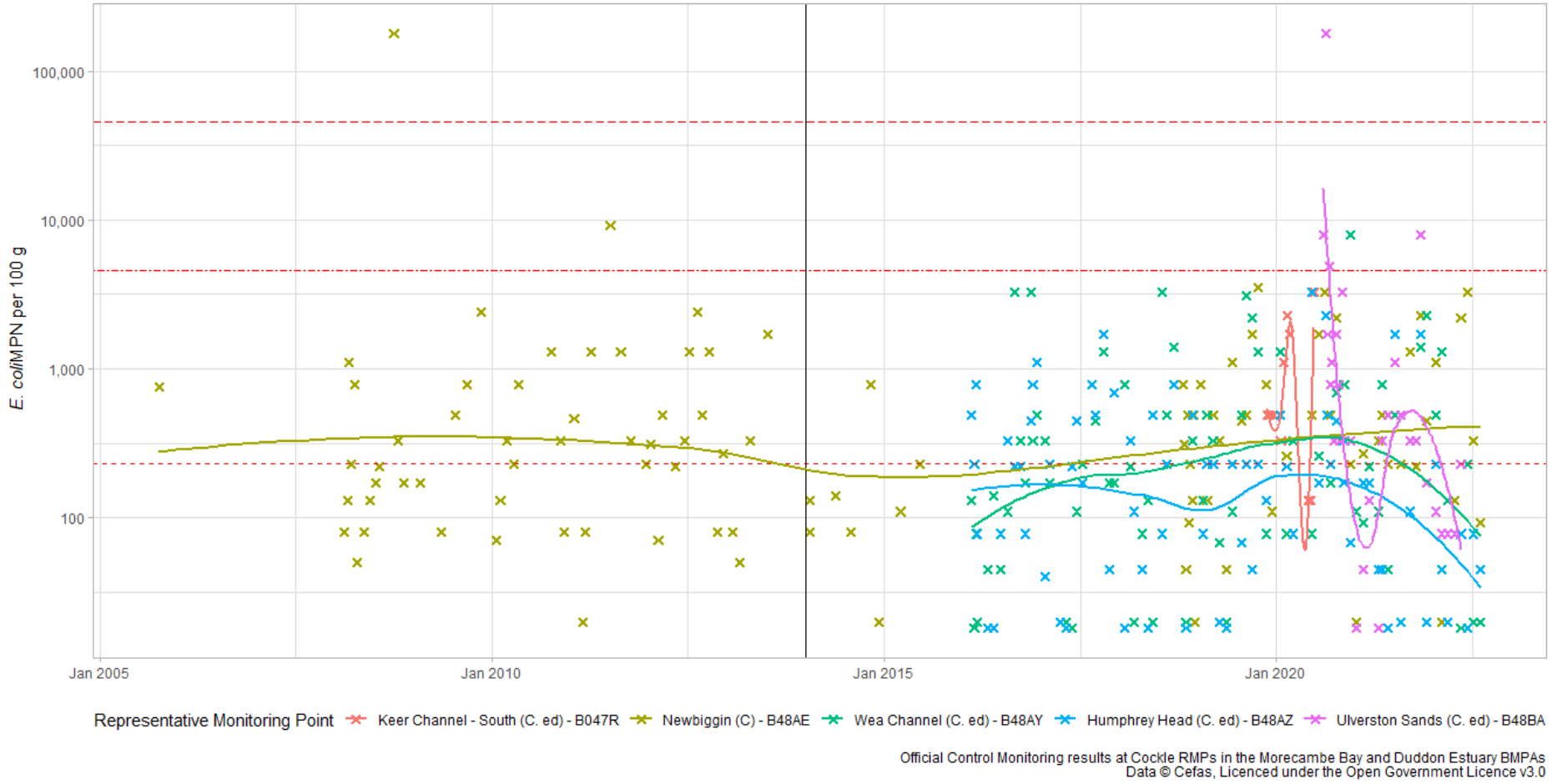

Figure 6.5 Timeseries of E. coli levels at cockle RMPs sampled in the Morecambe BMPA since 2005. Scatter plots are overlaid with a loess model fitted to the data. Horizontal lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

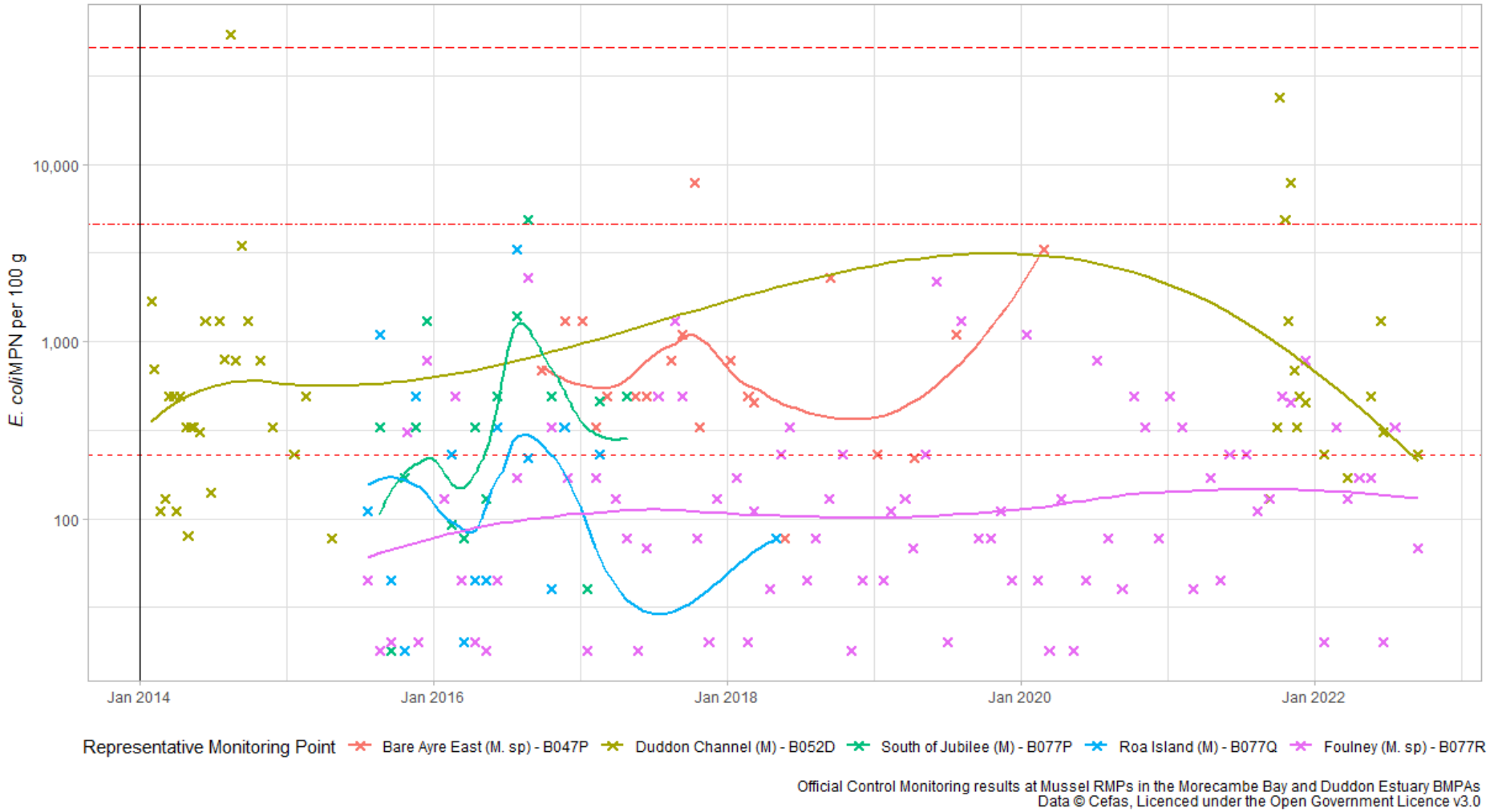

Figure 6.6 Timeseries of E. coli levels at mussel RMPs sampled in the Morecambe and Duddon BMPAs since 2005. Scatter plots are overlaid with a loess model fitted to the data. Horizontal lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

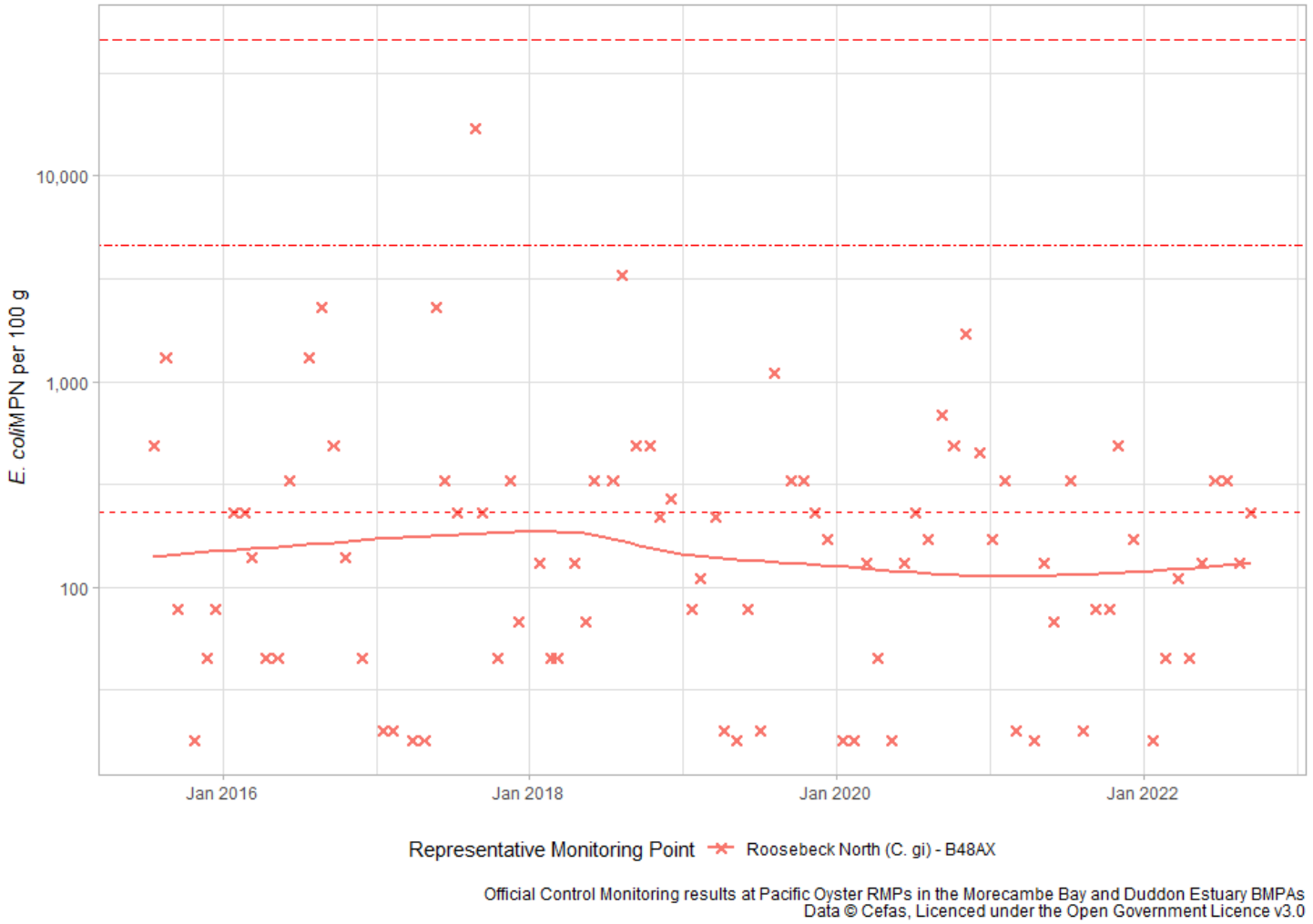

Figure 6.7 Timeseries of E. coli levels at cockle RMPs sampled in the Morecambe BMPA since 2005. Scatter plots are overlaid with a loess model fitted to the data. Horizontal lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

6.3 Seasonal patterns of results

The seasonal patterns of *E. coli* levels at the various RMPs within the Morecambe Bay and Duddon Estuary BMPAs were investigated and are shown for cockles in Figure 6.8, for mussels in Figure 6.9 and for Pacific oysters in Figure 6.10. The data for each year were averaged into the four seasons, with winter comprising data from January to 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 (if there is more than one RMP for a given species) as independent factors (i.e., pooling the data across season and RMP respectively), as well as the interaction between them (i.e., exploring seasonal differences within the results for a given RMP). Significance was taken at the 0.05 level.

At all cockle RMPs (Figure 6.8), results from summer and autumn months are generally higher than at other times of year, particularly at Ulverston Sands (B48BA). All results > 4,600 MPN/100 g have occurred between July and December, and all results >46,000 occurred in either August or October. However, no statistically significant differences in the data were found, either when the data were pooled between RMPs or the RMPs considered individually.

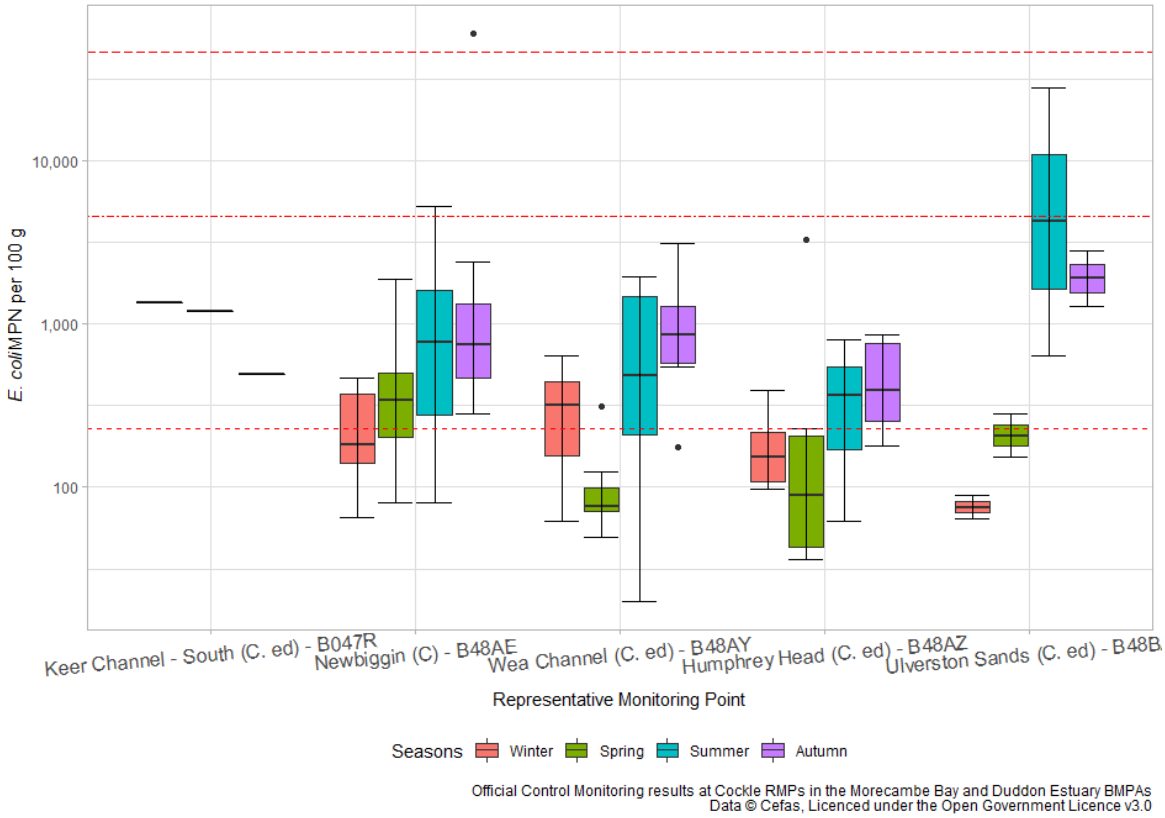

Figure 6.8 Boxplots of E. coli levels per season at cockle RMPs sampled within the Morecambe Bay BMPA. Horizontal dashed lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

A similar pattern can be seen in the mussel data (Figure 6.9), with results from autumn and winter generally higher than at other times of year. However, as with cockles, no statistically significant differences in the data were found.

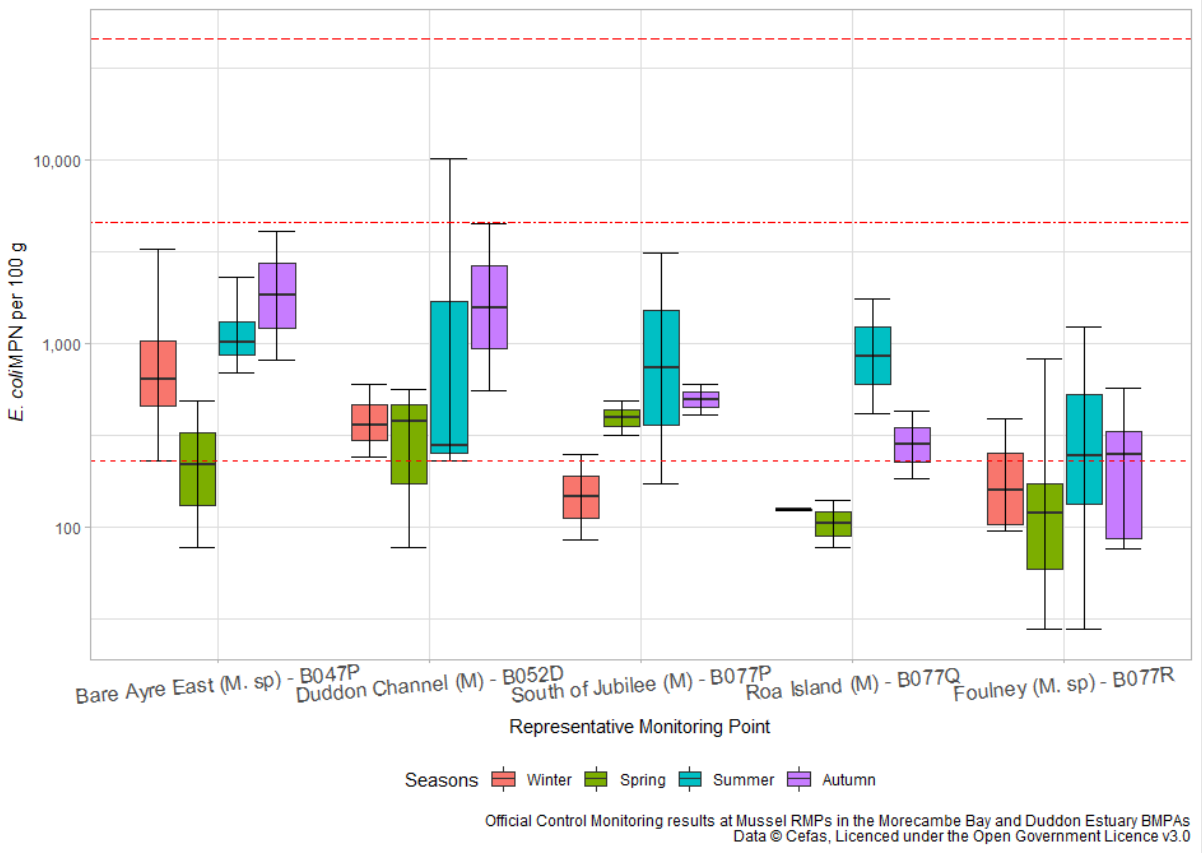

Figure 6.9 Boxplots of E. coli levels per season at mussel RMPs sampled within the Morecambe Bay and Duddon Estuary BMPAs. Horizontal dashed lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

No statistical comparison between RMPs was possible for the Pacific oyster data as there is only one RMP for this species. No significant differences were found within the single RMP, despite the fact that results from autumn and winter were higher.

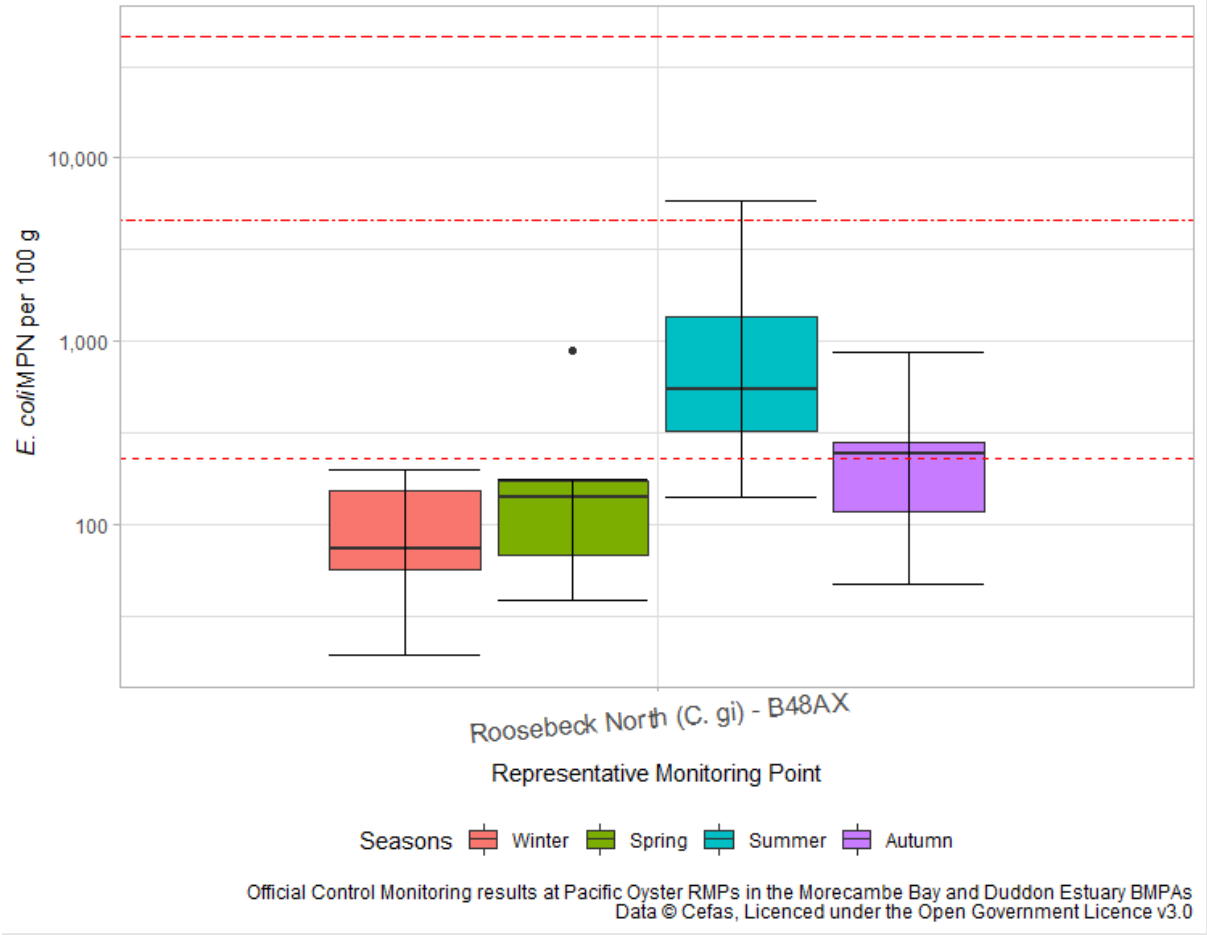

Figure 6.10 Boxplots of E. coli levels per season at Pacific oyster RMPs sampled within the Morecambe Bay BMPA. Horizontal dashed lines indicate classification thresholds at 230, 4,600 and 46,000 MPN/100 g respectively.

Across all RMP species, results from autumn and winter were higher, most probably due to increased rainfall during these times of year carrying additional contamination over the shellfish beds.

6.4 Action States

6.4.1 Morecambe Bay

An Action State was triggered within the *Central East* CZ following a result of 54,000 *E. coli* MPN/100 g in *C. edule* collected at the Humprey Head B48AZ RMP on 12 October 2021. No Action State sampling was conducted, although the subsequent monthly sample returned a result of 1,700 *E. coli* MPN/100 g.

The LEA expressed a concern raised by a member of trade that in the week previous, slurry spreading at a farm during a period of heavy rain caused slurry to wash into the water course at Aldingham. The EA reported > 1 in 5 year rainfall on 4 October (8 days before the Action State report), but noted that the dispersive properties of Morecambe Bay meant that any peak would also rapidly decline. No spills from water company (United Utilities) assets were recorded in the 3 days prior to the Action State result. Furthermore, sampling on the

same day at RMPs closer to the suspected slurry spreading location did not show any elevated results. The Action State result exceeded 3 standard deviations from mean *E.coli* levels for the site, and in accordance with classification procedures, considered statistically anomalous.

6.4.2 Duddon Estuary

The most recent Action State result at RMPs within the Duddon BMPA was returned in August 2014, the same month that the original sanitary survey was published. A result of 54,000 *E. coli* MPN/100 g was recorded with no grounds to waive it, and the result echoed a trend of increasing results in the months before this action state.

7 Conclusion and overall assessment

The Morecambe Bay BMPA covers the majority of the embayment with which it shares a name, but does not include the waters off Fleetwood to the south. Morecambe Bay is hydraulically connected to the Duddon Estuary via the Walney Channel. The Duddon Estuary BMPA covers the entirety of that estuary. Both BMPAs are subject to the byelaws of NW-IFCA, who have the right to close any bed within the fishery due to stock availability or other conservation concerns. The mussel fishery in both areas is open year round, but the cockle fishery for all beds within Morecambe Bay was not opened in 2022 due to concerns over its viability. The fishery was open in 2021, but the LEA indicated during initial consultations that landings were down on previous years, in part due to difficulties exporting shellfish to European markets following the UK's departure from the EU. The Morecambe Bay BMPA contains five Classification Zones, three for cockles and one each for mussels and Pacific oysters. An application to classify mussels in the Walney Channel was received in 2022 but this was retracted by the LEA following a change in commercial interest. The Pacific oyster zone represents an aquaculture production operation, and approximately 30,000 kg of oysters were sold in 2022. The mussel Classification Zone within the Duddon BMPA, *Duddon Sands* was declassified in February 2023 due to a lack of stock.

Both the sanitary surveys of Morecambe Bay (conducted in 2015) and the Duddon Estuary (conducted in 2014) cite the results of the 2011 census of the United Kingdom. No further Census data are available as the results of the 2021 Census have not yet been published. However, if the catchments match the UK government's estimated population trend, the total population within the catchment will be approximately 300,000 people.

The largest population centre in the vicinity of the Duddon is Barrow-in-Furness, though only the north-west part of this conurbation is in the catchment of that Production Area (the rest falls within the Morecambe Bay catchment). On the western side of the estuary is the only other significant population centre – the town of Millom. The Morecambe Bay catchment is much larger than that of the Duddon, and consequently has more significant population centres: Barrow-in-Furness and Ulverston on the north-west side of the bay, Morecambe on the south-east, and the towns of Kendal, Windermere and Ambleside in the upper reaches of the catchment. The geographical extent of these conurbations has not increased significantly since the original sanitary survey, but any increase in population size

will increase the loading to the sewage treatment network. The area remains a popular tourist destination, and recent statistics suggest that numbers of visitors are increasing. It is likely that the main swelling in population size (and associated increase in loading to the WWTN) will occur during summer months. No information was received during initial consultation to suggest the existing capacity of the network is not sufficient to handle this increase.

No changes to either the treatment methodologies or the consented discharge volumes of those discharges closest to the BMPAs have occurred. The most relevant discharges in terms of the contamination they cause are Barrow STW (No. 15 in Table 3.1), Roa Island WWTW (No. 9), Newbiggin (Leven) WWTW (No. 1), Ulverston WWTW (No. 5) and Grange-over-sand WWTW (No. 7). Comparison of EDM data from intermittent discharges in the catchment suggests that spill events are occurring more frequently than at the time of the original sanitary survey, and the *Newbiggin*, *Aldingham* and *Central East* CZs within Morecambe Bay are most likely to be affected by this. Additional consideration should therefore be given to the presence of any intermittent discharges within a CZ in any updated sampling plan.

Livestock populations within the catchment (based on the annual June Survey of Agriculture) were provided by DEFRA under the Open Government Licence v3.0 for 2013 and 2021 to give an indication of changes in livestock populations within the catchment. These data suggest that livestock populations have remained broadly similar since the original sanitary surveys were published, with poultry still the dominant group in terms of population size. There are several areas of pasture, or grazing saltmarsh immediately adjacent to the estuary and run-off from these areas could represent a significant source of contamination following heavy rainfall. The areas most at risk include the *Newbiggin* and *Aldingham* CZs, although the extent of that risk have not changed significantly since the original sanitary survey and therefore the recommendations made in that document remain valid.

Land cover maps show that Morecambe Bay and the Duddon estuary contain a variety of habitats that support a large diversity of wildlife. One of the groups of animals that is most likely to contribute significant levels of contamination to the BMPA are overwintering and water-birds. The annual counts by the Wetland Bird Survey suggest that the population of wildfowl, waders and gulls within Morecambe Bay is the second highest of any are in the UK, after the wash. Average bird counts have fallen slightly since the original sanitary was published, although the area still contains nationally and internationally significant populations of several species. Avian pollution may represent a significant source of contamination to both BMPAs, but is impossible to reliably capture using an RMP due to its spatial and temporal variability. Seals may also forage in the area from time to time, but pollution is likely to be diffuse and intermittent. No other wildlife species of significance to the sampling plan were identified.

Morecambe Bay and the Duddon estuary are both characterised by shallow bathymetry and constantly shifting intertidal sand banks, meaning that boat traffic in the inner reaches is

necessarily significantly restricted. Most recreational activity will be limited to the Walney channel, and overboard discharges from vessels of a sufficient size to contain onboard toilets may occur from time to time. There is some commercial shipping activity with one large commercial port and another significant international ferry terminal, although merchant vessels are prohibited from making overboard discharges within 3 nm of land. The risk of pollution from this source is not considered to have changed since the original sanitary surveys were published.

Official Control Monitoring data from 10 RMPs in the Morecambe Bay BMPA (including a mussel RMP B077P in the Walney Channel) and 1 in the Duddon Estuary BMPA was available for analysis. Generally, monitoring results were higher the further in-shore and up-channel an RMP was located, possibly due to the increased proximity to shoreline runoff sources. No significant differences were found in the data, although generally monitoring results were higher in winter months, again likely to increased rainfall and shoreline runoff during these periods. It should be noted that at several RMPs, the trend in monitoring result is one of improving water quality. Only one RMP (Ulverston Sand B48BA) has returned a result >46,000 since the original sanitary surveys were published, and across all RMPs, only 11 results >4,600 MPN/100 g have been recorded since the original sanitary surveys.

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

Having reviewed and compared the desk-based study with the findings of the original sanitary surveys in 2014, the FSA are also content that a shoreline assessment is not required.

8 Recommendations

Recommendations for the various Classification Zones within the Morecambe Bay and Duddon Estuary BMPAs are given below and are summarised in Table 8.1.

8.1 Morecambe Bay

8.1.1 Cockles

Keer Channel

This historic zone has been declassified since 2021, although in case re-classification is required in the future, a recommendation for this zone is provided below.

The 2014 sanitary survey identified that the main contaminating influences on this zone was the Carnforth WWTW outfall, which discharges to the River Bela, the areas of grazed saltmarsh to the north and a surface outfall at Hest Bank. It recommended placing an RMP adjacent to the Bela drainage channel, as far inshore as stocks extend (NGR SD 4568 6953). The RMP position that was used was at NGR SD 4623 6878, approximately 1 km south east of the position originally recommended. Should reclassification be required, the RMP should

be placed as close to the main Bela drainage channel as possible, as the main sources of contamination, from continuous and intermittent discharges in the area, will drain over the zone from this channel.

Newbiggin

This zone covers an area of nearly 40 km² and situated on the western side of Morecambe Bay. It was not commercially active at the time of the original sanitary survey, but the authors of that report identified that cockle stocks would probably be present across the entire zone, and recommended placing an RMP as close to the edge of the Deep Meadow Beck drainage channel as possible, and as inshore as it was possible to sample. The 2022 stock assessment identified that there are still good stocks of cockles in this area, and so the RMP should be retained as it will still be representative of the main sources of contamination – mainly arising from the Newbiggin STW.

Aldingham

This zone covers an area of 12.55 km², and is situated to the north of the *Newbiggin* zone. It is currently prohibited for all species. This zone was referred to as *Ulverston* in the original sanitary survey, and the authors of that report identified that the main contaminating influences would originate from the main Leven Channel to the north, carrying contamination from discharges including that from Ulverston STW. It recommended placing an RMP as far north and as close as possible to the main Leven Channel to capture contamination arriving from the north, but were advised that no stock was present in that location, so provided a revised location adhering to the same principals. The 2022 IFCA stock assessment suggests that the main stock in this zone is in the far south-west. However, provided that reliable stock for sampling does exist in the current location, the current RMP should be retained as it will be more representative of the contamination sources arising from the north.

Central West

This zone covers an area of 35 km², and is positioned between the *Newbiggin and Aldingham* zones to the west and *Central East* to the eastern side. The original sanitary survey recommended placing an RMP as far north-west as stocks extend, and as close to the Eea channel as possible to pick up contamination from Ulverston WWTW and intermittent discharges which drain into it. This continues to be the main route of contamination impacting this CZ. The 2022 cockle stock assessment suggests that there would be sufficient stock for sampling much further north. As such, the RMP should be positioned as far north as stock allows as this would be more representative of the contamination sources affecting this zone.

Central East

This zone covers an area of 55.12 km², making it the largest zone in the Morecambe Bay BMPA. The original sanitary survey recommended the RMP be placed as far north and as close to the main Kent channel as possible to capture contamination sources from that estuary. This continues to be the main source of contamination impacting this CZ. As with

the *Central West* zone, the 2022 cockle stock assessment suggests that there would be sufficient stock for sampling much further north-east than currently sampled. There fore, the RMP should be positioned as far north as stock allows, as this would be more representative of the contamination sources affecting this zone.

8.1.2 Mussels

Foulney

This classification zone covers an area of 24.8 km², and contains several disparate mussel beds based on the findings of the 2022 IFCA stock assessment. The original sanitary survey identified no direct point sources of contamination within the zone itself, but did note some originating from Walney Channel. That report did not specify, but it is likely it was referring to continuous and intermittent discharges at the mouth of the Walney Channel It recommended placing an RMP at the centre of the northern edge of the main size fishery. This RMP should be retained as it continues to be representative of the main sources of contamination to this zone, which are likely to originate from the Walney Channel.

8.1.3 Pacific oyster

Roosebeck

This zone represents the only aquaculture operation in the BMPA. The original sanitary survey recommended placing the RMP at the northern end of the site to capture contamination originating from Newbiggin WWTW. There are two intermittent discharges near the Walney Channel, and so we recommend conducting a period of concurrent sampling from the current RMP location and a position at the western corner (around NGR: SD 24776 65333) for a period of 10 samples, and retaining whichever returns the higher results.

8.2 Duddon Estuary

8.2.1 Mussels

Duddon Channel

This zone was declassified in 2023 due to a lack of stock. However, an RMP recommendation is still given in case re-classification is required in the future. The boundaries of the zone prior to its declassification extended beyond the mussel bed as described in the 2022 IFCA stock assessment. The original sanitary survey identified that the main sources of contamination would be up-estuary, and recommended moving the RMP to the upstream extremity of the bed. The Millom and Askham-in-Furness WWTWs continue to be the major impacting contamination sources and for which the current RMP position continues to be representative and should be retained.

8.3 General Information

8.3.1 Location Reference

Production Area	**Morecambe Bay**
Cefas Main Site Reference	M047, M048 and M077
Ordnance survey 1:25,000	Explorer OL6, OL7 and 296

Admiralty Chart	2010, 3164, 1320
Production Area	**Duddon Estuary**
Cefas Main Site Reference	M052
Ordnance survey 1:25,000	Explorer OL6
Admiralty Chart	1320

8.3.2 Shellfishery (Morecambe Bay)

Species	Culture Method	Seasonality of Harvest
Cockles (*Cerastoderma edule*)	Wild	Close season 1st May – 31st August. All Morecambe Bay beds currently closed under IFCA byelaw
Mussels (*Mytilus* spp.)	Wild	Year round
Pacific oyster (*Crassostrea gigas*)	Culture	Year round

8.3.3 Shellfishery (Duddon Estuary)

Species	Culture Method	Seasonality of Harvest
Mussels (*Mytilus* spp.)	Wild	Year round

8.3.4 Local Enforcement Authority(s)

Name **Address**	**Public Protection, Barrow Borough Council**
Website	www.barrowbc.gov.uk
Telephone number	01229 876543
E-mail address	commercial@barrowbc.gov.uk
Name **Address**	**Public Protection, South Lakeland District Council** South Lakeland House, Kendal, Cumbria LA9 4DQ
Website	www.southlakeland.gov.uk
Telephone number	01539 733 333
E-mail address	publicprotection@southlakeland.gov.uk
Name **Address**	**Lancaster City Council** Morecambe Town Hall, Marine Road

	Morecambe Lancashire, LA4 5AD
Website	www.lancaster.gov.uk
Telephone number	01524 582935
E-mail address	environmentalhealth@lancaster.gov.uk

*Table 8.1 Proposed sampling plan for the Morecambe Bay & Duddon Estuary BMPA. Suggested changes are given in **bold red** type.*

Classification Zone	RMP	RMP Name	NGR (OSGB 1936)	Lat / Lon (WGS 1984)	Species Represented	Harvesting Technique	Sampling Method	Sampling Species	Tolerance	Frequency
Morecambe Bay - Roosebeck										
Newbiggin (Cockles)	B48AE	Newbiggin	SD 2760 6883	54° 06.614'N 03° 06.535'W	*C. edule*	Hand picked	Hand picked	Cockles	100 m	Monthly
Aldingham (all species)	B48BA	Ulverston Sands	SD 2992 7278	54° 08.763'N 03° 04.461'W	All Species	Hand picked	Hand picked	Cockles	100 m	Monthly
Central West (Cockles)	**TBC**	**TBC**	**TBC**	**TBC**	*C. edule*	Hand picked	Hand picked	Cockles	100 m	Monthly
Central East (Cockles)	**TBC**	**TBC**	**TBC**	**TBC**	*C. edule*	Hand picked	Hand picked	Cockles	100 m	Monthly
Roosebeck (Pacific oysters)	**TBC**	**TBC**	**TBC**	**TBC**	*C. gigas*	Hand picked	Hand picked	Pacific oysters	100 m	Monthly
Keer Channel	**TBC**	**TBC**	**TBC**	**TBC**	*C. edule*	Hand picked	Hand picked	Cockles	100 m	N/A – zone currently declassified

Classification Zone	RMP	RMP Name	NGR (OSGB 1936)	Lat / Lon (WGS 1984)	Species Represented	Harvesting Technique	Sampling Method	Sampling Species	Tolerance	Frequency
Morecambe Bay - Barrow										
Foulney (Mussels)	B077R	Foulney	SD 2491 6365	54°3.798N 3°8.926W	*Mytilus* spp.	Hand picked	Hand picked	Mussels	100 m	Monthly
Duddon Estuary										
Duddon Channel (Mussels)	B052D	Duddon Sands	SD 1655 7625	54° 0.514'N, 3° 16.797'W	*Mytilus* spp.	Hand raked / dredge	Hand raked	Mussels	50 m	Monthly

9 References

Associated British Ports (2022) *Associated British Ports | Barrow*. Available at: https://www.abports.co.uk/locations/barrow/ (Accessed: 19 May 2022).

Carcinus (2022) *Sanitary Survey of the Walney Channel*. Carcinus report on behalf f the Food Standards Agency, to demonstrate compliance with the requirements for classification of bivalve mollusc production areas in England and Wales under EC Regulation 2019/627. Hampshire: Carcinus Ltd.

Environment Agency (2022) *Event Duration Monitoring - Storm Overflows - Annual Returns*. Available at: https://data.gov.uk/dataset/19f6064d-7356-466f-844e-d20ea10ae9fd/event-duration-monitoring-storm-overflows-annual-returns (Accessed: 21 June 2022).

Environment Agency (2023) *Swimfo: Find a bathing water*, *Bathing Water Quality*. Available at: https://environment.data.gov.uk/bwq/profiles/ (Accessed: 2 February 2023).

European Commission (2021) *Community Guide to the Principles of Good Practice for the Microbiological Classification and Monitoring of Bivialve Mollusc Production and Relaying Areas with regard to Implementing Regulation 2019/627*. Issue 4. Available at: https://www.aesan.gob.es/en/CRLMB/docs/docs/procedimientos/Micro_Control_Guide_DEC_2021.pdf (Accessed: 24 October 2022).

Frost, T.M. *et al.* (2016) *Waterbirds in the UK in 2014/15: The Wetland Bird Survey.* Thetford: BTO/RSPB/JNCC.

Frost, T.M. *et al.* (2021) *Waterbirds in the UK 2019/20: The Wetland Bird Survey.* Thetford: BTO/RSPB/JNCC.

gov.uk (2022) *UK fishing vessel lists*. Available at: https://www.gov.uk/government/collections/uk-vessel-lists (Accessed: 7 June 2022).

Lake District National Park (2022) *Lake District facts and figures*, *Lake District National Park*. Lake District National Park: hq@lakedistrict.gov.uk. Available at: https://www.lakedistrict.gov.uk/learning/factsandfigures (Accessed: 5 October 2022).

NW-IFCA (2022) *NWIFCA-MB-EMS-UNDERSIZE MUSSEL MORECAMBE BAY HANDGATHERING AND DREDGE FISHERY*. North West Inshore Fisheries and Conservation Authority. Available at: https://www.nw-ifca.gov.uk/app/uploads/NWIFCA-MB-EMS-UNDERSIZE-MUSSEL-FISHERIES-2022-amended.pdf (Accessed: 10 November 2022).

ons.gov.uk (2022) *National population projections - Office for National Statistics*. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2020basedinterim (Accessed: 27 May 2022).

R Core Team (2021) ‘R: A language and environment for statistical computing’. Vienna, Austria: R Foundation for Statistical Computing. Available at: https://www.R-project.org/ (Accessed: 8 June 2022).

SCOS (2022) *Scientific Advice on Matters Related to the Management of Seal Populations: 2021*. Aberdeen: Natural Environment Research Council Special Committee on Seals. Available at: http://www.smru.st-andrews.ac.uk/files/2022/08/SCOS-2021.pdf (Accessed: 7 October 2022).

10 Appendices

Appendix I. 2021 EDM Summary (Intermittent discharges)

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
SPARK BRIDGE PUMPING STATION	LAK0108	SD3068084701	87	1211.27
CONISTON WWTW	17370035	SD3072097050	138	2710.23
TORVER STW	17370039	SD2817093930	0	0
GREENODD PUMPING STATION	LAK0109	SD3148082410	60	675.51
CRAKE VALLEY WWTW	EPRFP3828GS	SD3141682708	0	0
27/29 ABBOTSMEAD CSO	BRW0042	SD2194069331	Unspecified	Unspecified
BRIDGEGATE AVENUE MANHOLE 5800 CSO	BRW0041	SD2194069333	Unspecified	Unspecified
GRANGE PUMPING STATION	LAK0074	SD4125078160	38	144.4
CART LANE PUMPING STATION	LAK0073	SD4027076810	25	370.72
RAMPARTS CSO 25075	LAN0072	SD4792062410	4	6.76
BARDSEA SPS(TOILET BLOCK)	LAK0093	SD3021074320	5	43.44
OWEN ROAD COMBINED SEWER OVERFLOW	LAN0116	SD4788062360	5	36.7
HEST BANK PUMPING STATION	LAN0120	SD4684066860	36	324.38
GRANGE OVER SANDS WWTW GRNGS	17370128	SD3926075060	71	141.28
MIDDLE POOL PS MIDDP LAN0099	LAN0099	SD4348058330	0	0
188 RATING LANE CSO	BRW0038	SD2194069330	Unspecified	Unspecified
FLASS LANE AT BRIDGEGATE CSO	BRW0039	SD2194069335	Unspecified	Unspecified
HOLLOW LANE/OLD HARREL LANE CSO	BRW0036	SD2194069338	Unspecified	Unspecified
RATING LANE/MEADOWLANDS AVENUE CSO	BRW0037	SD2194069339	Unspecified	Unspecified
BARROW-IN-FURNESS WWTW	17470166	SD2200068190	57	469.21
AINSLIE STREET/NEWPORT ST CSO 041A7	BRW0011	SD1966070552	0	0

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
GREETY GATE PUMPING STATION	LAK0098	SD2030186811	39	272.47
PALACE NOOK SEWAGE PUMPING STATION	BRW0097	SD1887071800	55	452.64
CARTMEL IN CARK PUMPING STATION	LAK0099	SD3651076350	314	4701.64
LINDALE WASTEWATER TREATMENT WORKS	17370073	SD4234280672	68	947.62
WILLOW LANE SEWAGE PUMPING STATION	LAN0106	SD4665962201	36	180.86
BIGGAR VILLAGE PUMPING STATION	BRW0001	SD1916066320	1	0.24
BARROW-IN-FURNESS WWTW	17470166	SD2200068190	67	935.65
ASH MEADOW PUMPING STATION	LAK0100	SD4463178321	29	315.6
ASKHAM-IN-FURNESS WWTW ASKAM	17470136	SD2118078600	20	398.28
BAYCLIFF PUMPING STATION 39051	LAK0001	SD2905071910	72	905.61
BAZIL LANE PUMPING STATION	LAN0034	SD4411057280	15	35.1
BULK ROAD CSO 25097	LAN0018	SD4799062091	13	26.83
CABLE STREET CSO 251H9	LAN0020	SD4761061941	26	37.65
CARK TANK NO.1 PUMPINT STATION	LAK0076	SD3578076410	88	1363.03
CRAG BANK PUMPING STATION	LAN0062	SD4871070000	8	21.9
DOCK STREET CSO 52567	WYR0080	SD3363047580	4	1.99
FERRY PUMPING STATION SITE ID 04528	BRW0099	SD1878068750	58	492.47
ST NICHOLAS LANE PUMPING STATION	LAN0057	SD4782068760	55	114.03
TOWN BECK CSO 39065	LAK0059	SD2918078120	15	20.22

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
ASKHAM-IN-FURNESS WWTW ASKAM	17470136	SD2118078600	216	4908.83
DAMSIDE	LAN0113	SD4757062060	Unspecified	Unspecified
DOCK ST OVERFLOW	WYR0028	SD3389047630	Unspecified	Unspecified
HEYSHAM VILLAGE PUMPING STATION	LAN0043	SD4100061990	0	0
OVERTON PEDDAR-FAR PS	LAN0101	SD4328057900	Unspecified	Unspecified
RIBBLESDALE DRIVE PS	WYR0068	SD4876051400	Unspecified	Unspecified
HAWCOAT LANE/HARTLAND ROAD CSO	BRW0031	SD2194069336	Unspecified	Unspecified
HAWCOAT LANE/THORNCLIFFE ROAD CSO	BRW0032	SD2194069337	Unspecified	Unspecified
SCALE HALL PUMPING STATION	LAN0039	SD4643062240	226	5351.88
OXFORD STREET/AINSLIE STREET CSO	BRW0091	SD1966070553	28	56.17
MEATHOP PUMPING STATION	LAK0102	SD4415080530	20	167.67
K SHOES CSO 042B6	BRW0056	SD2144077990	2	0.17
31 ABBOTSMEAD APPROACH CSO	BRW0040	SD2177069780	24	15.13
OAKWOOD DRIVE CROFTLANDS CSO	LAK0058	SD2907277209	0	0
FOXFIELD SEWAGE PUMPING STATION	LAK0097	SD2096085270	28	340.08
ARNSIDE PROMEDE PUMPING STATION	LAK0002	SD4573078950	29	220.76
RAILWAY FARM CSO 25051	LAN0031	SD4808055240	30	103.66
DOCK STREET CSO 52567	HAL0111	SD3363047580	14	42.37
LOW WOOD BRIDGE PUMPING STATION	LAK0054	SD3453083680	43	230.24
RAMPSIDE PUMPING STATION	BRW0071	SD2390065800	55	379.72

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
ROMNEY ROAD/TITCHFIELD STREET CSO	BRW0088	SD1966070554	0	0
ROSEMARY LANE CSO 252PG	LAN0075	SD4782061820	7	0.97
ST NICHOLAS LANE PUMPING STATION	LIV0027	SD4782068760	8	3.98
THORNCLIFFE RD/CLIFF LN CSO	BRW0033	SD2194069340	Unspecified	Unspecified
ULVERSTON WWTW	17370179	SD3071077240	0	0
SCHOLA GREEN LANE PS	LAN0109	SD4355063580	16	46.27
SOUTH EAST OF NEWTON SSO	BRW0073	SD2342071280	Unspecified	Unspecified
DANE AVENUE/WHEATCLOSE ROAD CSO	BRW0035	SD2194069334	Unspecified	Unspecified
AINSLIE ST/HARROGATE ST	BRW0012	SD1966070551	42	13.23
COCKERHAM CSO	LAN0081	SD4520051300	191	2073.23
MIDDLETON OVERTON WWTW MIDDL	17270051	SD4304057960	6	34.76
DALTON SCREENS CSO	BRW0074	SD2232073490	55	101.84
AINSLIE ST OXFORD ST CSO 041A9	BRW0013	SD1966070550	41	6.43
GLEASTON CASTLE CSO	LAK0053	SD2607072140	129	2858.53
GREETY GATE PUMPING STATION	SRI0014	SD2030186811	106	323.2
JUNC PROMEDE SILVERDALE RD CSO	LAK0101	SD4558678760	0	0
LANCASTER WWTW LANCA	17270050	SD4570058710	49	846.71
LINDAL PUMPING STATION 04509	BRW0072	SD2471075510	95	395.54
MILLOM WASTEWATER TREATMENT WORKS	17470048	SD1922079410	1	0.98
MORECAMBE BANK CSO	LAK0071	SD4087077860	2	0.83
OVERTON GARDEN TERRACE PS	LAN0098	SD4234058510	0	0

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
PROMEDE COMBINED SEWER OVERFLOW	LAK0072	SD4067077560	20	20.4
SOUTERGATE WWTW SOUTE SOUTE	17470020	SD2205081370	84	634.33
DAMSIDE SCREENING CSO 25076	LAN0078	SD4754062030	31	109.14
OXCLIFFE RD PS NO 1 & EO TO OVERTON	LAN0028	SD4476061080	0	0
FIELD HEAD PUMPING STATION LAK0090	LAK0090	SD3660075500	164	2233.96
HEVERSHAM SEWAGE PUMPING STATION	LAK0055	SD4864083090	74	714.12
SOUTERGATE VILLAGE PUMPING STATION	LAK0094	SD2205081371	4	5.08
ROA ISLAND PUMPING STATION	BRW0102	SD2318164600	131	492.74
COOPER LANE SPS	LAK0092	SD3085074800	27	379.54
RAVENSTOWN PUMPING STATION	LAK0103	SD3616074931	10	37.84
HAVERIGG PUMPING STATION	BRW0005	SD1608078760	48	560.63
NEWBIGGIN (LEVEN) WWTW NEWBG	17370051	SD2675168941	176	3877.88
ABBEY RD/HOLLOW LANE CSO	BRW0034	SD2194069332	192	850.23
FREDERICK ST PS	BRW0044	SD2123068810	27	108.38
GRAVING DOCK PUMPING STATION	BRW0100	SD1889069320	42	31.54
HARBOUR YARD PUMPING STATION	BRW0101	SD1944067720	55	23.44
LUNE STREET PUMPING STATION 25030	LAN0007	SD4757062170	1	0.54
NEWBIGGIN (LEVEN) WWTW NEWBG	17370051	SD2675168941	6	1.93
PILLING LANE PS	WYR0073	SD3607048950	17	1.65
PRIORY ROAD CSO 392MO	LAK0005	SD2973076700	22	62.6
SANDSIDE PUMPING STATION	LAK0057	SD4779080770	1	1.51
SCHNEIDER ROAD CSO	BRW0009	SD1958070871	81	959.92

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
KING STREET PUMPING STATION	COP0049	SD1783180401	26	13.93
THURTELL COTTAGES CSO LAN0091	LAN0091	SD5280065240	36	73.33
KENDAL WASTE WATER TREATMENT WORKS	17370100	SD5170090790	55	613.57
HUTTON ROOF STW	17370069	SD5705077900	Unspecified	Unspecified
HOLME WWTW	17370138	SD5179078540	55	728.72
MILNTHORPE SEWAGE PS MLNTH	LAK0052	SD4939081400	96	1808.89
ARTLE BECK COMBINED SEWER OVERFLOW	LAN0119	SD5339064880	17	37.23
BULL BECK BROOKHOUSE CSO	LAN0089	SD5408064800	13	69.13
CATON WASTEWATER TREATMENT WORKS	17270001	SD5277065250	0	0
FAIRFIELD RD RUSSELL RD CSO 25026	LAN0070	SD5038070130	0	0
HOLME STATION CSO 391HY LAK0046	EDE0061	SD5227077300	4	0.67
DUKE STREET	LAK0044	SD5171078500	Unspecified	Unspecified
HOLME WWTW	SRI0004	SD5179078540	56	202.2
HAGG LANE MIDLAND TERRACE PS	LAN0059	SD4966071170	13	43.18
HALTON EAST STW	17270002	SD5053064611	21	40.59
LARBURNUM PARK PUMPING STATION	LAN0061	SD4915069680	36	97.01
CASTERTON WWTW	17270014	SD6176079550	9	52.8
ARTLE BECK COMBINED SEWER OVERFLOW	LAN0108	SD5339064880	11	2.03
HALTON EAST SEWAGE PUMPING STATION	LAN0060	SD5030064700	73	156.43
HALTON WEST PUMPING STATION HLTWE	LAN0097	SD4998064660	21	46.07
HOLME STATION CSO 391HY LAK0046	LAK0046	SD5227077300	5	85.47

Site Name	Permit Reference	NGR	Count of Spills in 2021	Duration (hrs) of spills in 2021
KENDAL WASTE WATER TREATMENT WORKS	17370100	SD5170090790	32	203.73
KIRKBY LONSDALE STW	17270006	SD6152077880	71	481.98
NETHER KELLET WTW NETHK	17370074	SD5018068160	74	1031.22
OVER KELLET WWTW	17370075	SD5164070240	121	2036.05
SEDGWICK PUMPING STATION	LAK0091	SD5083087230	0	0
GARDNER ROAD PUMPING STATION	LAN0058	SD5003071450	21	188.78
KIRKBY LONSDALE STW	17270006	SD6152077880	45	77.37
GLEBE ROAD PUMPING STATION	LAK0045	SD3941096350	2	0.83
STAVELEY WWTW	17370061	SD4827098020	80	1171.79
STAVELEY WWTW	17370061	SD4827098020	Unspecified	Unspecified
AMBLESIDE WWTW	17370024	NY3722003890	Unspecified	Unspecified
NEAR SAWREY WWTW NEARS	17370030	SD3660095110	82	1459.36
HAWKSHEAD PUMPING STATION	LAK0107	SD3552197931	67	1371.86
ELTERWATER PUMPING STATION	LAK0025	NY3279004720	31	422.85
GRASMERE WWTW	17370027	NY3392006840	90	1347.88

Morecambe Bay Sanitary Survey 2014

https://www.cefas.co.uk/media/rf1bui5n/morecambe-sanitary-survey-report-2014-final-table-issues-dj.pdf

Duddon Estuary Sanitary Survey 2014

https://www.cefas.co.uk/media/taol1u4x/duddon-sanitary-survey-report-2014-final-table-issues-dj.pdf

11 About Carcinus Ltd

Carcinus Ltd is a leading provider of aquatic environmental consultancy and survey services in the UK.

Carcinus was established in 2016 by its directors after over 30 years combined experience of working within the marine and freshwater environment sector. From our base in Southampton, we provide environmental consultancy advice and support as well as ecological, topographic and hydrographic survey services to clients throughout the UK and overseas.

Our clients operate in a range of industry sectors including civil engineering and construction, ports and harbours, new and existing nuclear power, renewable energy (including offshore wind, tidal energy and wave energy), public sector, government, NGOs, transport and water.

Our aim is to offer professional, high quality and robust solutions to our clients, using the latest techniques, innovation and recognised best practice.

12 Contact Us

Carcinus Ltd

Wessex House

Upper Market Street

Eastleigh

Hampshire

SO50 9FD

Tel. 023 8129 0095

Email. enquiries@carcinus.co.uk

Web. https://www.carcinus.co.uk

13 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.

14 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.

15 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*"