Thames Estuary
Cockle Survey Report 2021

Kent & Essex IFCA

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Executive Summary

This report gives an annual up-date assessment of all cockle stock surveys carried out by the Kent and Essex Inshore Fisheries & Conservation Authority (KEIFCA) during 2021. The data from these surveys are added to the previous annual surveys to provide current information which is used to assess the management strategy of the district's commercial cockle stocks.

NOT TO BE QUOTED WITHOUT PRIOR REFERENCE TO KEIFCA

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1 INTRODUCTION

This report presents the results of the 2021 annual surveys in Thames Estuary to provide data used to inform sustainable management of the cockle (*Cerastoderma edule*) fishery.

The Thames Estuary supports an important cockle fishery, and the commercial harvesting of the cockles is regulated by KEIFCA under the Thames Estuary Cockle Fishery Order, 1994 (TECFO) and relevant byelaws. The Authority has conducted annual surveys of the cockle beds within the Thames Estuary since 1988 to provide robust data to inform sustainable management of the cockle (*Cerastoderma edule*) fishery.

The annual cockle surveys are critical in providing information to open the TECFO and Outside cockle fisheries, and to set their annual Total Allowable Catch (TAC) limits. That allows for a sustainable fishery to operate. The sustainable management of the cockle stocks also provides important information for environmental management, such as continued adequate food for wading birds and marine species, within the numerous Marine Protected Areas (MPAs) within which the fishery operates. The management controls the exploitation of the cockle population to ensure that there is not any significant adverse impact upon the features of the Essex Estuaries SAC along with the Mid Essex Coast and Outer Thames Estuary SPA sites.

The cockle survey programme was designed to allow for assessing annual and seasonal trends in cockle stocks within the major commercial harvesting areas of the Thames Estuary. The annual surveys take place on known cockle beds in the Thames Estuary, which were divided into cockle management areas (Figure 1) within which stocks and fishing activity are assessed annually.

The results of the stock assessment surveys were used to examine the distribution, density and age structure of cockles in the different areas, and to produce estimated values of population size and biomass. The results from the preceding autumn survey, together with the results from the following spring survey are analysed and evaluated within the context of the long-term trend to inform setting the total allowable catch (TAC) for the commercial fishing sector. The TAC for the fishery which was divided between licence holders (for areas inside the TECFO area) or permit holders (for areas outside the TECFO area).
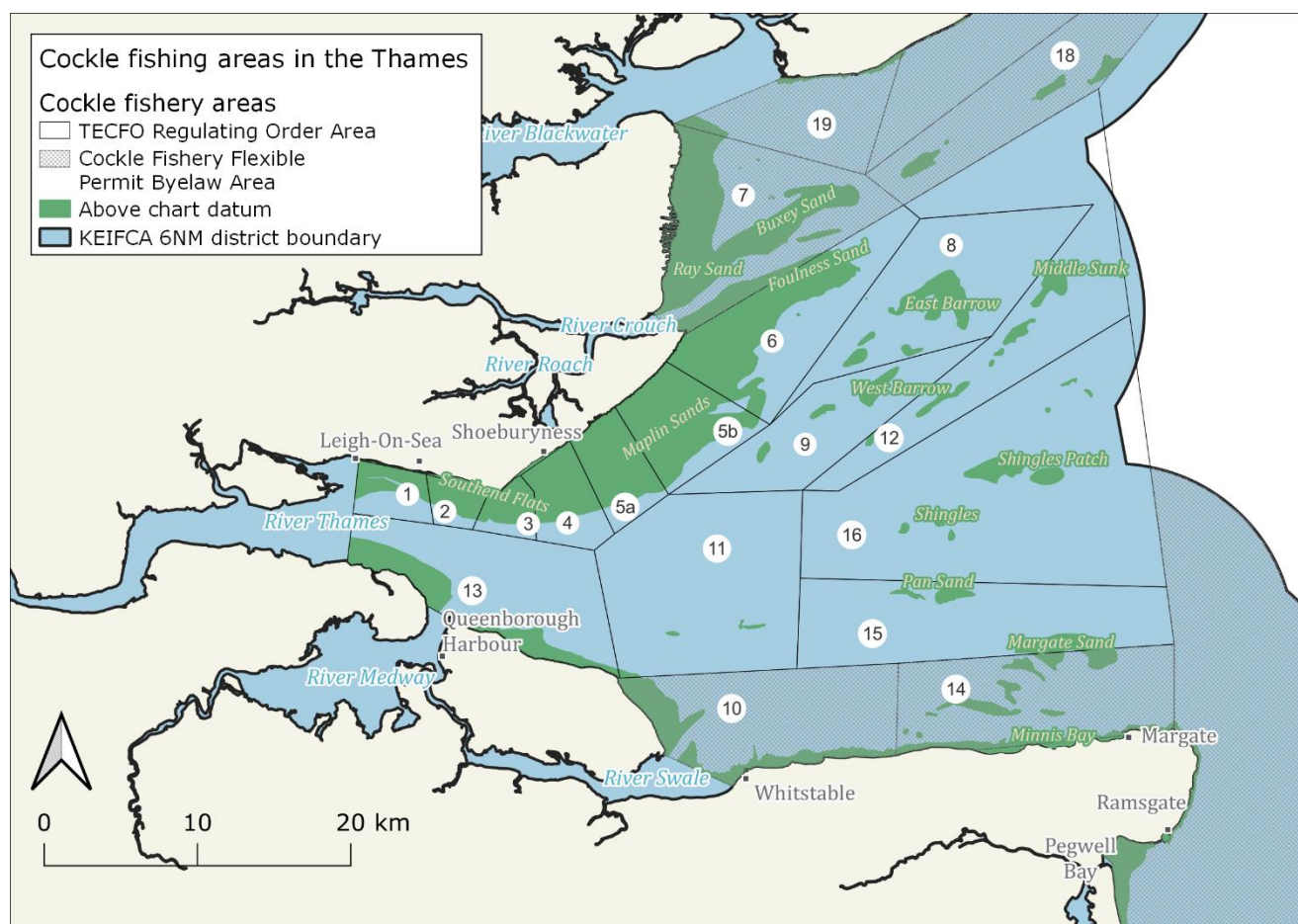
Figure 1: Cockle management areas in the Thames Estuary, showing two types of cockle fishery areas, as well as seabed above chart datum and sandbank names.

Chart area key:

Grounds within the area covered by the Thames Estuary Cockle Fishery Order 1994

1. Marsh End & Chapman Sands
2. East of pier
3. West of Shoebury boom
4. East of Shoebury boom
5a. South Maplin
5b. Mid Maplin
6. North Maplin & Foulness Sands
8. East Barrow & Maplin Spit
9. West Barrow
11. East Cant, Middle & Red Sand
12. Sunk Sand
13. West Cant & Scrapsgate
15. North Margate Sand & Pan Sand
16. Shingles & Long Sand

Grounds outside the area covered by the Thames Estuary Cockle Fishery Order 1994

1a. Inner Estuary
7. Buxey Ray & Dengie Sands
10. Leysdown & Ham.
14. South Margate Sands
17. South Kent Coast to Dungeness
18. Gunfleet Sand
19. Blackwater Estuary
20. Wallet & North Essex Coast

2   METHODS

2.1   Survey methodology

2.1.1   Sample collection from shore (quadrats)

Intertidal sandflats, accessible from shore in areas 2, 3, 4, 5a, 5b and 6 were accessed using all-terrain vehicles (ATVs; Figure 2a) within 2 hours of low water. Sampling of these areas was conducted during spring low tides in April 2021 and repeated for the subset of main cockle harvesting areas; 4, 5a, 5b and 6, in September 2021 (Table 1). Samples were collected at each sample point in the survey grid (Figure 3) using a 0.1 m^2 quadrat. Sediment was removed from the upper 6 cm inside the 0.1 m^2 quadrat using a rake and sieved through a 5 mm square meshed sieve. Any cockles retained on the sieve were collected for further analyses.

2.1.2   Sample collection at sea (Day grab)

Surveys of intertidal cockle beds not accessible from shore were carried out from KEIFCA's vessel 'FPV Tamesis' during periods of high tide in April 2021 for all other areas (See Table 1). Samples were collected using a 0.1 m^2 Day grab which was lowered from the vessel via a hydraulic winch (Figure 2b). The contents of the day grab were emptied and sieved through a 5 mm square meshed sieve. Any cockles retained on the sieve were collected for further analyses.

The 2021 survey included new sample locations in areas 14 and 15. These locations represented an area (bisected by the boundary between these areas) which comprise a shallow sand bank on the Margate Sands. Additional samples were collected from the Margate Hook, another shallow sand bar in area 14. This followed the discovery of very high-quality cockles from the area during the 2020 fishing season.

Figure 2: Sample collection methods; (a) ATV, quadrat, rake and sieve; and (b) Day grab deployed from vessel

2.1.3   Biomass and stock size measurements

Cockles from each sample point were separated into year classes, identified by the number of growth rings visible on the outside of the shell. The cockles were tallied and cockles from each sample point in each year class were combined for each cockle management area. Cockles from each age class in each area were sorted into 3 size classes (<14 mm, 14 – 16 mm and >16 mm) using 14 mm and 16 mm sorting riddles. The minimum landing size for cockles within the KEIFCA district is 16 mm which relates to the smallest dimension of the cockle.

The total weight and number of cockles in each year and size class for each cockle management area were measured and used to estimate the total stock size and biomass of each age and size class of cockles.

2.2 Survey schedule

Sampling of the cockle beds commenced on the 1st April 2021, with the final cockle survey completed on the 12 September 2021. All surveys, areas and sampling methods are shown in Table 1.

Spring surveys tend to take place during April while autumn surveys are carried out for a subset of the sampling grid during September. The main objectives of the spring surveys are to estimate the population size and biomass and distribution of different age classes to base the TAC on. The main objectives of the autumn survey being to assess spat settlement and abundance, along with the distribution of the remaining cockles. The survey schedule is provided in Table 1.During the period from the 20th June to 7 October, the grounds were subject to controlled commercial fishing activity during 2021.

Table 1: Date and survey method, Thames Estuary, 2021

Survey Area	Survey Date	Survey Method	Platform
Area 1 – Marsh End	26 April	Day grab	Tamesis FPV
Areas 2 & 3	13 April	Quadrat	All-terrain vehicles
Areas 4, 5 & 6 (Spring)	10 – 14 April	Quadrat	All-terrain vehicles
Areas 4, 5 & 6 (Autumn)	8 – 12 September	Quadrat	All-terrain vehicles
Area 7 – (N. Foulness)	Not surveyed 2021		
Area 7 – Ray Sand	25, 26, 29 May	Day grab	Tamesis FPV
Area 7 – Dengie	24 May	Day grab	Tamesis FPV
Area 7 – Buxey	27 April, 11, 26, 27 May	Day grab	Tamesis FPV
Area 8 – East Barrow	31 March	Day grab	Tamesis FPV
Area 8 – West Barrows*	23 April	Day grab	Tamesis FPV
Area 9/12 – Mouse/Knob	30 March	Day grab	Tamesis FPV
Area 10 – Leysdown & Ham	26, 29 April	Day grab	Nerissa FPV
Area 13 - Scrapsgate	29 April	Day grab	Nerissa FPV
Area 14 – Minnis Bay	19, 29 April	Day grab	Nerissa FPV
Area 14 – Margate Hook*	16 April	Day grab	Nerissa FPV
Area 14 – Margate Sands*	16, 19, 28 April	Day grab	Nerissa FPV
Area 15 – Margate Sands*	19, 27 April	Day grab	Nerissa FPV
Area 17 – Pegwell Bay	Not surveyed 2021		

* Sites which were had a follow up survey carried out during summer (July 2021), see Annex 1.

2.3 Survey Array

Cockle sampling was carried out over a predetermined systematic sampling grid, for which their geographical localities are kept consistent over time to allow comparing the same areas over time. The sampling grid consisted of a series of parallel transect lines which were evenly spaced across the cockle beds. Samples were taken at predetermined points along each transect line. All samples were taken at positions recorded by GPS to be within 10 m of the target transect position, unless otherwise recorded.

The majority of the surveys utilised a sample grid consisting of one quarter of a minute latitude by one quarter of a minute longitude (464 m by 290 m) apart. Autumn surveys of the Maplin sands (areas 4, 5 & 6) use a sample grid of one-half minute latitude by one quarter of a minute longitude, covering the same total area.
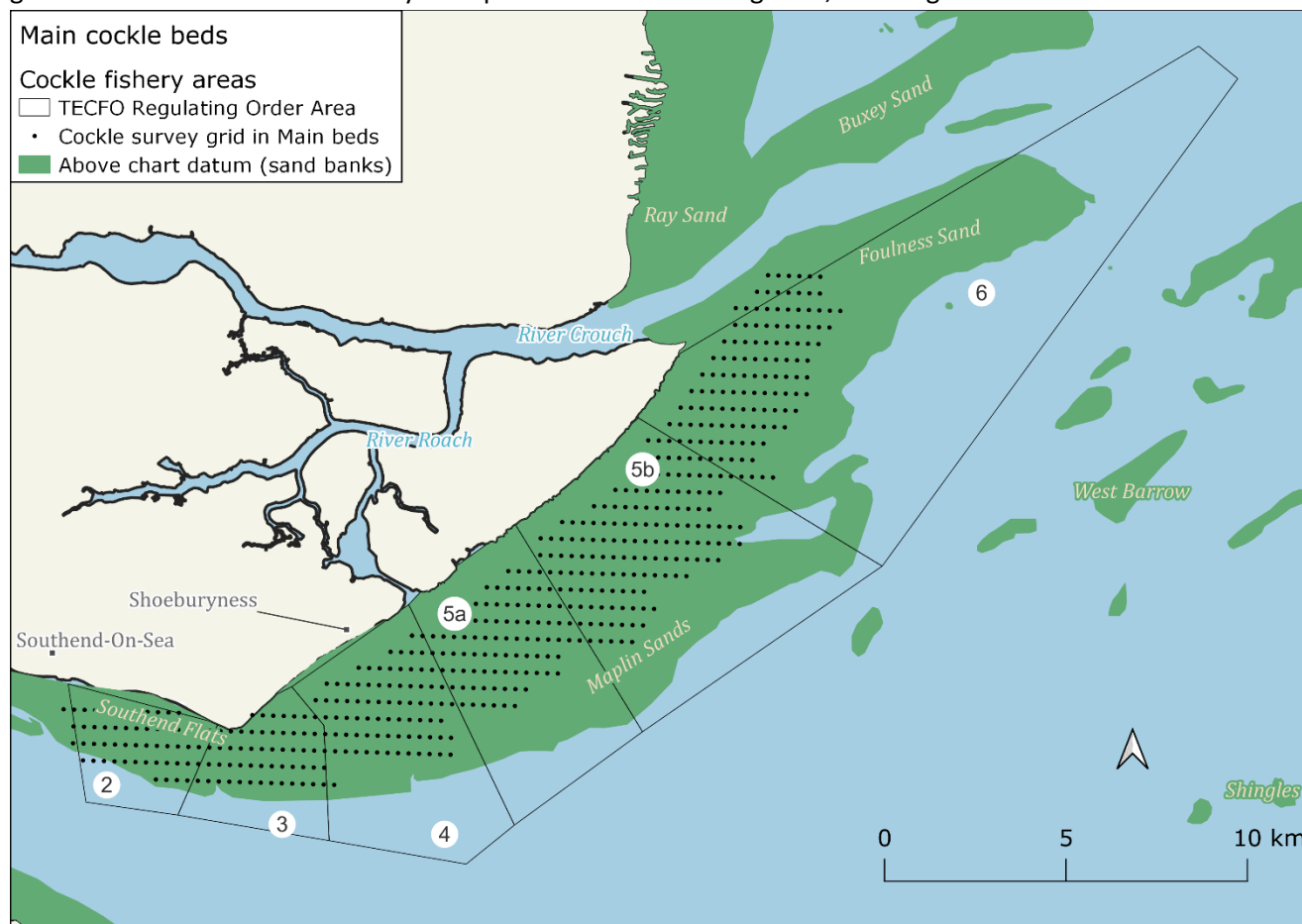
Figure 3: Cockle survey sampling positions in the main cockle harvesting areas: 2, 3, 4, 5a, 5b and 6

2.4 Area covered by survey

A total of 1214 samples were taken during the 2021 spring surveys, and a further 205 during Autumn. The spring surveys covered an area of 158.5 km² (not including additional surveys in areas which were surveyed multiple times – see Annex 1) (Table 2)

Table 2: Number of samples taken and area of cockle beds surveyed in the Thames Estuary in 2021.

Area	Number of samples	Area surveyed (km²)
1 Marsh End (includes Chapman Sands)	41	2.8
2 East of pier	52	7.0
3 West of Shoebury boom	50	6.7
4 East of Shoebury boom	76	10.2
4 East of Shoebury boom (autumn)	41	10.2
5 Maplin Sands	221	29.7
5 Maplin Sands (autumn)	110	29.7
6 North Maplin and Foulness Sand	111	14.9

6 North Maplin and Foulness Sand (autumn)	54	14.9
7 Buxey	110	14.8
7 Dengie	52	7.0
7 Ray Sands	103	13.9
8 East Barrow and Maplin Spit	63	8.5
9-12 Mouse Knob	49	6.6
9 West Barrows	30	4.0
10 Leysdown	41	5.5
13 Scrapsgate	15	1.0
14 Margate Hook	12	1.6
14 Margate Sand	100	13.5
14 Minnis Bay	17	1.2
15 Margate Sand	71	9.6
Spring totals	**1214**	**158.5**
Autumn totals	**205**	**54.8**
Overall totals	**1419**	**213.3**

*(All samples in spring unless otherwise stated, blue represents spring samples, and orange-yellow represents autumn samples)

2.5   Data analysis

The mean density of cockles in a given cockle management area, together with the size of the area (km^2) was used to calculate the number of each year class of cockles in that area. The number of cockles and the mean weight of cockles in each age class were used to calculate the biomass of each year and size class of cockles within each cockle management area. The proportions of cockles above and below 16 mm were used to calculate the biomass of each year class cockles in that area above and below 16 mm.

3   RESULTS

- MAIN BEDS -

AREA 2

3.1   Area 2 stock assessment (spring survey)

A total of 52 sites were sampled covering a total area of 7.0 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 3 and a summary of the stock assessment is presented below.

Table 3: Area 2 stock parameters, spring 2021

	No. Samples	Area size	Year Class			
			2020	**2019**	**2018**	**2017**
Area 2	52	7.0	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			6.7	140.0	36.9	1.9
Stock (millions)			47.1	979.6	258.4	13.5
Mean Weight (g)			0.7	2.1	3.2	5.5
Biomass (tonnes)			33.1	2077.0	834.2	74.0
Biomass below 16 mm			33.1	2077.0	776.4	22.9
Biomass 16 mm and above			0.0	0.0	57.7	51.1

Summary of stock assessment for Area 2 (spring survey)

The final stock estimation, based on the survey area of **7.0 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **47.1 million**
Total number of 2019 and older year class   **1251.4 million**

Total stock biomass
Total stock (all cockles)   **1298.5 tonnes**
Total stock biomass   - cockles below 16mm   **2909.4 tonnes**
                                       - cockles 16mm and above   **108.9 tonnes**

AREA 3

3.2   Area 3 assessment of stock (spring survey)

A total of 52 sites were sampled covering a total area of 7.0 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 4 and a summary of the stock assessment is presented below.

Table 4: Area 3 stock parameters, spring 2021

Area 3	No. Samples	area size	Year Class			
			2020	**2019**	**2018**	**2017**
	50	6.7	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			14.8	50.2	86.8	11.8
Stock (millions)			99.6	337.7	584.0	79.4
Mean Weight (g)			0.9	2.0	3.0	1.1
Biomass (tonnes)			86.9	662.0	1733.3	89.9
Biomass below 16 mm			86.9	662.0	1674.6	82.4
Biomass 16 mm and above			0.0	0.0	58.7	7.5

Summary of stock assessment for Area 3 (spring survey):

The final stock estimation, based on the survey area of **6.7 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **99.6 million**
Total number of 2019 and older year class   **1001.1 million**

Total stock biomass
Total stock (all cockles)   **2572.1 tonnes**
Total stock biomass   - cockles below 16mm   **2505.9 tonnes**
                                        - cockles 16mm and above   **66.2 tonnes**

AREA 4

3.3   Area 4 assessment of stock (spring survey)

A total of 76 sites were sampled covering a total area of 10.2 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 5 and a summary of the stock assessment is presented below. The distribution of each year class is presented in Figures 3 – 7.

Table 5: Area 4 stock parameters, spring 2021

Area 4	No. Samples	Area km²	Year Class			
			2020	**2019**	**2018**	**2017**
	76	10.2	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			42.8	122.5	70.3	11.4
Stock (millions)			437.3	1252.8	718.6	117.1
Mean Weight (g)			0.7	3.5	3.7	5.6
Biomass (tonnes)			302.8	4351.9	2654.5	659.0
Biomass below 16 mm			302.8	4163.2	1832.8	138.1
Biomass 16 mm and above			0.0	188.8	821.8	520.9

Summary of stock assessment for Area 4 (spring survey)

The final stock estimation, based on the survey area of **10.2 km²** are as follows:

Total number of cockles:
Total number of 2020 year class   **437.3 million**
Total number of 2019 and older year class   **2088.4 million**

Total stock biomass
Total stock (all cockles)   **7968.2 tonnes**
Total stock biomass   - cockles below 16mm   **6436.8 tonnes**
                                           - cockles 16mm and above   **1531.4 tonnes**

AREA 4

3.4   Area 4 assessment of stock (autumn survey)

The mean density, total stock, mean weight and biomass of each year class of cockles from the autumn 2021 survey are presented in Table 6 and a summary of the stock assessment is presented below. The density and distribution of spat is presented in Figures 3 – 7.

Table 6: Area 4 stock parameters, autumn 2021

Area 4	No. Samples	Area km²	Year Class			
			2021	2020	2019	2018
	41	10.2	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			135.1	35.9	130.5	62.7
Stock (millions)			1381.8	366.7	1334.4	641.0
Mean Weight (g)			0.2	2.0	3.6	5.1
Biomass (tonnes)			219.5	748.1	4832.3	3298.2
Biomass below 16 mm			219.5	748.1	4031.7	1044.3
Biomass 16 mm and above			0.0	0.0	800.7	2253.9

Summary of stock assessment for Area 4 (autumn survey)

The final stock estimation, based on the survey area of **10.2 km²** are as follows:

Total number of cockles
Total number of 2021 year class   **1381.8 million**
Total number of 2020 and older year class   **2342.1 million**

Total stock biomass
Total stock (all cockles)   **9098.1 tonnes**
Total stock biomass   - cockles below 16mm   **6043.5 tonnes**
                                          - cockles 16mm and above   **3054.6 tonnes**

AREA 5

3.5   Area 5 assessment of stock (spring survey)

A total of 221 sites were sampled covering a total area of 29.7 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 7 and a summary of the stock assessment is presented below. The distribution of each year class is presented in Figures 3 – 7.

Table 7: Area 5 stock parameters, spring 2021

Area 5	No. samples	area km²	Year Class			
			2020	**2019**	**2018**	**2017**
	221	29.7	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			38.3	30.5	51.1	21.8
Stock (millions)			1139.7	906.9	1519.2	648.6
Mean Weight (g)			0.7	2.7	4.1	5.7
Biomass (tonnes)			818.1	2403.4	6302.8	3665.9
Biomass below 16 mm			818.1	2301.3	3487.8	371.0
Biomass 16 mm and above			0.0	102.0	2815.0	3294.9

Summary of stock assessment for Area 5 (spring survey)

The final stock estimation, based on the survey area of **29.7 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **1139.7 million**
Total number of 2019 and older year class   **3074.7 million**

Total stock biomass
Total stock (all cockles)   **13190.2 tonnes**
Total stock biomass   - cockles below 16mm   **6978.3 tonnes**
                                          - cockles 16mm and above   **6212.0 tonnes**

3.6 Area 5 assessment of stock (autumn survey)

The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 8 and a summary of the stock assessment is presented below. The density and distribution of spat is presented in Figures 3 -7.

Table 8: Area 5 stock parameters, autumn survey 2021

Area 5	No. samples	Area km²	Year Class			
			2021	2020	2019	2018
	110	29.7	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			146.1	38.0	38.9	44.4
Stock (millions)			4344.4	1130.0	1157.1	1319.3
Mean Weight (g)			0.1	2.1	3.6	5.5
Biomass (tonnes)			551.5	2414.7	4173.5	7198.5
Biomass below 16 mm			551.5	2414.7	3064.9	848.5
Biomass 16 mm and above			0.0	0.0	1108.6	6350.0

Summary of stock assessment for Area 5 (autumn survey)

The final stock estimation, based on the survey area of **29.7 km²** are as follows:

Total number of cockles
Total number of 2021 year class   **4344.4 million**
Total number of 2020 and older year class   **3606.4 million**

Total stock biomass
Total stock (all cockles)   **14338.2 tonnes**
Total stock biomass   - cockles below 16mm   **6879.5 tonnes**
                                       - cockles 16mm and above **7458.7 tonnes**

3.7   Area 6 assessment of stock (spring survey)

A total of 111 sample sites were surveyed covering an area of 14.9 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 9 and a summary of the stock assessment is presented below. The distribution of each year class is presented in Figures 3 – 7.

Table 9: Area 6 stock parameters, spring 2021

Area 6	No. samples	Area km²	Year Class			
			2020	**2019**	**2018**	**2017**
	111	14.9	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			7.9	9.9	23.5	16.1
Stock (millions)			118.4	148.0	351.2	240.9
Mean Weight (g)			0.7	2.2	3.6	4.9
Biomass (tonnes)			86.1	325.6	1252.4	1186.8
Biomass below 16 mm			86.1	325.6	987.3	310.8
Biomass 16 mm and above			0.0	0.0	265.1	876.0

Summary of stock assessment for Area 6, spring survey

The final stock estimation, based on the survey area of **14.9 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **118.4 million**
Total number of 2019 and older year class   **740.1million**

Total stock biomass
Total stock (all cockles)   **2851.0 tonnes**
Total stock biomass   - cockles below 16mm   **1709.9 tonnes**
                                             - cockles 16mm and above   **1141.0 tonnes**

3.8   Area 6 assessment of stock (autumn survey)

The mean density, total stock, mean weight and biomass of each year class of cockles form the 2021 autumn survey are presented in Table 10 and a summary of the stock assessment is presented below. The density and distribution of spat is presented in Figures 3 – 7.

Table 10: Area 6 stock parameters, autumn 2021

Area 6	No. samples	Area km²	Year Class			
			2021	2020	2019	2018
	54	14.9	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			82.2	29.4	19.8	24.6
Stock (millions)			1228.1	439.8	296.0	367.9
Mean Weight (g)			0.1	2.0	3.5	5.0
Biomass (tonnes)			130.0	870.5	1025.6	1856.3
Biomass below 16 mm			130.0	870.5	764.8	345.2
Biomass 16 mm and above			0.0	0.0	260.8	1511.1

Summary of stock assessment for Area 6 (autumn survey)

The final stock estimation, based on the survey area of **14.9 km²** are as follows:

Total number of cockles
Total number of 2021 year class   **1228.1 million**
Total number of 2020 and older year class   **1103.6 million**

Total stock biomass
Total stock (all cockles)   **3882.4 tonnes**
Total stock biomass   - cockles below 16mm   **2110.5 tonnes**
                         - cockles 16mm and above   **1771.9 tonnes**

3.9 Distribution of cockles in the main beds (areas 4, 5 & 6)
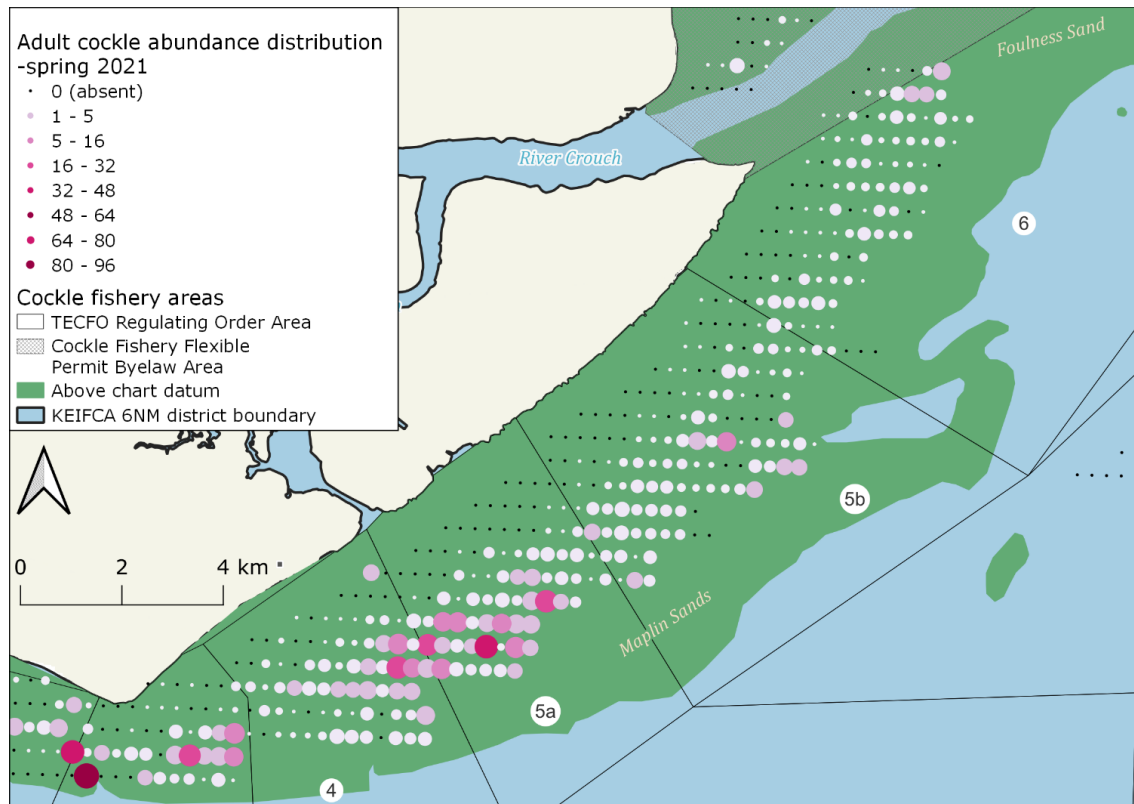
Figure 3: Distribution of 2 year and older (2017, 2018) adult class cockles in a subset of the main beds (focussing on areas 4, 5 & 6), Thames Estuary, spring 2021.
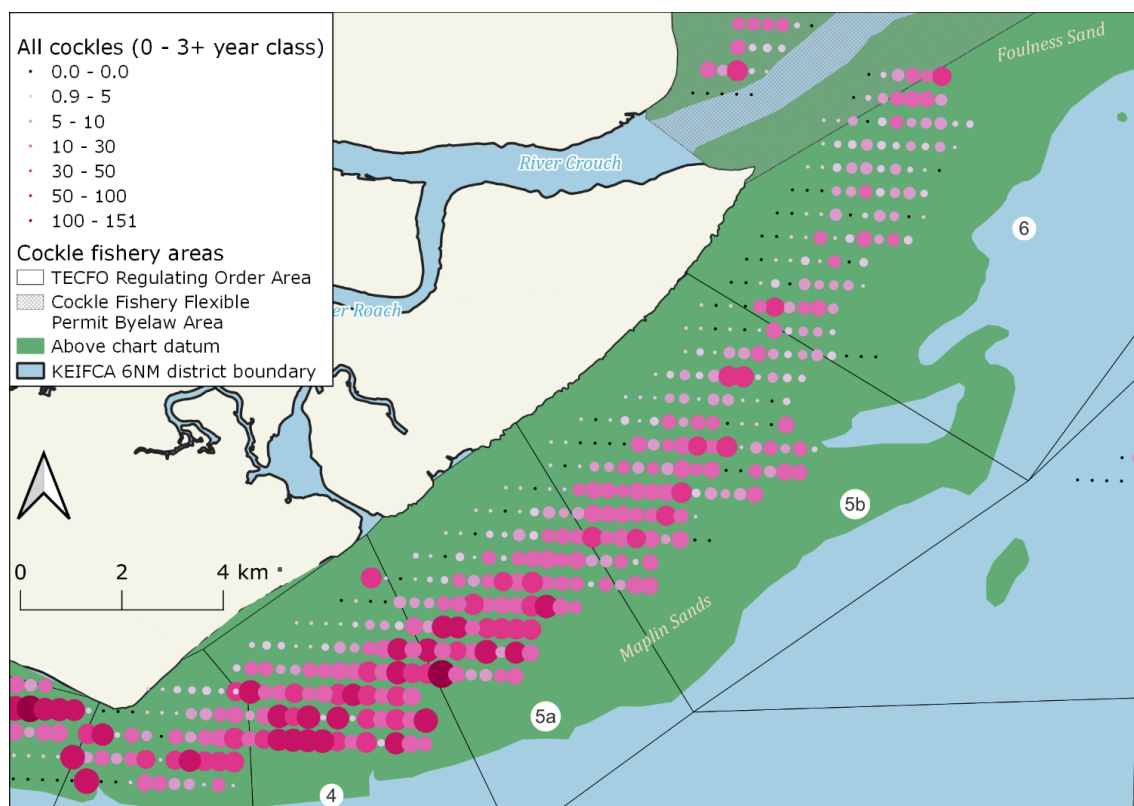
Figure 4: Distribution of all cockles (0 to 3+ year classes, where 3+ is the 2017 year class) in areas 4, 5 & 6 of the Thames Estuary, spring 2021
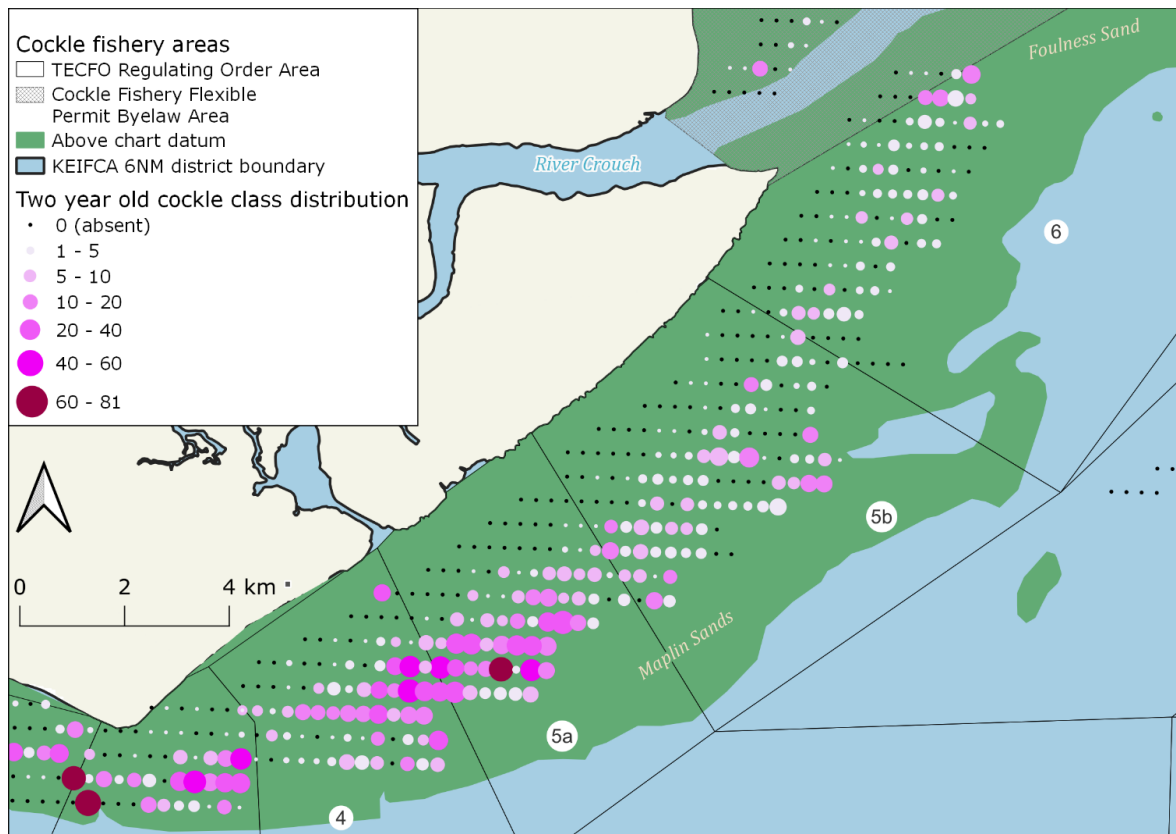
Figure 5: Distribution of 2-year-old class (2018) year class cockles in areas 4, 5 & 6 of the Thames Estuary, spring 2021
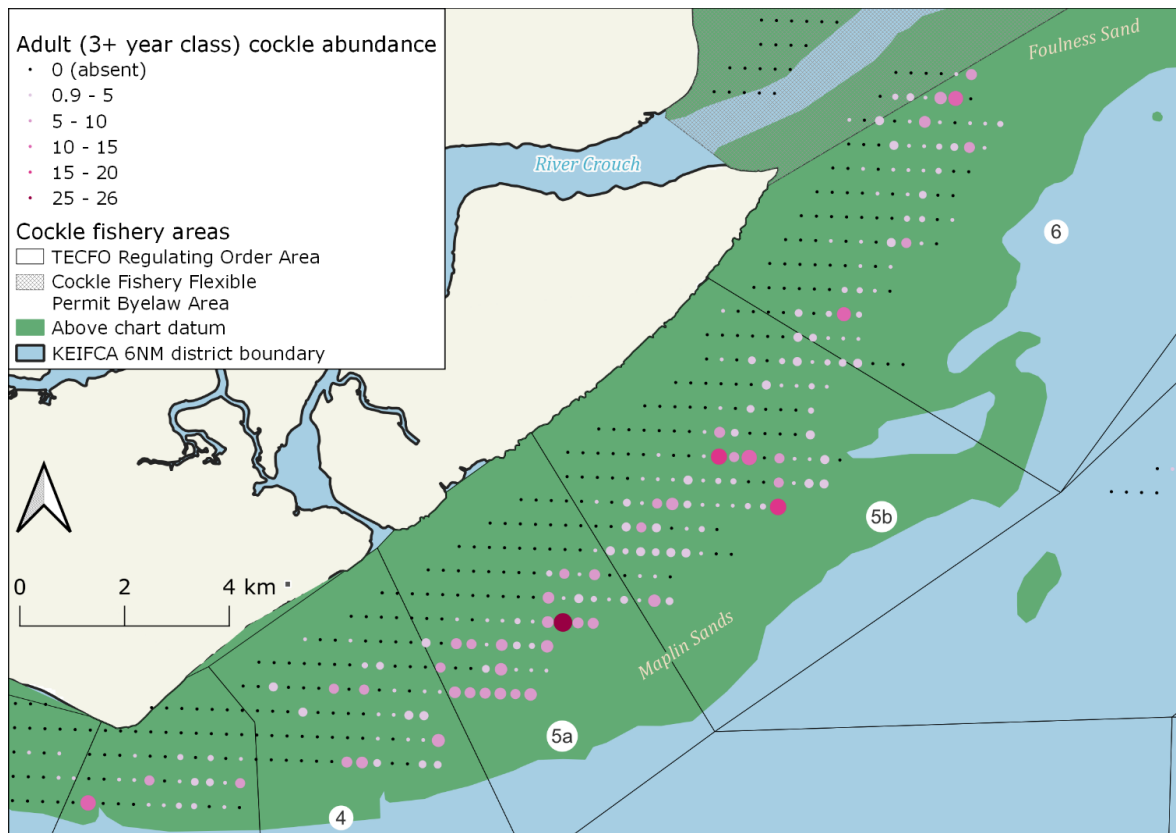
Figure 6: Distribution of 3-year-and_older year class (2017 and earlier) cockles in areas 4, 5 & 6 of the Thames Estuary, spring 2021
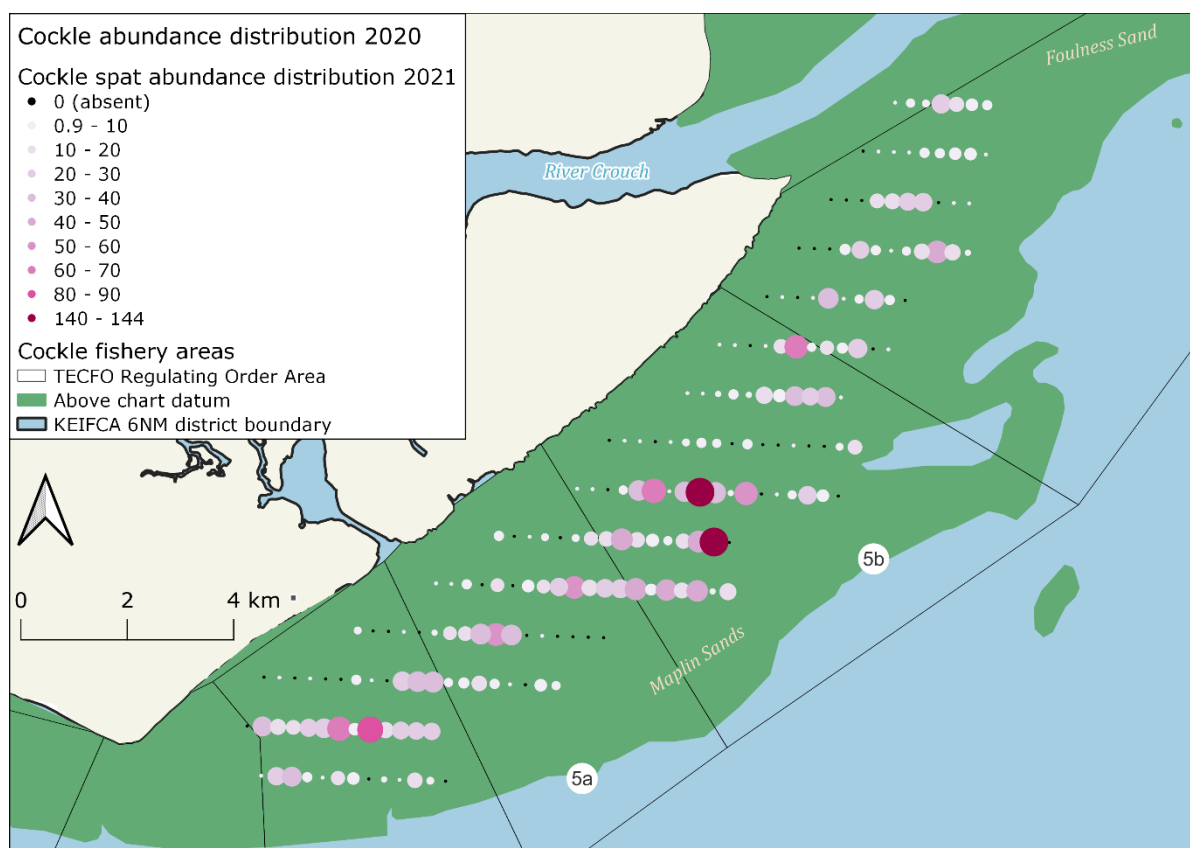
Figure 7. Distribution of cockle spat (0-year-class) in areas 4, 5 & 6 of the Thames Estuary, autumn 2021

3.10   Area 1 – Marsh End assessment of stocks

A total of 41 sampling stations were surveyed in Marsh End covering an area of 2.8 km^2. The mean density, total stock, mean weight and biomass of each year class of cockles are presented below in Table 11, and a summary of the stock assessment is presented below. Marsh End's 1- 2 years class had the highest density of 1 -2-year-old cockles of all the TECFO cockle fishing areas. The area contributed a disproportionately high biomass of cockles in this age class to the overall stock in the TECFO area, but had relatively low abundance and biomass for cockles older than 2 years, and a very low level of recruitment (2020 year class) observed during the spring 2021 survey.

Table 11: Marsh End stock parameters

			Year Class			
Area 1	**No. Samples**	**Area km^2**	**2020**	**2019**	**2018**	**2017**
	41	2.8	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.2	216.3	7.6	0.7
Stock (millions)			0.7	596.8	20.9	2.0
Mean Weight (g)			2.0	2.6	4.7	9.5
Biomass (tonnes)			1.3	1560.6	97.3	19.2
Biomass below 16 mm			1.3	1525.8	38.2	0.0
Biomass 16 mm and above			0.0	0.0	34.9	59.1

Summary of stock assessment for Area 1 – Marsh End

The final stock estimation, based on the survey area of **2.8 km²** are as follows:

Total number of cockles:

Total number of 2020 year class	**0.7 million**
Total number of 2019 and older year class	**619.6 million**

Total stock biomass		
Total stock (all cockles)		**1678.5tonnes**
Total stock biomass	- cockles below 16mm	**1565.4 tonnes**
	- cockles 16mm and above	**113.1 tonnes**

3.11 Area 7 – Ray Sands assessment of stocks

A total of 103 sampling stations were surveyed covering an area of 13.9 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented below in Table 12, and a summary of the stock assessment is presented below. The majority of the total stock biomass was comprised by the high density of the 1 - 2-year-old age class and supplemented by the comparatively low density but high mean weight per cockle in the 2 – 3 year age class.

Table 12: Ray Sands stock parameters

Area 7 - Ray	No. Samples	Area km²	Year Class			
			2020	**2019**	**2018**	**2017**
	103	13.9	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			4.6	44.1	11.9	0.0
Stock (millions)			63.2	610.9	165.5	0.0
Mean Weight (g)			0.1	2.5	5.9	0.0
Biomass (tonnes)			6.0	1501.0	982.6	0.0
Biomass below 16 mm			6.0	1501.0	547.5	0.0
Biomass 16 mm and above			0.0	0.0	435.2	0.0

Summary of stock assessment for Area 7 – Ray Sands

The final stock estimation, based on the survey area of **13.9 km²** are as follows:

Total number of cockles:

Total number of 2020 year class	**63.2 million**
Total number of 2019 and older year class	**776.4 million**

Total stock biomass	
Total stock (all cockles)	**2489.7 tonnes**
Total stock biomass - cockles below 16 mm	**2054.5 tonnes**
- cockles 16 mm and above	**435.2 tonnes**

3.12   Area 7 – Dengie Flats assessment of stock

A total of 52 sampling stations were surveyed covering an area of 7.0 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented below in Table 13, and a summary of the stock assessment is presented below. The high density of the 1-2 year class, all under 16 mm, contributed 84 % of the area's stock biomass.

Table 13: Dengie Flats stock parameters

Area 7 - Dengie	No. Samples	Area km²	Year Class			
			2020	**2019**	**2018**	**2017**
	52	7.0	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	46.7	9.8	0.0
Stock (millions)			0.0	326.5	68.6	0.0
Mean Weight (g)			0.0	3.6	3.2	0.0
Biomass (tonnes)			0.0	1174.5	216.8	0.0
Biomass below 16 mm			0.0	1174.5	216.8	0.0
Biomass 16 mm and above			0.0	0.0	0.0	0.0

Summary of stock assessment for Area 7 – Dengie Flats

The final stock assessment, based on the survey area of **7.0 km²** is as follows:

Total number of cockles:

Total number of 2020 year class	**0**
Total number of 2019 and older year class	**395.1 million**

Total stock biomass	
Total stock (all cockles)	**1391.2 tonnes**
Total stock biomass - cockles below 16mm	**1391.2 tonnes**
- cockles 16mm and above	**0 tonnes**

3.13 Area 7 – Buxey Sands assessment of stocks

A total of 110 sampling stations were surveyed covering an area of 14.8 km^2. The mean density, total stock, mean weight and biomass of each year class of cockles are presented below in Table 14, and a summary of the stock assessment is presented below. There were no cockles in the 0 -1 year class recorded in spring 2021 in the Buxey Sands sampling area, but the majority of the stock biomass for the area was contributed by the relatively high density of 1 – 2 old year class (847.1 tonnes).

Table 14: Buxey Sands stock parameters

Area 7 – Buxey Sands	No. Samples	Area km^2	Year Class			
			2020	2019	2018	2017
	110	14.8	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	17.7	5.3	0.9
Stock (millions)			0.0	262.4	78.0	13.5
Mean Weight (g)			0.0	3.2	5.2	7.1
Biomass (tonnes)			0.0	847.1	404.4	95.7
Biomass below 16 mm			0.0	847.1	43.6	7.5
Biomass 16 mm and above			0.0	0.0	360.8	88.2

Summary of stock assessment for Area 7 – Buxey Sands

The final stock assessment, based on the survey area of **14.8 km^2** is as follows:

Total number of cockles:

Total number of 2020 year class	**0**
Total number of 2019 and older year class	**353.9 million**

Total stock biomass	
Total stock (all cockles)	**1347.2 tonnes**
Total stock biomass - cockles below 16mm	**898.1 tonnes**
- cockles 16mm and above	**449.0 tonnes**

AREA 8

3.14   Area 8 – East Barrow assessment of stock

A total of 63 sampling stations were surveyed covering an area of 8.5 km² in the East Barrows. The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 15 and a summary of the stock assessment is presented below. No individuals were recorded in the 0 – 1 year class in spring 2021. The larger 16 mm age class contributed most to the area's biomass (928 .5 tonnes).

Table 15: East Barrow stock parameters

Area 8	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	63	8.5	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	7.9	0.0	8.4
Stock (millions)			0.0	67.3	0.0	71.3
Mean Weight (g)			0.0	1.7	0.0	13.0
Biomass (tonnes)			0.0	114.4	0.0	928.5
Biomass below 16 mm			0.0	85.0	0.0	0.0
Biomass 16 mm and above			0.0	0.0	0.0	928.5

Summary of stock assessment for Area 8 – East Barrow

The final stock estimation, based on the survey area of **8.5 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **0**
Total number of 2019 and older year class   **138.6 million**

Total stock biomass
Total stock (all cockles)   **1042.8 tonnes**
Total stock biomass   - cockles below 16mm   **85.0 tonnes**
                                           - cockles 16mm and above   **928.5 tonnes**

3.15 Area 8 – East Barrow assessment of stock

A total of 29 sampling stations were surveyed covering an area of 3.9 km² in the West Barrows. The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 16 and a summary of the stock assessment is presented below. No individuals were recorded in the 0 – 1 year class during the spring 2021 survey. The larger 16 mm age class contributed most to the area's biomass (68.9 tonnes).

Table 16. East Barrow stock parameters

Area 8	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	29	3.9	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	1.7	0.0	1.3
Stock (millions)			0.0	6.5	0.0	5.2
Mean Weight (g)			0.0	1.6	0.0	13.3
Biomass (tonnes)			0.0	10.4	0.0	68.9
Biomass below 16 mm			0.0	8.0	0.0	0.0
Biomass 16 mm and above			0.0	0.0	0.0	68.9

Summary of stock assessment for Area 8 – East Barrow

The final stock estimation, based on the survey area of **3.9 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **0**
Total number of 2019 and older year class   **11.7 million**

Total stock biomass
Total stock (all cockles)   **79.3 tonnes**
Total stock biomass   - cockles below 16mm   **8.0 tonnes**
                                       - cockles 16mm and above   **68.9 tonnes**

3.16 Area 9/12 – Mouse/Knob assessment of stock

A total of 49 sampling stations were surveyed in the Mouse knob area covering a surface area of 6.6 km². The mean density, total stock, mean weight and biomass of each year class of cockles are presented in Table 17 and a summary of the stock assessment is presented below. The biomass for the area was extremely low, estimated at 47.1 tonnes with very low or zero densities for all age classes.

Table 17: Mouse/Knob stock parameters

Area 9/12	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	49	6.6	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.00	0.61	0.00	0.41
Stock (millions)			0.00	4.04	0.00	2.69
Mean Weight (g)			0.00	1.67	0.00	15.00
Biomass (tonnes)			0.00	6.73	0.00	40.37
Biomass below 16 mm			0.00	6.73	0.00	0.00
Biomass 16 mm and above			0.00	0.00	0.00	0.00

Summary of stock assessment for Area 9/12 – Mouse/Knob

The final stock estimation, based on the survey area of **6.6 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **0**
Total number of 2019 and older year class   **6.7 million**

Total stock biomass
Total stock (all cockles)   **47.1 tonnes**
Total stock biomass   - cockles below 16mm   **6.7 tonnes**
                                         - cockles 16mm and above   **0 tonnes**

3.17 Area 10 - Leysdown assessment of stock

A total of 41 sampling stations were surveyed in Leysdown covering an area of 5.5 km². The mean density, total stock, mean weight and biomass of each year class of cockles' age presented in Table 18 and a summary of the stock assessment is presented below. The total biomass for Leysdown was relatively low (356 tonnes) compared to other areas, and the bulk of the biomass was comprised of 2 – 3 year age class cockles of which the majority were over 16 mm.

Table 18: Leysdown stock parameters

Area 10	No. Samples	Area km²	Year Class			
			2020	**2019**	**2018**	**2017**
	41	5.5	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			9.5	22.2	4.6	0.2
Stock (millions)			52.5	122.4	25.6	1.3
Mean Weight (g)			0.6	1.1	6.9	13.0
Biomass (tonnes)			31.8	130.4	176.3	17.5
Biomass below 16 mm			31.8	130.4	5.4	0.0
Biomass 16 mm and above			0.0	0.0	170.9	17.5

Summary of stock assessment for Area 10 - Leysdown

The final stock estimation, based on the survey area of **5.5 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **52.5 million**
Total number of 2019 and older year class   **149.9 million**

Total stock biomass
Total stock (all cockles)   **356.0 tonnes**
Total stock biomass   - cockles below 16mm   **167.6 tonnes**
                                          - cockles 16mm and above   **188.4 tonnes**

3.18   Area 13 - Scrapsgate assessment of stock

A total of 15 sampling stations were surveyed in Scrapsgate covering an area of 1.0 km². The mean density, total stock, mean weight and biomass of each year class of cockles' age presented in Table 19 and a summary of the stock assessment is presented below. The biomass for Scrapsgate was relatively low (245.6 tonnes) compared to other areas, and the bulk of the biomass was comprised of 2 – 3 year age class cockles, of which about half was over 16 mm in width.

Table 19: Scrapsgate stock parameters

Area 13	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	15	1.0	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	6.7	47.3	2.7
Stock (millions)			0.0	6.7	47.8	2.7
Mean Weight (g)			0.0	1.8	4.4	8.0
Biomass (tonnes)			0.0	12.1	211.9	21.5
Biomass below 16 mm			0.0	12.1	106.3	0.0
Biomass 16 mm and above			0.0	0.0	105.6	21.5

Summary of stock assessment for Area 13 - Scrapsgate

The final stock estimation, based on the survey area of **1.0 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **0**
Total number of 2019 and older year class   **57.2 million**

Total stock biomass
Total stock (all cockles)   **245.6 tonnes**
Total stock biomass   - cockles below 16mm   **118.4 tonnes**
                                        - cockles 16mm and above   **127.2 tonnes**

AREA 14

3.19 Area 14 – Minnis Bay assessment of stock

A total of 17 sampling stations were surveyed in Minnis Bay covering an area of 0.9 km². The mean density, total stock, mean weight and biomass of each year class of cockles' age presented in Table 20 and a summary of the stock assessment is presented below. The biomass for Minnis Bay was (582.4 tonnes) and the bulk of the biomass was comprised of 3+ year age class cockles, of which the majority was over 16 mm in width.

Table 20: Minnis Bay stock parameters

Area 14	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	17	0.9	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			67.1	7.6	21.2	55.3
Stock (millions)			61.2	7.0	19.3	50.4
Mean Weight (g)			0.9	1.4	5.9	8.0
Biomass (tonnes)			56.3	10.0	114.6	401.4
Biomass below 16 mm			56.3	8.5	0.0	0.0
Biomass 16 mm and above			0.0	1.5	114.6	401.4

Summary of stock assessment for Area 14 - Minnis Bay

The final stock estimation, based on the survey area of **0.9 km²** are as follows:

Total number of cockles
Total number of 2020 year class **61.2 million**
Total number of 2019 and older year class **76.7 million**

Total stock biomass
Total stock (all cockles) **582.4 tonnes**
Total stock biomass   - cockles below 16mm **64.8 tonnes**
                        - cockles 16mm and above **517.5 tonnes**

AREA 14

3.20   Area 14 – Margate Hook assessment of stock

A total of 12 sampling stations were surveyed in Margate Hook covering an area of 1.6 km². The mean density, total stock, mean weight and biomass of each year class of cockles' age presented in Table 21 and a summary of the stock assessment is presented below. The biomass for Margate Hook was 20.2 tonnes and the bulk of the biomass was comprised of 2 – 3 year age class cockles, of which the all was over 16 mm in width. This area was surveyed for the first time in 2021 to explore cockle stock on the shallow sand banks in the area. As this area only had extremely low levels of stock KEIFCA will consider dropping this area from the 2022 survey.

Table 21: Margate Hook stock parameters

			Year Class			
Area 14 - Margate Hook	**No. Samples**	**Area km²**	**2020**	**2019**	**2018**	**2017**
	12	1.6	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	0.0	0.8	0.0
Stock (millions)			0.0	0.0	1.3	0.0
Mean Weight (g)			0.0	0.0	15.0	0.0
Biomass (tonnes)			0.0	0.0	20.2	0.0
Biomass below 16 mm			0.0	0.0	0.0	0.0
Biomass 16 mm and above			0.0	0.0	20.2	0.0

Summary of stock assessment for Area 14 - Margate Hook

The final stock estimation, based on the survey area of **1.6 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **0**
Total number of 2019 and older year class   **1.3 million**

Total stock biomass
Total stock (all cockles)   **20.2 tonnes**
Total stock biomass   - cockles below 16mm   **0.0 tonnes**
                                            - cockles 16mm and above   **20.2 tonnes**

3.21 Area 14 – Margate Long Sands assessment of stock

A total of 68 sampling stations were surveyed in Margate Long Sands covering an area of 9.2 km². The mean density, total stock, mean weight and biomass of each year class of cockles' age presented in Table 22 and a summary of the stock assessment is presented below. The biomass for Margate Long Sands was 412.9 tonnes and the bulk of the biomass was comprised of 3+ year age class cockles, of which the majority was over 16 mm in width.

Table 22: Margate Long Sands stock parameters

Area 14 - Margate Long Sands	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	68	9.2	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.0	0.4	0.7	3.5
Stock (millions)			0.0	3.7	6.4	32.0
Mean Weight (g)			0.0	1.5	6.4	11.4
Biomass (tonnes)			0.0	5.5	41.0	366.4
Biomass below 16 mm			0.0	5.5	2.1	0.0
Biomass 16 mm and above			0.0	0.0	38.9	366.4

Summary of stock assessment for Area 14 - Margate Long Sands

The final stock estimation, based on the survey area of **9.2 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **0**
Total number of 2019 and older year class   **42.1 million**

Total stock biomass
Total stock (all cockles)   **412.9 tonnes**
Total stock biomass   - cockles below 16mm   **7.6 tonnes**
                                        - cockles 16mm and above   **405.3 tonnes**

AREA 15

3.22   Area 15 – Margate Long Sands assessment of stock

A total of 71 sampling stations were surveyed in Margate Long Sands covering an area of 9.6 km². The mean density, total stock, mean weight and biomass of each year class of cockles' age presented in Table 23 and a summary of the stock assessment is presented below. The biomass for Margate Long Sands in Area 15 was 898.1 tonnes and the bulk of the biomass was comprised of 3+ year age class cockles, of which all were over 16 mm in width.

Table 23: Margate Long Sands stock parameters

Area 15 - Margate Long Sands	No. Samples	Area km²	Year Class			
			2020	2019	2018	2017
	71	9.6	0-1 year	1-2 year	2-3 year	3+ years
Mean Density			0.1	0.1	2.4	5.2
Stock (millions)			1.3	1.3	22.9	49.8
Mean Weight (g)			0.0	1.0	8.6	14.1
Biomass (tonnes)			0.0	1.3	197.1	699.6
Biomass below 16 mm			0.0	1.3	0.0	0.0
Biomass 16 mm and above			0.0	0.0	197.1	699.6

Summary of stock assessment for Area 15 - Margate Long Sands

The final stock estimation, based on the survey area of **9.6 km²** are as follows:

Total number of cockles
Total number of 2020 year class   **1.3 million**
Total number of 2019 and older year class   **74.0 million**

Total stock biomass
Total stock (all cockles)   **898.1 tonnes**
Total stock biomass   - cockles below 16mm   **1.3 tonnes**
                                          - cockles 16mm and above   **896.7 tonnes**

3.23   Combined data for all surveys

In total, 222.4 km^2 of cockle beds were surveyed within the Thames estuary, with 1373 sites sampled during Spring and Autumn 2021, as shown in Table 24. Within a subset of the main harvesting areas (areas 4, 5 & 6) a calculated total of 5903 million adult cockles were present during the Spring survey, and a calculated 7052 million adult cockles upon completion of the Autumn survey. The total biomass of cockles above 16 mm in a subset of the main harvesting areas was 8884 tonnes during the spring and 10115 tonnes in the autumn.

Table 24: Survey area and cockle densities in the Thames Estuary, 2021

Area		Total number of samples		Total biomass of 1-3 yc (tonnes)		Total biomass above 16mm (tonnes)		Total no. of 1-3 yc cockles (million)	
	Area surveyed (km2)	Spring	Other	Spring	Other	Spring	Other	Spring	Other
1 Marsh End	2.8	30		1677.1		113.1		619.6	
2 Southend	7.0	52		2985.1		108.9		1251.4	
3 Southend	6.7	50		2485.2		66.2		1001.1	
4 Maplin Sands	10.2	76	41	7665.4	8878.6	1531.4	3054.6	2088.4	2342.1
5 Maplin Sands	29.7	221	110	12372.1	13786.7	6212.0	7458.7	3074.7	3606.4
6 Maplin Sands	14.9	111	54	2764.9	3752.4	1141.0	1771.9	740.1	1103.6
7 Ray Sands	13.9	102		2483.6		435.2		776.4	
7 Dengie	7.0	51		1391.2		0.0		395.1	
7 Buxey	14.8	110		1347.2		449.0		353.9	
7 Foulness North	0.0	0		not surveyed		not surveyed		not surveyed	
8 East Barrow	8.5	63		1042.8		928.5		138.6	
8 West Barrows	3.9	29		79.3		68.9			
9/12 Mouse Knob	6.6	49.0		47.1					
10 Leysdown	5.5	41		324.2		188.4		149.4	
13 Scrapsgate	1.0	15		245.6		127.2		57.2	
14 Minnis Bay	0.9	17		516.0		517.5		76.7	
14 Margate Hook	1.6	12.0		20.2		20.2			
14 Margate Long Sands	9.2	68.0		407.4		405.3			
15 Margate Long Sands	9.6	71.0		896.7					
17 Pegwell Bay	0.0	0		0.0		0.0		0.0	
Total	**222.4**	**1168.0**	**205.0**	**38751.3**	**26417.7**	**12312.7**	**12285.2**	**10722.6**	**7052.1**

Survival of cockles in areas 4, 5 & 6

Comparison of the mean cockle density calculated from the 2021 spring survey and the autumn survey results in 2020 indicate that the survival over the 2020/21 winter period was within the normal range, although slightly lower than in the previous year, and is indicated in Table 25 below. Mean survival of all the 2018+ year class (3+ year old class) was within normal between year variation, with a mean survival percentage of 39.6 % across areas 4, 5 & 6 over the 2020/21 winter. The survival rate of the 2020 and 2017 and 2016+ year classes was relatively low (under 10 %) in area 6, but within normal ranges in area 4 and 5.

Table 25. Mean density and winter survival rates of cockles from 2020 to 2021 by year class in areas 4, 5 & 6

	2020 Autumn Survey			2021 Spring Survey		
	mean density			mean density		
year class:	2020	2019	2018+	2020	2019	2018+
AREA 6 (57 rectangles)	65.9	20.4	75.2	7.9	9.9	39.6
AREA 5 (110 rectangles)	68.7	23.0	111.0	38.3	30.5	72.9
AREA 4 (36 rectangles)	57.1	67.8	228.6	42.8	122.5	81.7
Cockle stock remaining (Area 6)				13.9%	14.6%	17.3%
Cockle stock remaining (Area 5)				55.8%	132.9%	65.7%
Cockle stock remaining (Area 4)				74.9%	180.7%	35.7%
			Mean	48.2%	109.4%	39.6%

3.24 Long term trends in cockle populations within areas covered by the TECFO

Table 26: Autumn cockle stocks (millions) excluding spat within areas covered by the TECFO between 1993 & 2021

| YEAR | AREA | | | | | | | |
	1	2	3	4, 5 & 6	8 East Barrows	11	13	TOTAL
1993				4371	237			4608
1994			162	5721	287			6107
1995		1276	2783	6789	26			10874
1996		857	1064	4641	358			6920
1997		166	1053	3963	78			5260
1998		112	361	2154	77			2704
1999	246	1004	2087	13412	68			16817
2000		397	941	8117	18		655	10128
2001		256	582	4588	<1			5426
2002		395	445	3907	3	3228		7978
2003		529	1156	8104	0		420	5639
2004		448	1495	4312				6255
2005		797	1086	3420			90	5393
2006		405	545	6646	9	1278		11484
2007		755	1286	8966	8	4158		15173
2008	535	433	385	7960	8			9321
2009		618	1260	6976				8854
2010		1234	1126	5916	20		172	8468
2011		275	663	5084	11		61	6094
2012		198	480	3259			94	4031
2013	159	65	109	7561			85	7979
2014		30	127	5152				5309
2015				6026				6026
2016				3597				3597
2017				7589				7589
2018				12030				12030
2019				13318				13318
2020				8635.4				8635.4
2021				7052.1				7052.1

* For details on Margate Long Sands, part of area 15, See Annex 1

Table 27: Stocks of all cockles (millions), excluding spat, in main areas outside of those covered by the TECFO between 1997 & 2021

YEAR	Area 7 Dengie	Area 7 Buxey	Area 7 Ray	Area 10	Area 14* Minnis Bay	TOTAL
1997	138	84				232
1998	926	232			10	1168
1999	2173	1130				3702
2000	1992	296				2288
2001	1220	486				1506
2002	1031	340				1371
2003	507	561	1193			2161
2004	245	405	272	69	9	1000
2005	1640	1418	540	3		3601
2006	891	445	1090		327	2753
2007	1120	2041	2430		100	5691
2008	1105	2211	2106		359	5781
2009	391	475	875	73	62	1876
2010	231	522	955	117	19	1844
2011	878	632	1330	63	33	2936
2012	319	299	1005	367	9	1999
2013	225	312	811	176	3	1527
2014	120	131	981	44	67	1343
2015	231	101	560	16	47	954
2016	429	655	1000	18	21	2123
2017	192	472	389	192	90	1335
2018	424	863	1978	86	129	3480
2019	263	839	1559	Not surveyed	Not surveyed	2661
2020	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed
2021	395	354	776	149	77	1751

* For details on Margate Long Sands, part of area 14, See Annex 1

3.25 Comparison of long-term trends for areas 4, 5 & 6

Surveys of the Areas 4, 5 & 6 within the TECFO have now been carried out for almost two decades.

Adult cockle stocks followed continued a short-term declining trend (Figure 8). This is not a cause for concern at this stage because the stock size recorded over spring 2021 was not far below the long-term spring mean value. The stock size recorded over autumn 2021 was above the long-term autumn mean value. The substantial variation observed in the stock size over time appears to be driven by recruitment success and over winter survivorship (Table 25**Error! Reference source not found.**). The relatively low spatfall values in 2020 and 2021 suggests that the adult cockle population size for 2022's may be smaller than the preceding two years.

Adult stock before and after winter
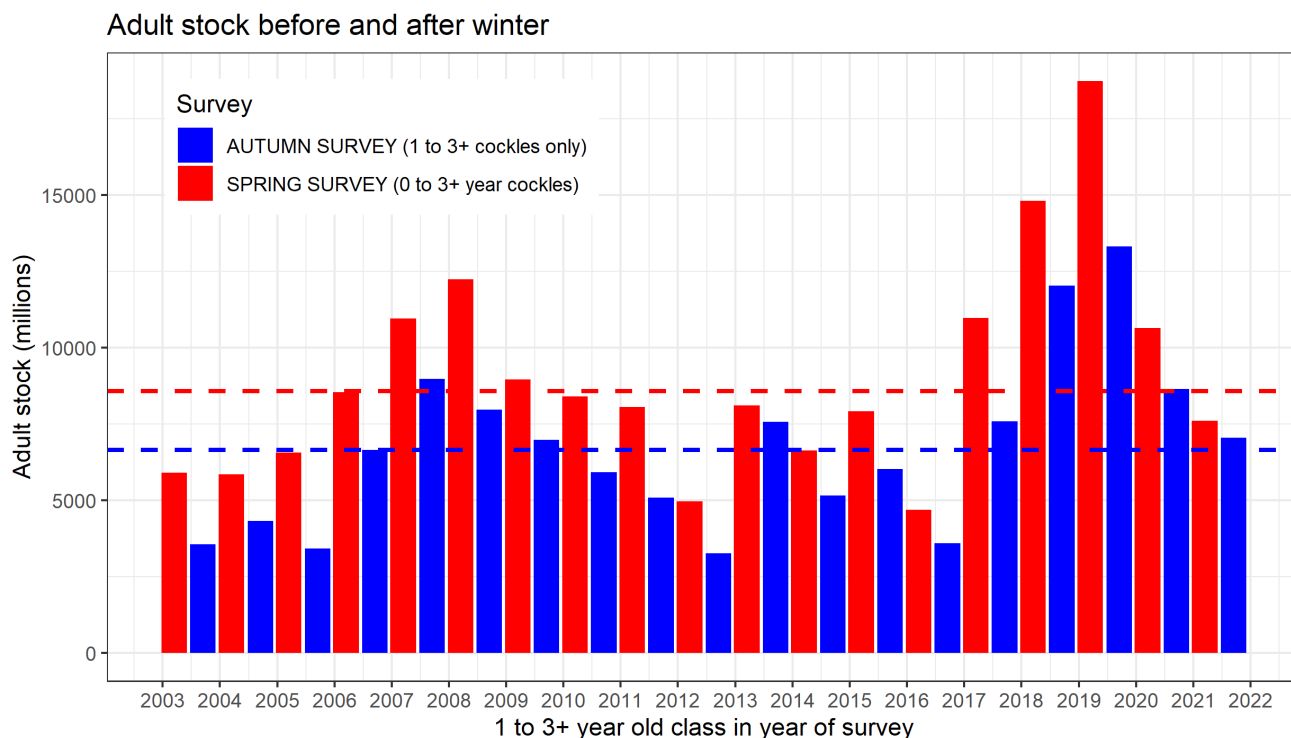
Figure 8: Adult cockle stocks (1 to 3+ year class in year of survey) on areas 4, 5 and 6 from 2003 to 2021, with mean values indicated by dashed lines for spring and autumn respectively.

Figure 9: Number of cockle spat before and after the first winter on areas 4, 5 and 6 from 2004-2021, with mean values indicated by dashed lines for spring and autumn respectively

3.26   Comparison of long-term trends for Area 4

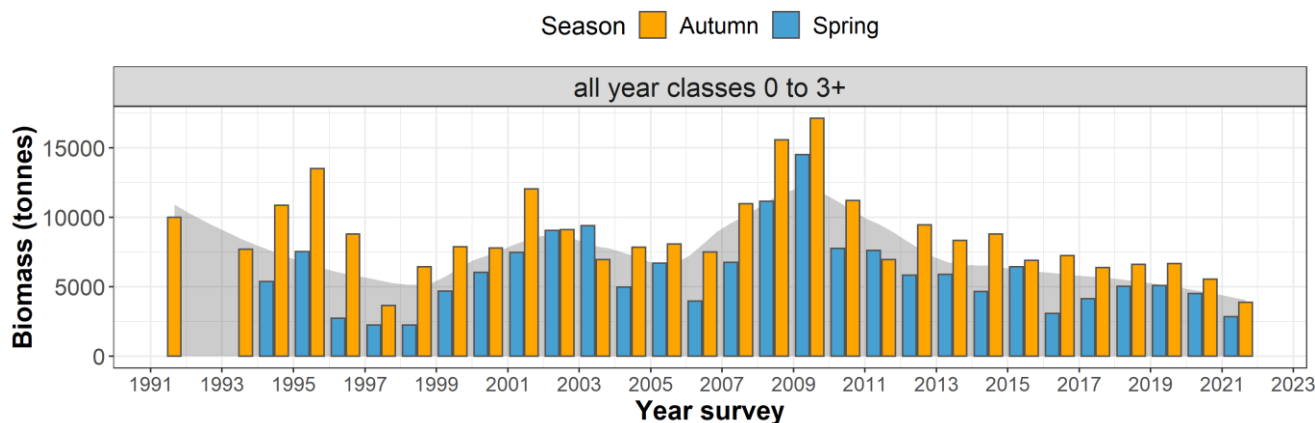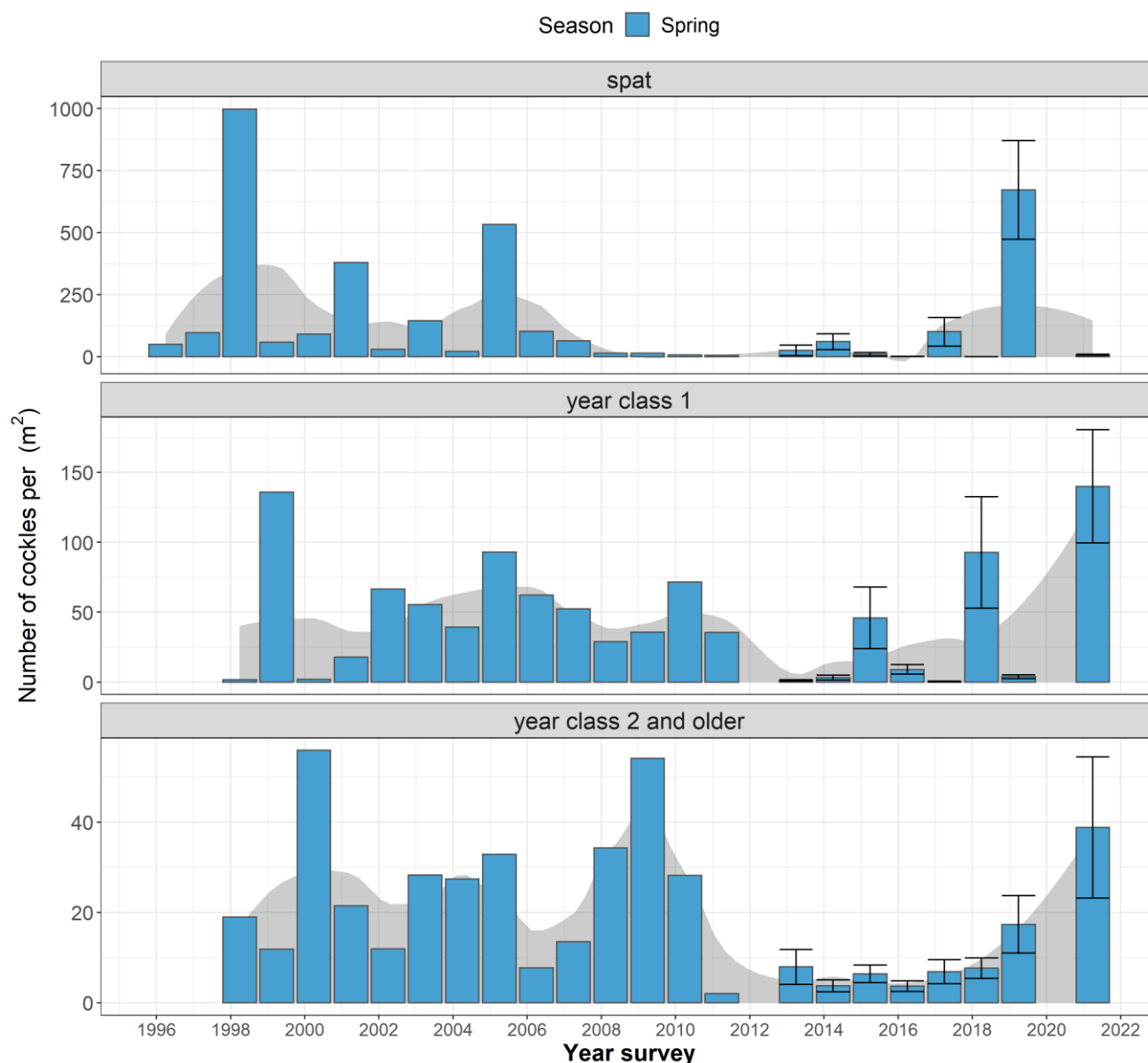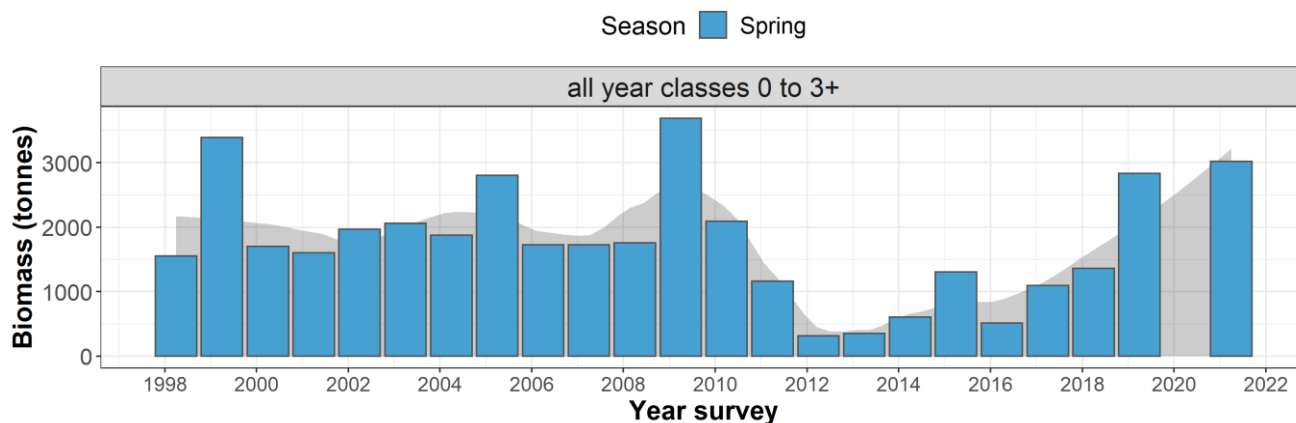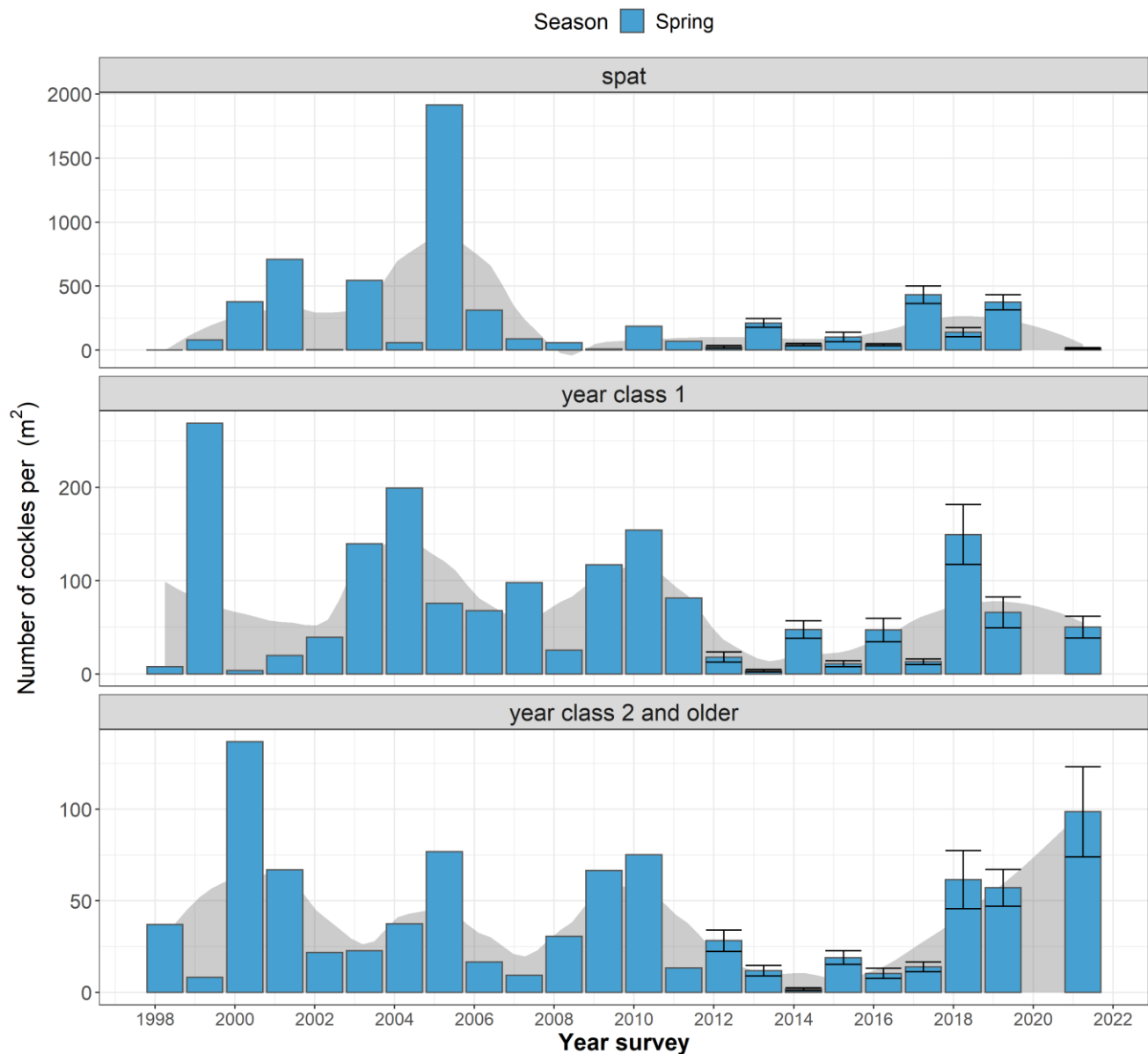**Cockle density for area: 4**
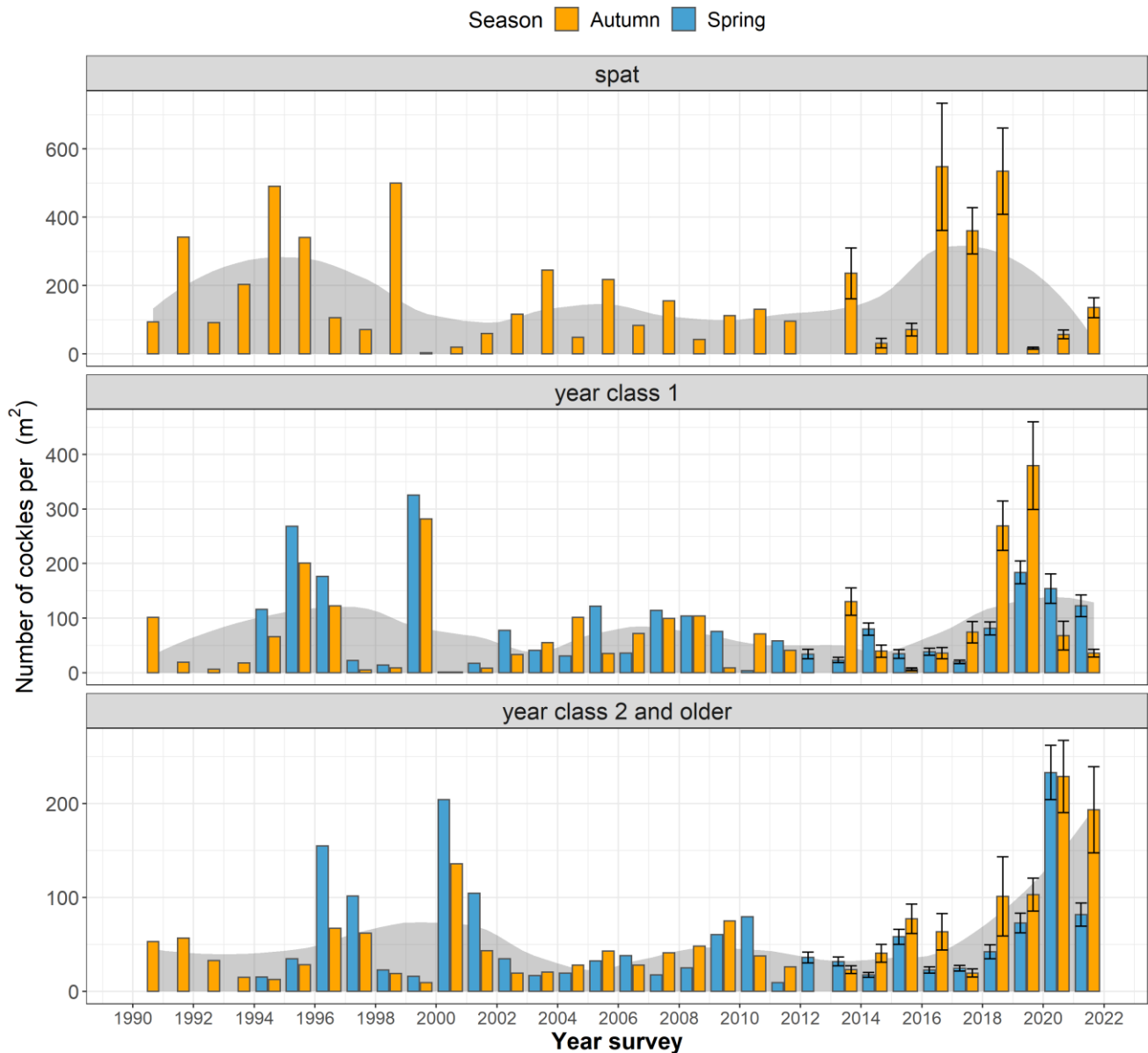
Cockle biomass for area: 4
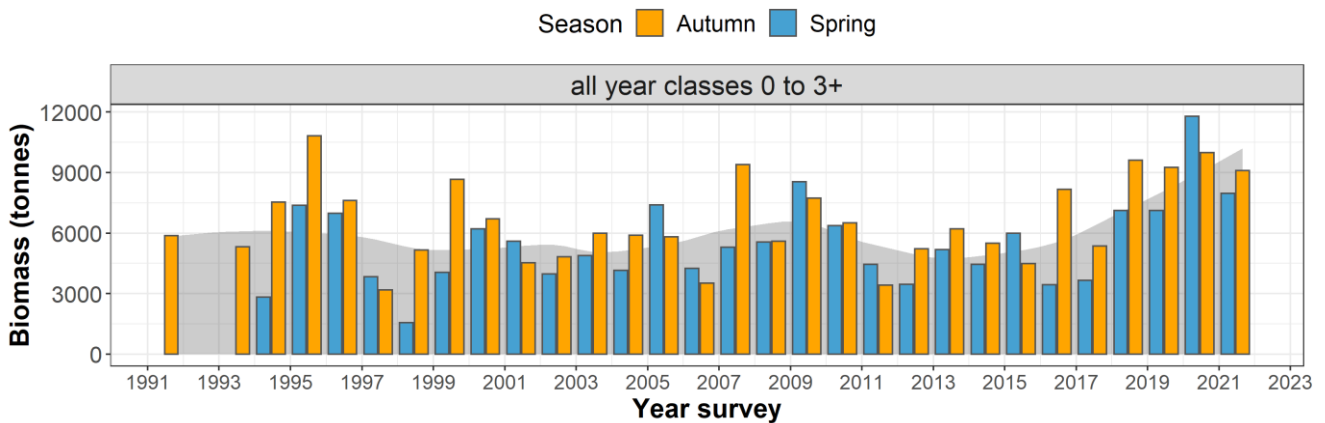
Figure 10: Mean cockle densities & total stock biomass in Area 4, 1990-2021

3.27   Comparison of long-term trends for area 5

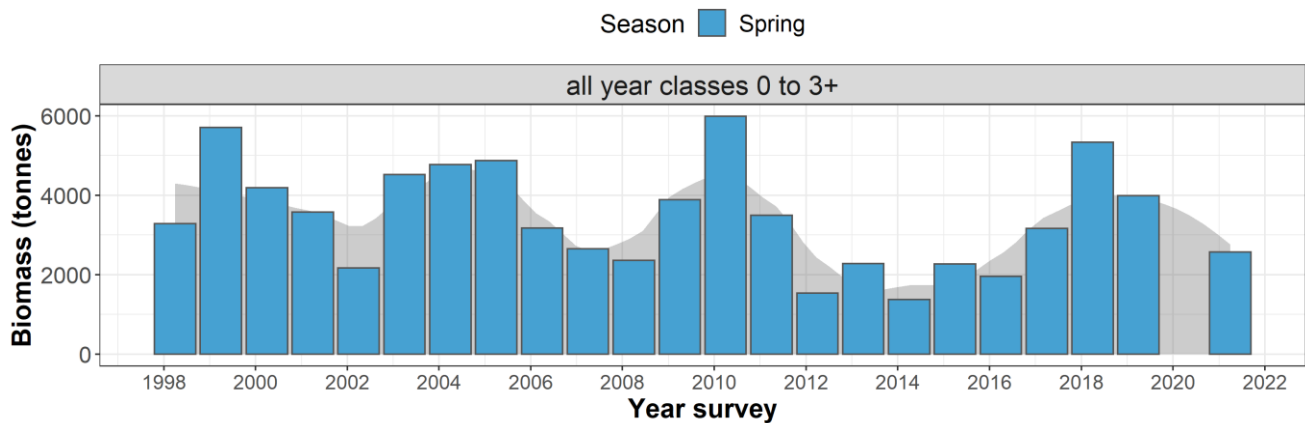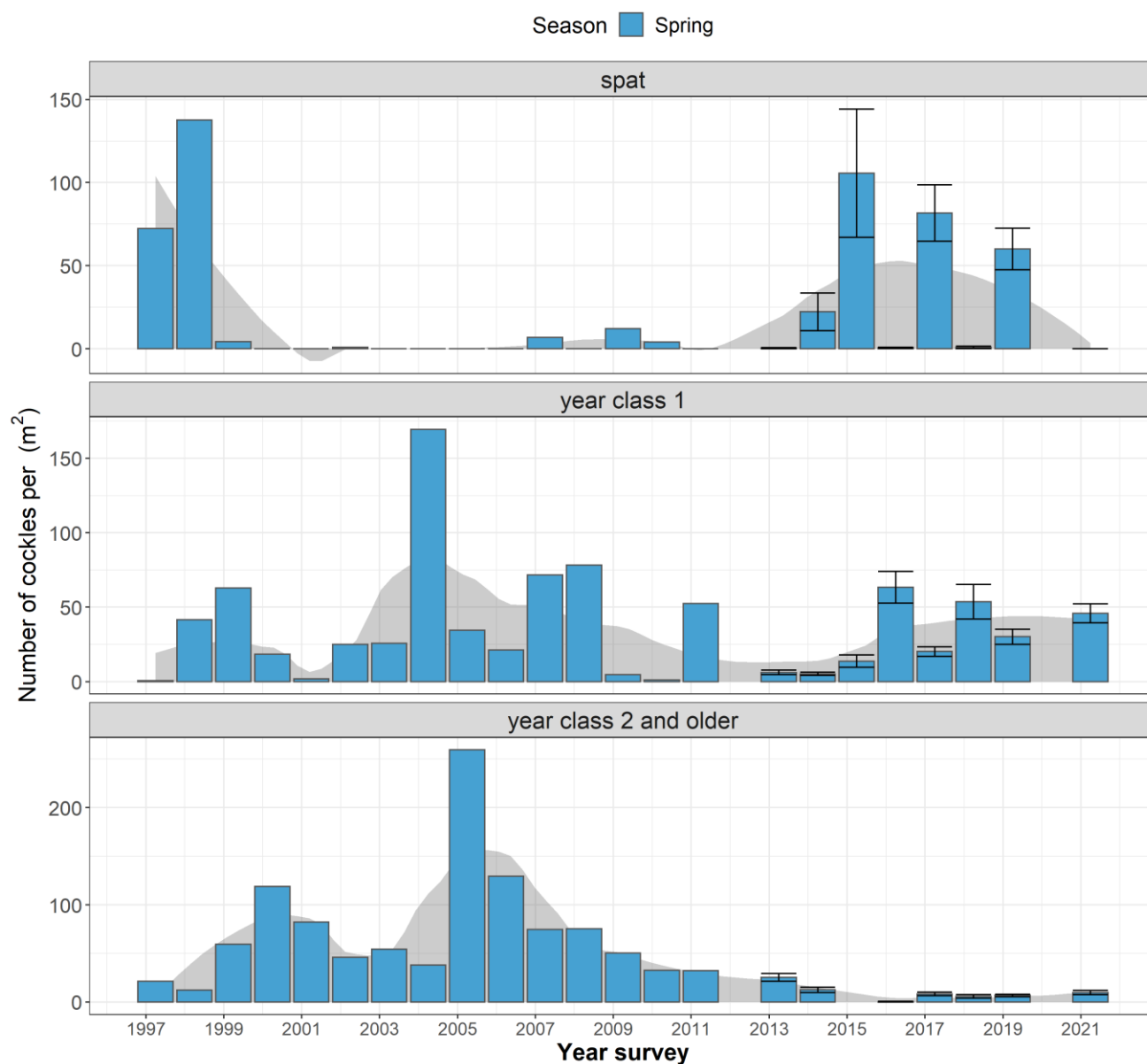**Cockle density for area: 5**

Cockle biomass for area: 5
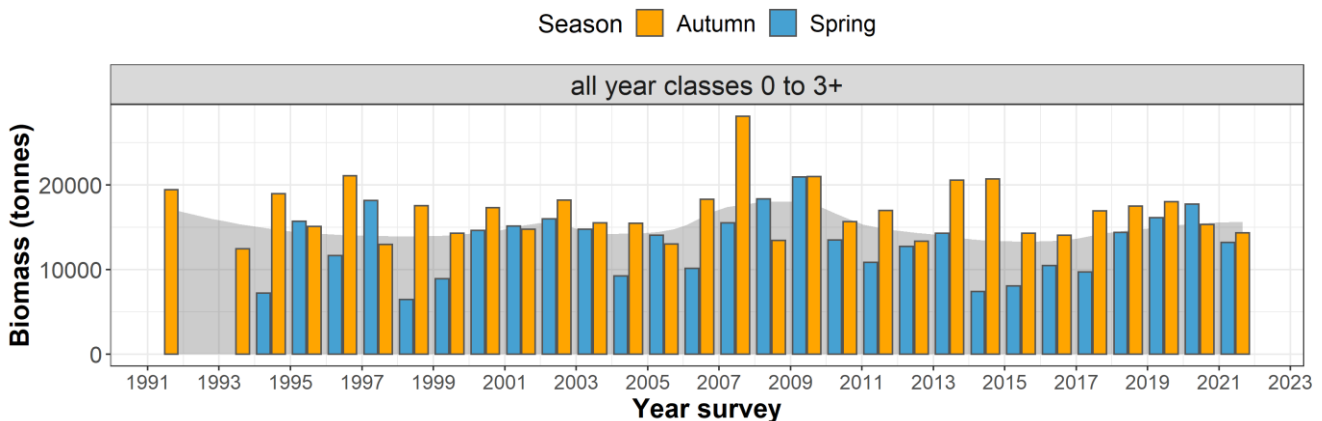
Figure 11: Mean cockle densities & total stock biomass in area 5, 1990-2021

3.28   Comparison of long-term trends for area 6
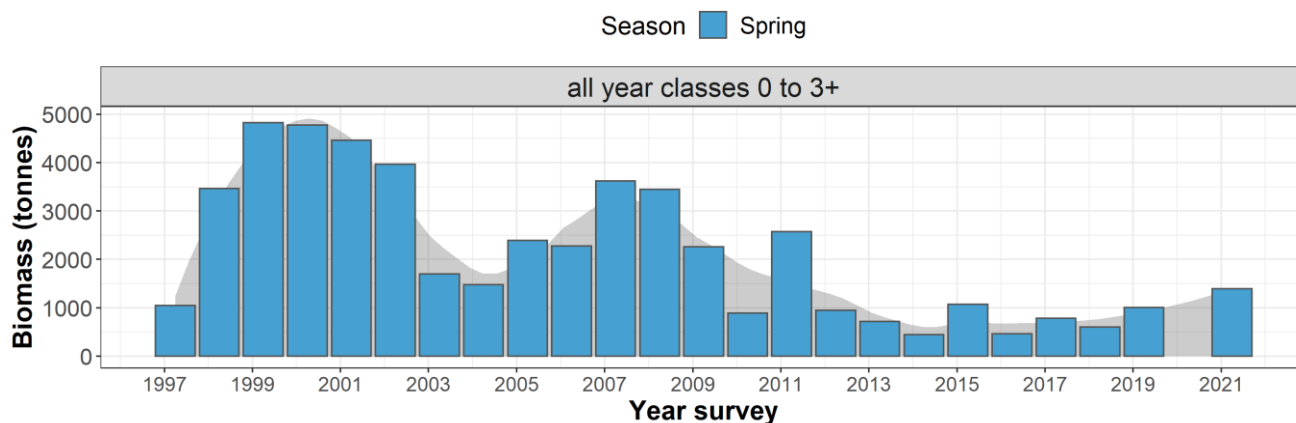
Cockle density for area: 6
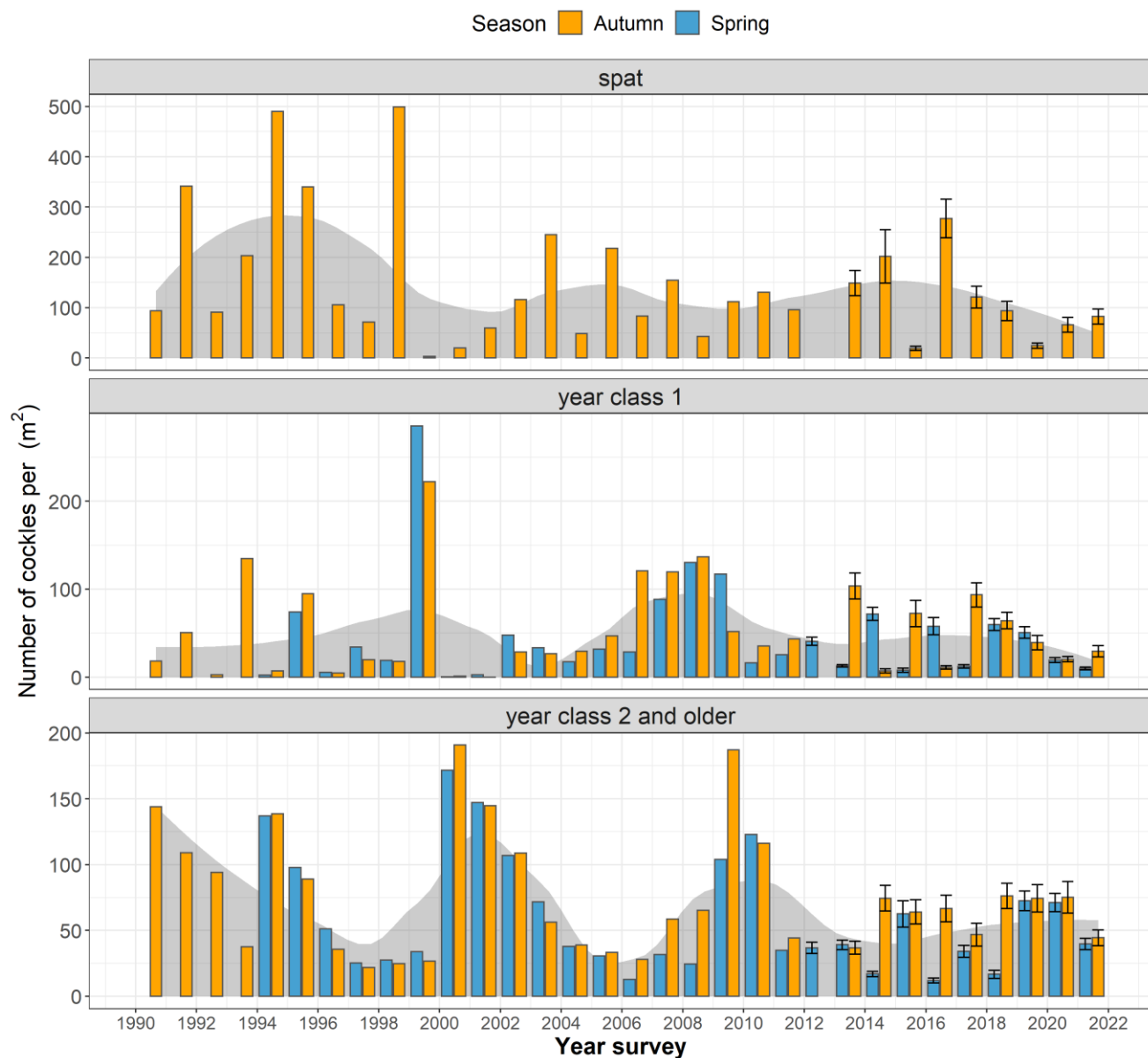
Cockle biomass for area: 6

Figure 12: Mean cockle densities & total stock biomass in area 6, 1990-2021

3.29   Comparison of long-term trends for area 2

Cockle density for area: 2

Cockle biomass for area: 2

Figure 13: Mean cockle densities & total stock biomass in area 2, 1998-2021

3.30   Comparison of long-term trends for area 3

Cockle density for area: 3

Cockle biomass for area: 3

Figure 14: Mean cockle densities & total stock biomass in area 3, 1998-2021

3.31   Comparison of long-term trends for area 7 – Dengie Flats

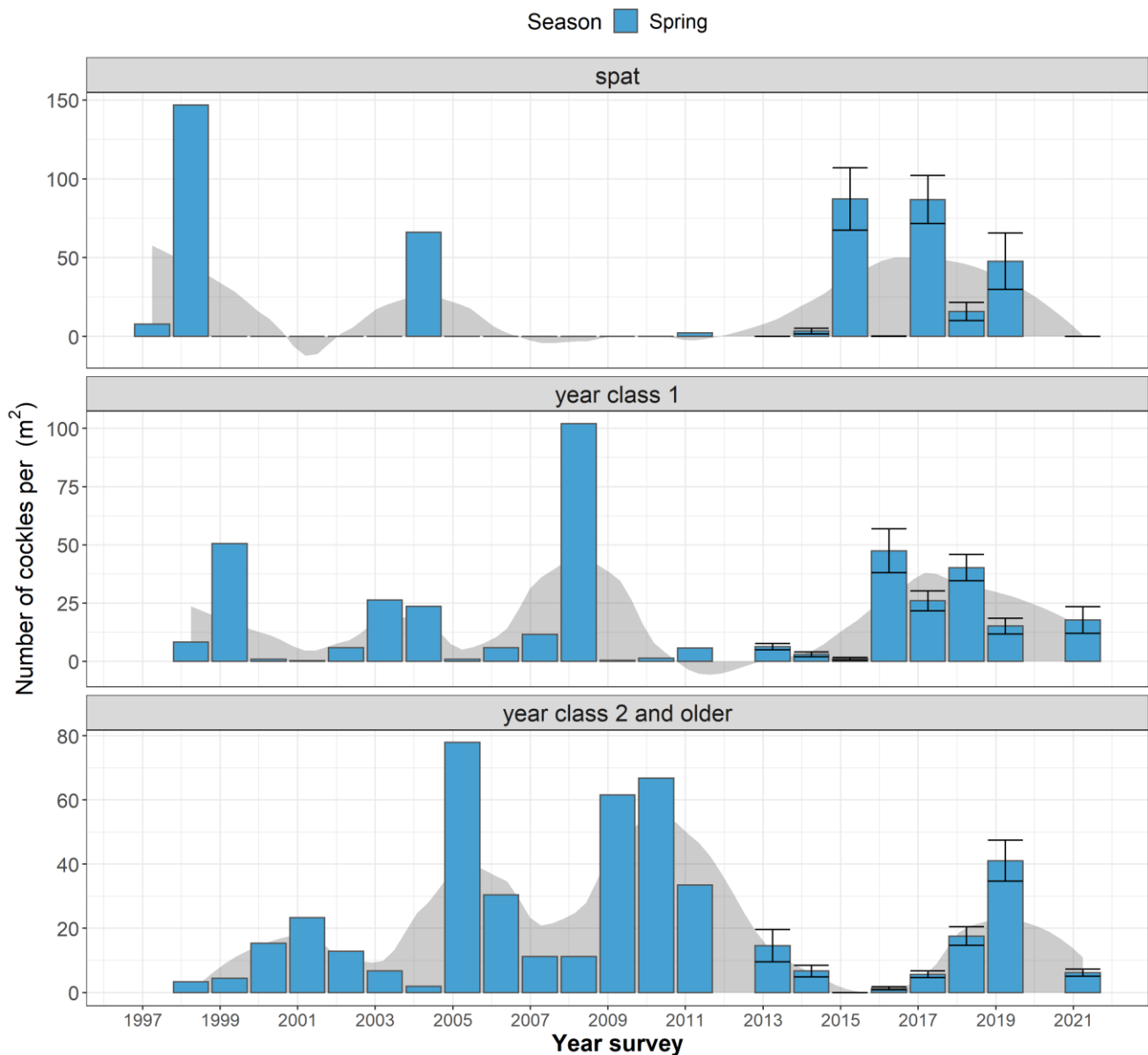**Cockle density for area: 7 Dengie**

Cockle biomass for area: 7 Dengie

Figure 15: Mean cockle densities & total stock biomass in area 7 - Dengie Flats, 1997-2021

3.32 Comparison of long-term trends for area 7 – Buxey Sands

Cockle density for area: 7 Buxey

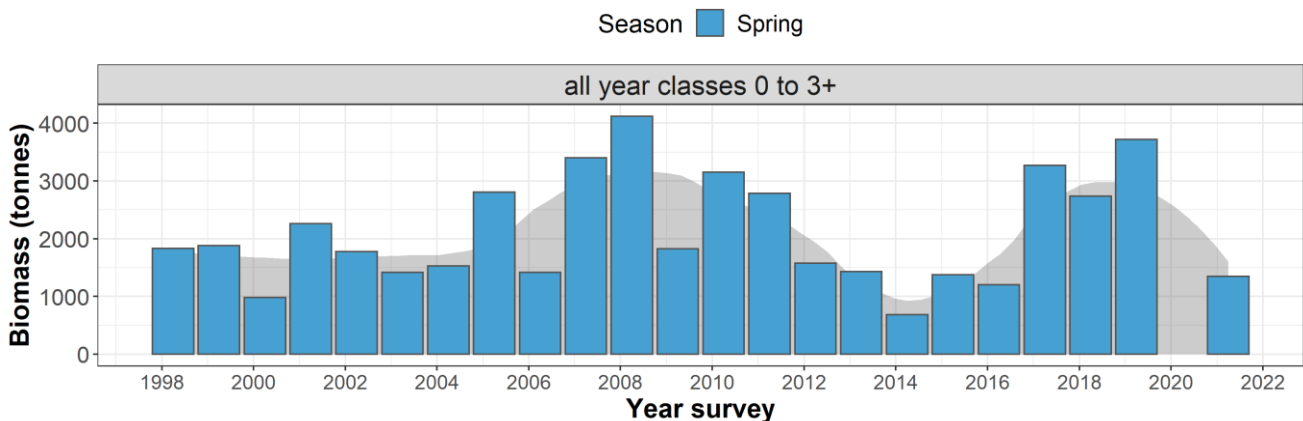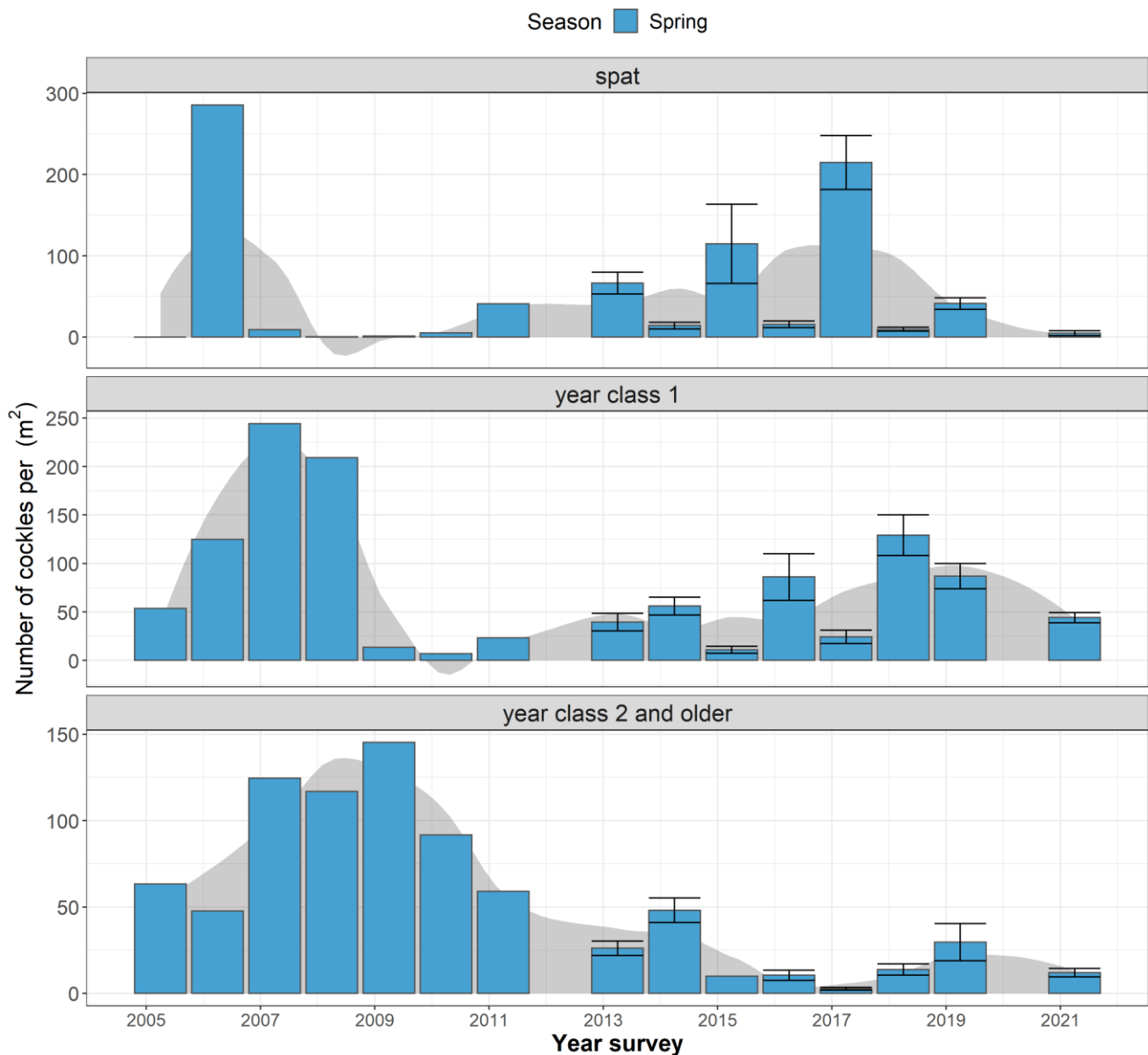### Cockle biomass for area: 7 Buxey

Figure 16: Mean cockle densities & total stock biomass in area 7 - Buxey Sand, 1998-2021

3.33   Comparison of long-term trends for area 7 – Ray Sands

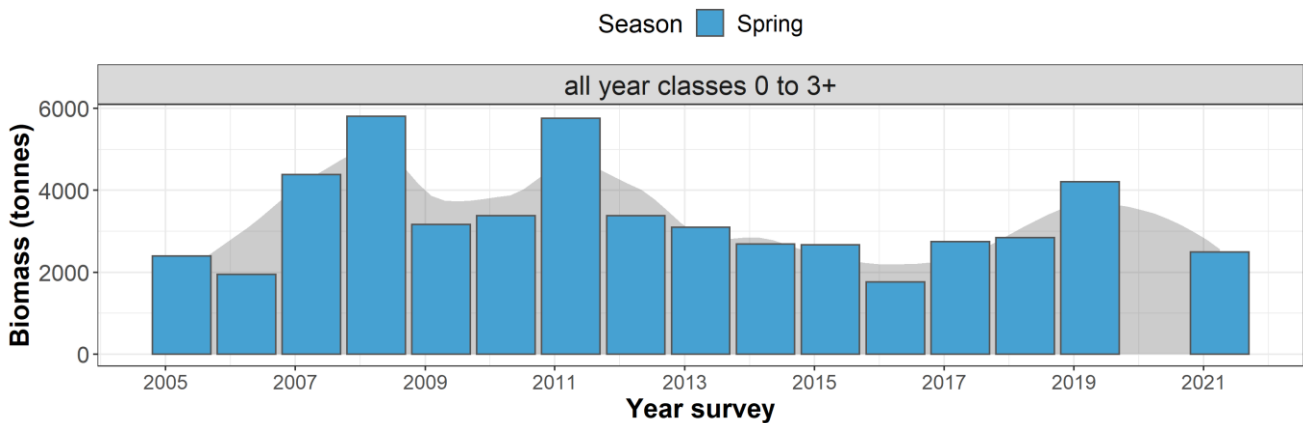### Cockle density for area: 7 Ray

Cockle biomass for area: 7 Ray

Figure 17: Mean cockle densities & total stock biomass in area 7 - Ray Sand, 1998-2021

4   CONCLUSION

4.1   Summary of results

A total area of 222.4 km^2 was surveyed during 2021, with a total of 1168 samples taken (excluding the second survey of Margate and Long Sands and that Barrows which were surveyed twice during spring-summer 2021 – see Annex 1 for separate report). On the Maplin and Foulness Sands (Areas 4, 5 & 6), which constitute the main commercial harvesting areas, a total of 613 samples were taken, of which 408 were collected during the Spring survey and 205 during the autumn survey.

The total number of adult cockles (excluding any spat) on the Maplin and Foulness Sands (core subset of the main beds) was estimated at 5903 million cockles in the spring and 7052 million by the autumn (representing approximately 19.4 % increase). In contrast to 2020, a 18 % decline was observed with a change from 10497 million cockles during spring to 8635.3 million by the autumn. This stock size declines were therefore lower in 2021 compared with 2020, however, the starting stock in spring 2020 was very high at nearly double to that in 2021. The 2021 total biomass of cockles above 16 mm in the core subset of the main harvesting areas was 8884.4 tonnes during the spring and increased to 12285.2 tonnes by the autumn. Adult stock increases from spring to autumn are a result of growth over the summer, when the 0-1 year class of cockles from the spring grows to reach adult size by the autumn of the same year. Conversely, declines are likely to be caused by mortality of adult stock. Mortality of can be attributed to environmental and fishing pressures.

The estimated number of cockle spat in 2021 (i.e. the number of individual cockles in the 0-1 year class in 2021) on the Maplin and Foulness Sands during autumn was 6954 million individuals. This is 1.8 times more spat compared with the spat level from 2020 (3727 million) and represents a substantial increase returning to normal levels (mean of 7035 million). The high variations in spatfall between years appears to be driven by environmental conditions and has gone through about 5 cycles of sinusoidal increases and decreases over the past 18 years.

Survival of spat over the winter of 2020/2021 increased to 48.2 % from the very low survival 15% recorded in 2020, but still below the historical average of 60 %. The substantial increase in spatfall from 2020, offset the below average survival resulting in an estimated spat during spring survey of 2021.

4.2   Implications for future management of the fishery

Data from the 2021 cockle survey contributes to a long-term data set of cockle stocks used to inform long term stock management strategies, and adjust year to year management measures, such as the Total Allowable Catch (TAC) limits from year to year.

The stocks recorded in 2021 represents a decline of the adult stock size, returning to normal levels following three bumper years (2017 – 2019). This peak in the Thames cockle stock-size followed three years (2016 – 2018) of exceptionally high levels of spatfall relative to that recorded over the last two decades.

Analysis of the cockle population since surveys commenced in 1998 indicate periodic fluctuations, with typical peaks and troughs. The adult population size on the core subset of the main cockle beds therefore is within the normal range and is considered relatively stable, despite this apparent declining trend since 2019. The increase

and continued upward trajectory of spatfall observed in 2021 further supports the notion that the stock is stable and within normal oscillation ranges. However, the influence of the two consecutive years of exceptionally low spatfall recorded in 2019 and 2020 on the adult stock of 2022 and potentially 2023 is likely to play out over the next two years, before the 2021 spat enters the adult population.

A substantial reduction of the adult cockle population size could affect the TAC, and fishing quotas by 2022. The TAC for 2022 will potentially be towards the lower half of the historical range owing to an average population size with two years of low levels of recruitment coming into the population. The recovery of the population size is further subject to winter survivorship and subsequent recruitment events. Consequently, it is imperative that annual surveys be continued to provide the critical data to inform the sustainable management of the fishery.

5   Annex 1

Cockle survey - Area 8 and 15

Philip Haupt (Kent and Essex Lead Science and Conservation Officer)

19/07/2021

5.1   Summary

Cockle sampling was carried out during April 2021 and repeated in July for TECFO fishing areas 8 and 15 to confirm if the low levels of stocks found in the April survey remained low later in the year.

There was an insignificant increase in the number of adult cockles in area 15 (0.25 cockles extra per sample), while area 8 showed a significant decline in the number of adult cockles. Overall, the greatest difference found was presence of spat in the July survey which was absent in the April survey. The apparent increase in stock on Area 15 must be treated with caution, because the sampling design was changed in July by restricting the sampled area to the area where the highest density of stock was found during the April surveys. Twice as many samples were collected in the new sampling area. The difference is therefore better examined by only comparing data from samples that fall within the "high density area" in area 15.

5.1.1   Area 15

More 3-year-old cockles were found per Day-grab sample in July than April. The difference is largely offset by the decrease in number of cockles in the 2-year July. It is likely that the cockles which were classified as 2-year-old, have now grown into three year old. When 1 - 3-year class over 14mm were added together (and considered as adult stock), the result was not statistically significant, with only 0.25 more adult cockles (1 - 3 year class) per Day-grab sample ($1m^2$).

There was also no significant change in the geographical distribution where the stock was found within areas 15 or 8. There average weight of adult cockles were very similar in April and July surveys. Extrapolation of this data therefore did not suggest sufficient growth that could support a cockle fishery. We therefore conclude that the existing stock in area 15 is not at a level that can be harvested without negatively impacting the sustainability of the stock and reducing spat fall opportunity for the following year.

5.1.2   Area 8

The amount of stock in Area 8 was lower during the July survey than during the April survey, with adult biomass dropping from 1043 tonnes to 827 tonnes. We therefore recommend that this area remains closed for the 2021 TECFO fishery.

5.2   Introduction

Cockles were surveyed twice in cockle fishing area 15 (Margate Sands) and the area 8 (East Barrows) in the Thames, first, during April 2021 and then again in July 2021.

5.2.1 Background

Area 15 was not opened to cockle fishing owing to insufficient stock to support a sustainable fishery on this bed at the time, to protect potential spat and not turn it over by fishing.

During a meeting raised with cockle fishermen, there was a call for surveying Area 15 again, owing the exceptionally good financial returns from the 2020 fishery on that cockle bed. It was agreed to resurvey the area during the quarterly KEIFCA Authority meeting in April prior to opening the fishing season. It was decided to carry out the survey in mid-July to address concerns raised by the fishermen with respect to persistent NE winds which they believed could have interfered with the survey.

Area 8 was not opened for the 2021 fishery due to insufficient stock to support a sustainable fishery. This is standard practice set out in the TECFO regulations. KEIFCA agreed to re-survey area 8 because the growth of individual size in the area is thought be exceptional, which may validate opening the area in future.
Both area 8 and 15 were surveyed between the 13 and the 19 July 2021. The survey methods used to collect were the same for both the two April and July surveys, using a Day-grab with a $1m^2$ surface area (33cm by 33cm), as has been done over the past 30 years. The method is thus supported by a robust data set underpinning the fisheries' successful management. The same survey teams and same survey vessels were used in the areas resurveyed in July, as it had been in April 2021.

5.3 Methods

The standard Day-grab sampling methods used during the Annual cockle survey were used during this survey. The same 61 sampling sites (GPS coordinates) were surveyed in April and July has been surveyed every year for Area 8 (Figure 1). Area 15 was newly surveyed in 2021. The survey area was informed by the VMS data locations from the 2020 fishery in the area. A 15 seconds survey grid, consistent with the grid spacing elsewhere, was overlaid on the area, and trimmed using the bathymetry data from the charts, yielding 71 sampling sites in Area 15. This area extended beyond the area fished in 2020 but was done to ensure detection of any stocks not fished, or new stocks inside and outside of the area fished in 2020. The survey results from April 2020 confirmed that the survey area could be trimmed tighter to the area in which the greatest density of VMS locality points from the 2020 cockle fishery were observed. This area overlapped very well with where cockles were present in 2021 during the April survey. For the July survey, the survey area was then focussed on the trimmed area. In total 41 sampling sites from the April survey grid (at 289.65 m by 463.57 m apart) remain within the "high density area". The density of the survey grid was then doubled to 82 points, adding a row of survey points between each of the existing rows of points from the April-survey grid (231.785 m by 289.678 m apart).
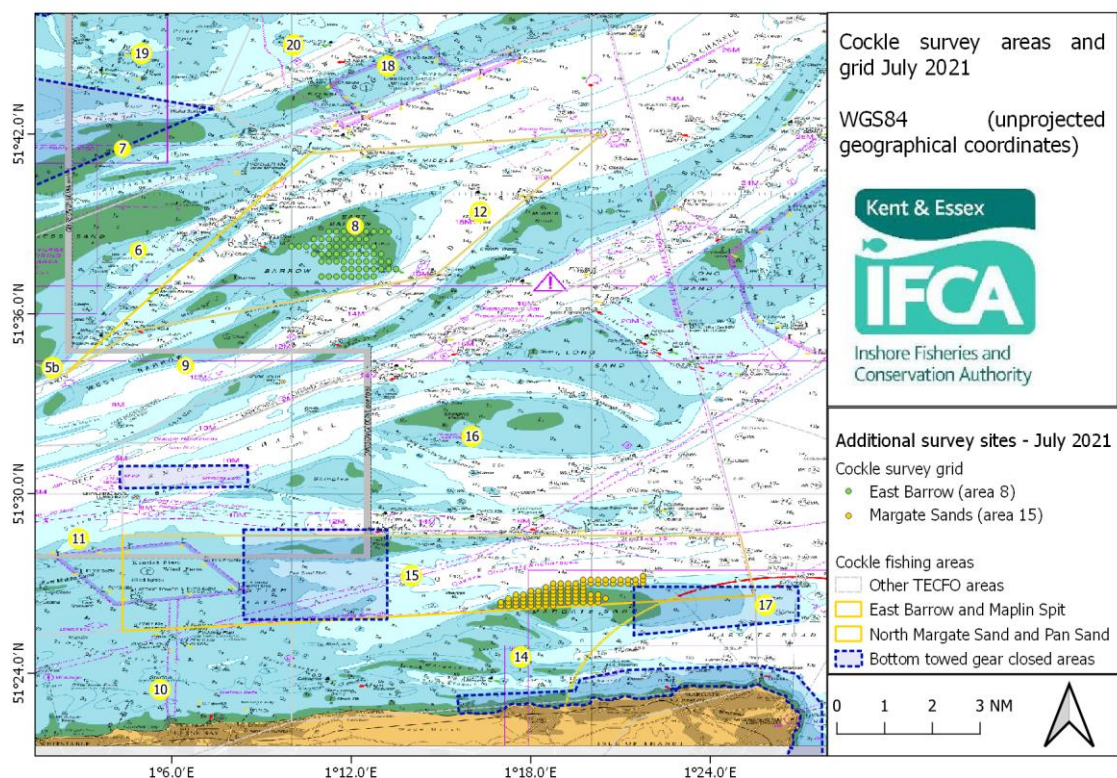
Figure. 1 (annex) Map of survey area and survey grids.

The data was then analysed, accounting for the fact that there were twice as many samples in the same area as during the April survey. The mean (average) number of cockles per sample with standard error (which represents the standardised variation between samples) is represented in bar plots: To make the survey results comparable (owing to the different number of sampling sites), the average number of cockles per sample is presented; this standardises the results. The variation (which is also dependent on the sample size was standardised and presented as standard error bars on the graph.

5.3.1 Statistical analysis

Following standard data exploration tests, spat was analysed separately from 1 - 3-year-old cockles in pooled analyses, to remove the effect of outliers.

The non-independence of the sampling design requires statistical analysis that account for spatial dependence structure in the model, such as mixed effects models. Furthermore, the data are strongly zero inflated, requiring the need for using a zero-inflated mixed effects model. This involves a high-level complex modelling technique which will require a few days to work up; in the interim a Wilcoxon rank summed test was used to assess the statistical significance of the differences between the density of cockles between the April and July surveys, for each of the two areas. The test was carried out for pooled data from 1 to 3-year classes and repeated for each year class. Statistical significance is reported at the 95 % confidence limits.

5.4 Results

Overall, there was no significant difference in the amount of adult stock found between the April and July in Area 15, but a small but significant decline in adult stock was observed in Area 8 by July when compared to April.

The largest difference in the number of cockles between the two surveys was that substantial levels of spat detected during the July survey, which was absent in April (Table 2 and Figure 2a). This report focusses on the adult cockles, as spat is surveyed and reported on later in the year following the Annual September surveys following main spatting events each year.

In Area 15, more adult cockles were found during the July survey (Table 2) but was largely explained by the fact that twice as many samples were collected (Table 1).

Table 1. The number of sampling sites in each of the areas in April and July 2021.

Area	April	July
15	41	82
8	63	64

Table 2. The total number of cockles in each of the areas in April and July 2021.

Area	Year class	April	July
15	0	0	1463
15	1	1	1
15	2	11	9
15	3+	37	114
8	0	0	534
8	1	50	21
8	2	0	35
8	3+	53	15

The apparent increase of average number of cockles per sample in the 3+ year classes in Figure 2b is explained by the concurrent decrease of the 2-year class: The 2 year old class has grown from April and by July they were classified as 3+ year class, and therefore the total adult stock remains very similar between surveys. The overlap of the standard error bars in Figure 2c suggests that the differences were not significant: The variation from sampling site to site within the same area during the same sampling period (April or July respectively) were greater than the differences between the mean number of cockles per sample between April and July.
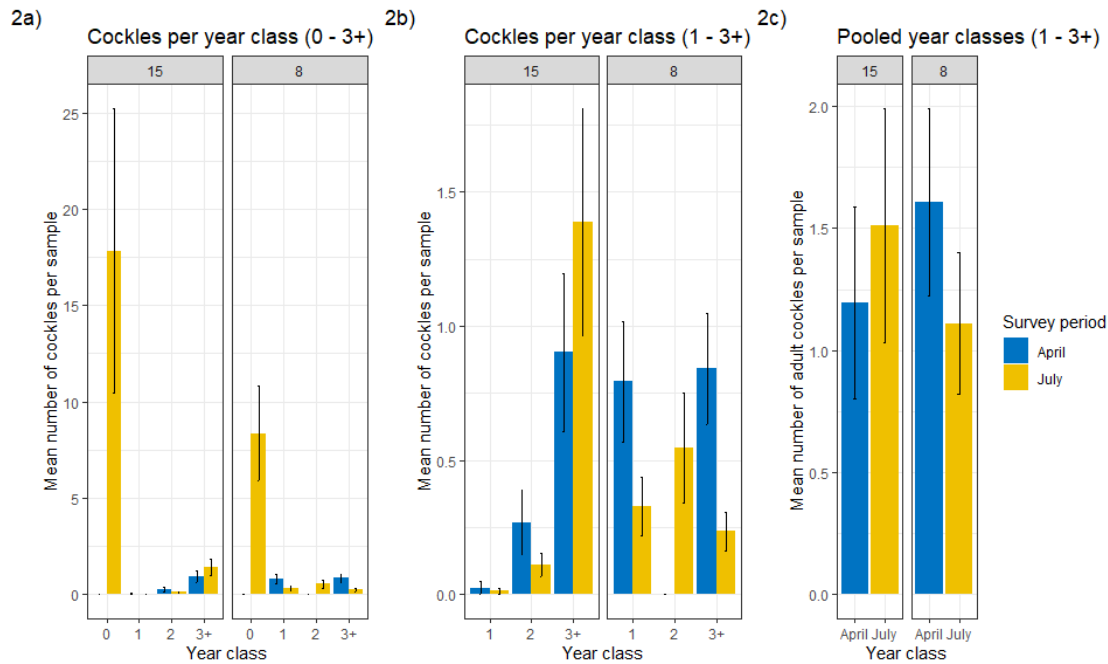
Figure 2 (Annex). The average number of cockles per Day-grab sample for Area 15 and 8: 1a) for 0,1,2, and 3+ year classes, 1b) for 1,2 and 3+ year class (spat omitted to aid viewing graph), 1c) total adult cockles

In Area 15, the increase recorded in July for total adults is approximately 0.25 additional cockles per sample site compared to the April survey. However, this slight increase does not represent a consistent increase across Area 15, but rather reflects the patchiness of the cockle concentrations: A few sites had a lot of cockles, but most sites did not have many or any cockles. This can be seen in the map below showing where cockles were found along the survey grid. In Area 15 there was no expansion in the geographical distribution of the adult cockle stock in Area 15 between April and July (Figure 3).
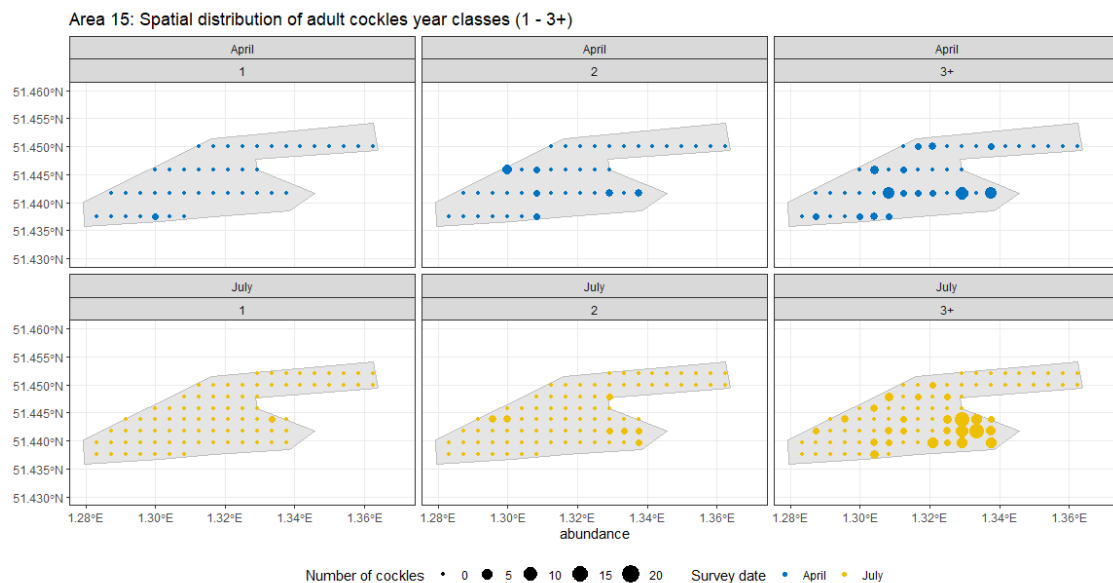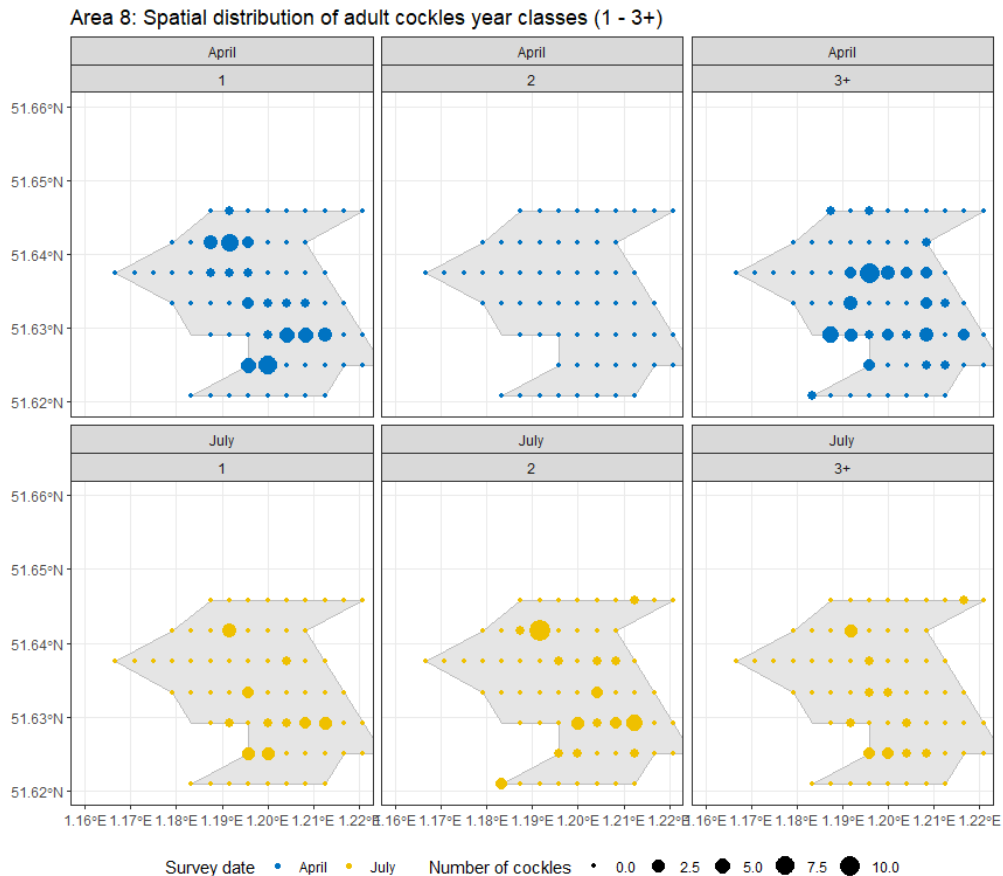

Fig 3. Geographical distributions of cockle year classes in Area 15 in April and July 2021.

There was also no obvious change to the geographical distribution of the adult cockle stocks between April and July in Area 8 (Figure 4).

Fig 4. Geographical distributions of cockle year classes in Area 8 in April and July 2021.

The average weight of cockles (3+ year class) deceased slightly from 14.05 g/cockle to 13.37 g/cockle in Area 15, while it declined from 13 g from to 12 g/cockle in Area 8 by July 2021.

5.5 Discussion

The results from this study confirmed that there was no increase of adult cockle stocks in Area 15 and Area 8 showed a slight decline between April to July 2021. Overall there is no evidence to support opening Area 15 (Margate Long sands) or 8 (East Barrows) to cockle fishing during the 2021.

The relatively small increases observed in particular year classes in Area 15 were sufficiently explained by growth of younger year classes recorded in April to older year classes by July, and can be seen when pooling the 1 to 3 year class data to obtain overall adult population abundances. The remaining differences (ca 1 extra cockle every four sampling sites), after accounting for promotion of cockles from younger to older year classes, is not substantial enough to be statistically, or biologically significant (in Area 15).

In Area 8 slightly fewer cockles were recorded in the adult population during July compared to April.
The similarity in the geographical distribution of adult cockle abundance showed that the cockles did not undergo an expansion in range at the onset of early summer and supports the idea that cockle populations are highly patchy within cockle beds. The similarity in these distributions and the similarity in variation in population sizes between sampling points reaffirms the robustness of the survey method to accurately detect cockle abundance within the district.

There was no evidence to suggest that individual cockles have gained biomass (weight) that would translate into a harvestable stock on either Area 15 or Area 8.

The presence of spat in July survey were detected at the same sampling sites as the areas in which the highest adult cockle densities were found during July survey. The presence of spat in Area 15 further supports not opening the fishery to protect the spat from being turned over and damaged, in the hope that the Margate Sands would become an established cockle bed over time. Cockle surveys will be carried during September 2021 to assess the 2021 summer spat fall.

The recommendations made in this report were made based on the evidence collected using the same methods that have supported a long running sustainable cockle fishery. It is hoped that the recommendations will be considered by those interested in the present and long term sustainability of the fishery.