2023 Wash Cockle Growth Study

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Introduction

The 2023 Wash inter-tidal cockle surveys found that while the overall stocks had increased from the previous year, the biomass of "adult" cockles (cockles ≥14mm width) had fallen to 3,457 tonnes, their lowest level for over 20 years (figure 1). Based on the usual "Rule of Thirds" method of calculation, in which the size of the Total Allowable Catch (TAC) for the coming cockle fishery would be equivalent to 1/3rd of the "adult" stock biomass, the TAC for the fishery would be 1,157 tonnes. Due to long-term changes to the cockle population dynamics as a result of "atypical" mortality, however, Eastern-IFCA had proposed the method of calculating the TAC should be changed to 1/6th total cockle stock (report available at https://www.eastern-ifca.gov.uk/wp-content/uploads/2023/06/2023_06_02_Review_of_Cockle_TAC_online_version.pdf). The TAC under this approach would be 2,937 tonnes. However, as the "adult" cockle stock was only just above the SSSI Conservation Objective target of 3,000 tonnes, it potentially restricted the TAC for the coming cockle fishery to just 457 tonnes.

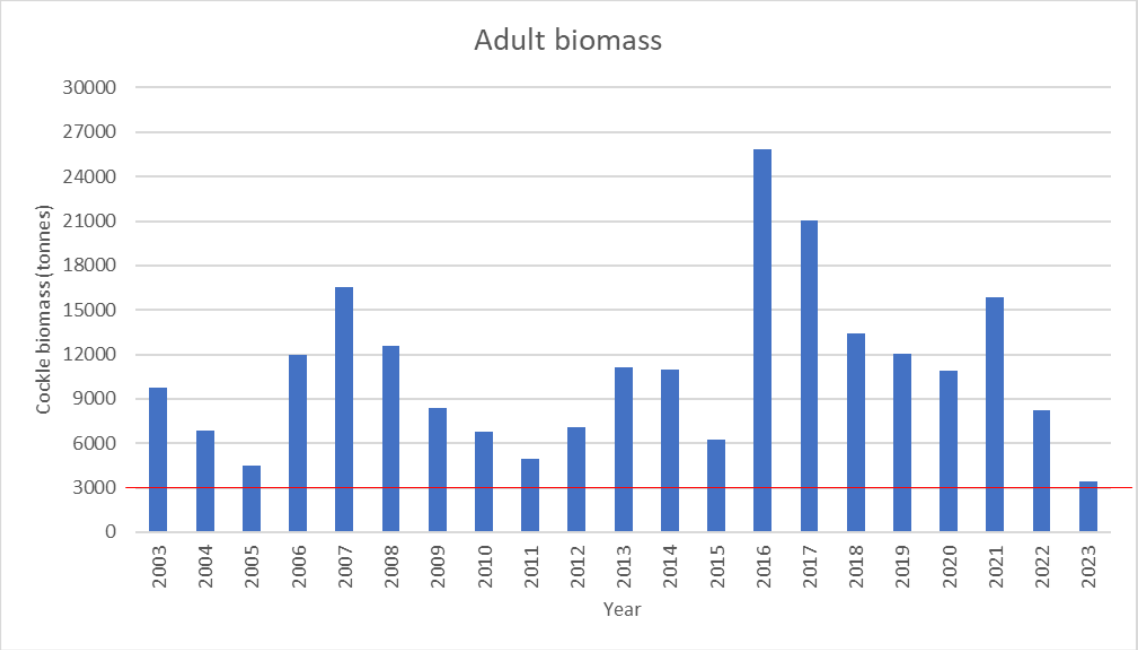

Figure 1 – Annual biomass of adult cockles at the time of the spring surveys. Red line shows Conservation Objective threshold

Evidence suggests the cause of the low adult stock this year is due to a combination of ongoing "atypical" mortality (now attributed to a *Marteilia* parasite) and two poor spatfalls in 2019 and 2020. In a healthy environment, cockles have a longevity of 5 to 7 years. However, since 2008, "atypical" mortality has resulted in the deaths of thousands of tonnes of cockles that have reached the size of maturity; usually when they are 2 to 3 years old. The loss of older, larger individuals from the population, has not only had a negative impact on the size of the adult stock biomass, but has also reduced the population resilience, placing greater reliance on successful recruitment to maintain stock levels. Between 2003-2018, there have been regular spatfalls at least every second year in The Wash (figure 2). This recruitment has helped to offset the effects of the high mortalities and maintain the stocks above the Conservation

Objective targets. However, two successive poor settlements in 2019 and 2020 interrupted this balance between recruitment and mortality, resulting in low juvenile stocks in 2021 and low adult stocks in 2022. Successful settlements have subsequently occurred in 2021 and 2022. Past trends suggest these settlements will help the stocks to recover from their current low levels.

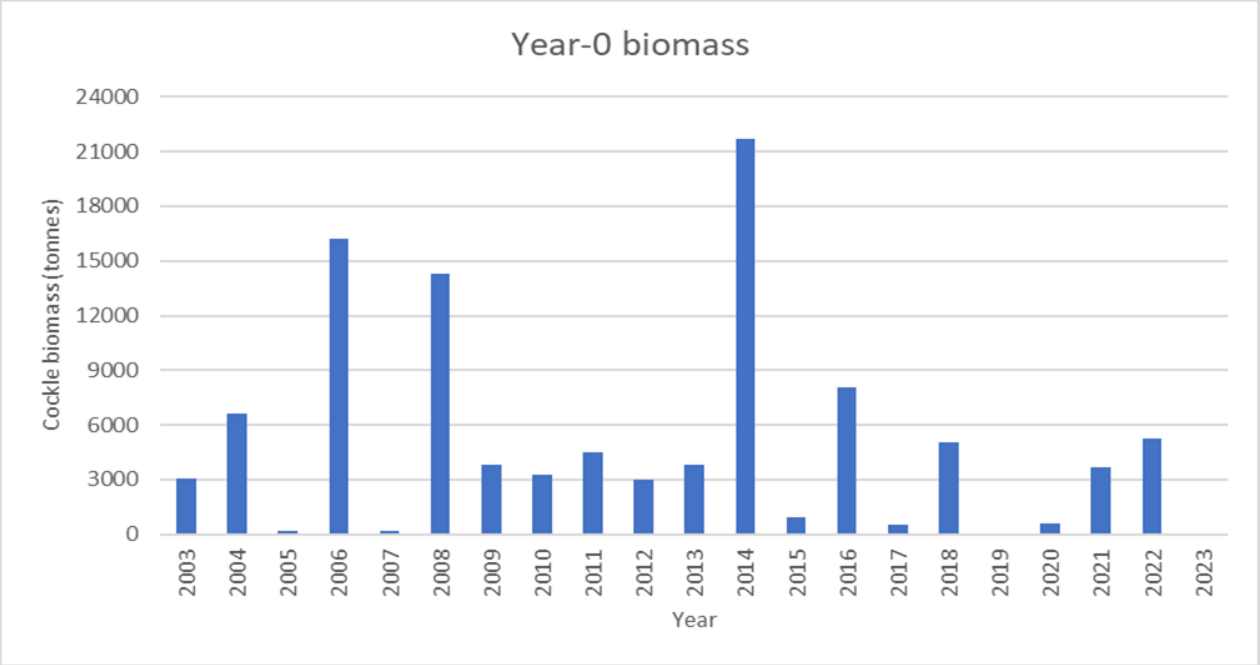

Figure 2 – Annual biomass of adult cockles at the time of the following spring surveys.

Although adult cockle stocks are currently only 457 tonnes above the Conservation Objective target, Eastern-IFCA believe there is sufficient evidence supporting a recovery that opening a fishery with a TAC of 2,937 tonnes would not prevent this target from being achieved. This is based on the current stock population demographic (predominated by the 2021 and 2022 year-class cohorts) and past cockle growth trends.

Figure 3, based on analysis of survey data from the period 2003-2019, shows the average biomass (at the time of the spring surveys) of a cockle cohort over time compared to its biomass at Year-0. For the 2021 settlement, the baseline Year+1 value would have been recorded during the 2022 spring survey. Although mortality at this age is usually high, growth is good, on average resulting in a stock biomass increase of 137.9% by the time of the Year-2 survey (the 2023 survey for the 2021 cockle cohort). Overall, and particularly so on the faster-growing beds where mortalities occur sooner, Year+2 is the peak biomass of a cohort. By the time of the year+3 survey, mortality losses are greater than growth resulting in a decline in biomass, albeit the biomass still being 102% higher than at the time of the cohort's first survey. Usually by this time, those cockles will have attained a size of 14mm width, so will be considered part of the adult population. As the 2021 cohort is much larger than its predecessor, the biomass of adult cockles can be expected to increase over the coming year as they recruit into the adult population and replace the previous cohort as the predominant adult cohort.

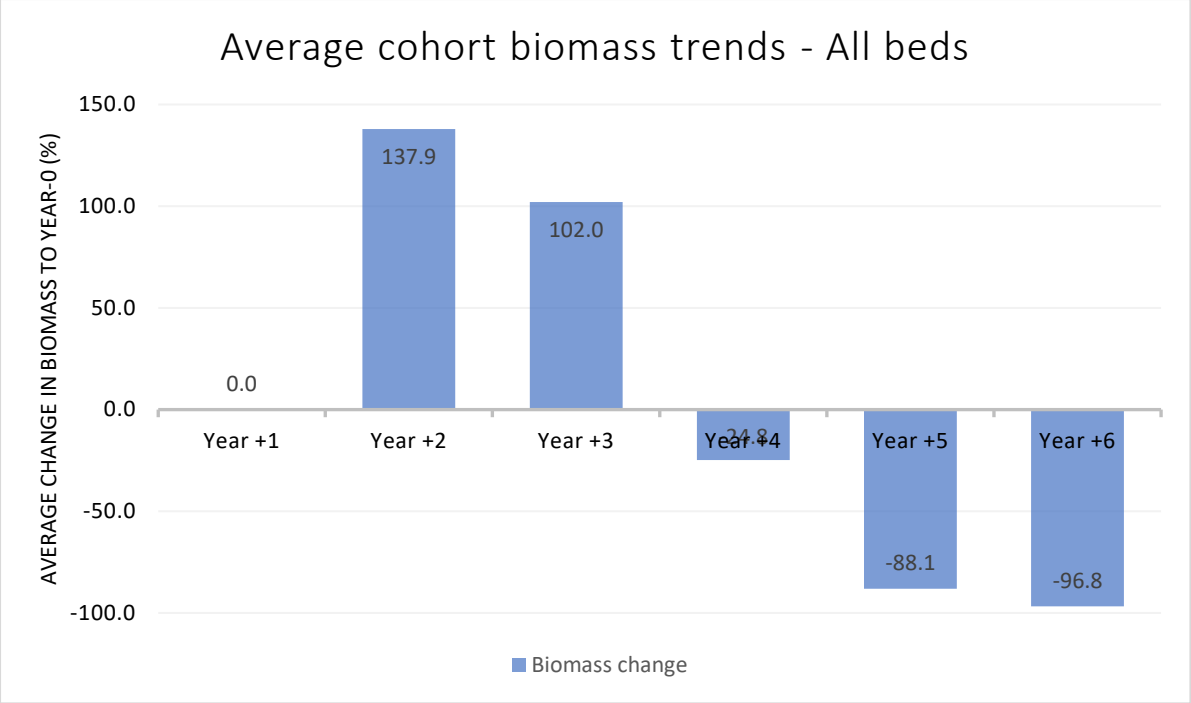

Figure 3 – Average cohort biomass as a percentage change to biomass at Year-0

At the time of the 2023 spring survey the cockle stock comprised the following cohort biomasses:

- 2022 cohort – 5,236 tonnes
- 2021 cohort – 10,172 tonnes
- 2020 cohort – 1,562 tonnes
- 2019 cohort - 535 tonnes
- 2018 cohort – 77 tonnes
- 2017 cohort – 38 tonnes
- Total - 17,620 tonnes

Of this population, all of the 2020 and older cohorts had attained 14mm width, so contributed towards the adult stock. In addition to these, 1,245 tonnes of the 2021 cohort had also reached this size. The juvenile stock comprised 8,927 tonnes of the 2021 cohort and all of the 2022 cohort.

To maintain the adult cockle biomass above the 3,000 tonnes Conservation Objective target, sufficient quantities of the juvenile cockles must recruit into the adult population to offset natural and fishery mortalities within the current adult population. When attempting to predict what the adult stock biomass will be next year, figure 3 would suggest that almost all of the cockles from the 2020 and older cohorts will have perished, so have minimal contribution to the stock biomass. The 2021 cohort had a Year+1 biomass of 3,680 tonnes. Its actual Year+2 biomass of 10,172 tonnes is slightly lower than the 10,890 tonnes predicted by figure 3, but close enough to provide confidence in the model's predictions. Based on this, the Year+3 prediction of 7,434 tonnes may also be high but is nevertheless expected to exceed 6,000 tonnes, the majority of which will have attained 14mm width.

While figure 3 predicts the 2021 cohort could produce over 6,000 tonnes of adults by the 2024 survey, it doesn't provide assurance that the coming fishery wouldn't cause the adult stock biomass to dip below the 3,000 tonnes threshold before that growth occurred. A previous growth study conducted by Eastern-IFCA in 2013, however, demonstrated that significant cockle growth occurred between April and June (Eastern-IFCA, 2023). In that study, the adult stock biomass across the Wash regulated beds increased by an average of 78% between those months. If the 78% rate of growth were applied to the current adult stock of 3,457 tonnes, it would result in a figure of 6,153 tonnes being present now. The rate of growth is known to be influenced by several factors, including location, elevation, population density and population structure. As these factors vary from year to year, the rate of biomass increase to the adult cockle population will vary greatly. There was concern, therefore, that if growth was slower this year than predicted and the adult stock failed to reach 6,000 tonnes, a fishery of 2,937 tonnes could potentially result in the Conservation Objective target not being achieved next year. As having a good understanding of current growth is critical to the management of this year's fishery, Eastern-IFCA conducted another growth study in July 2023.

Method

The study involved resampling 139 stations on July 5th and 6th that had been sampled during the surveys in April to determine what changes had occurred in the interim period in terms of growth and mortality. These stations were grouped in 6 areas that included complete re-surveys of the Black Buoy, IWMK and Thief beds, plus partial surveys of the Roger, Gat and Daseley's beds. The Gat survey also included 4 samples from the adjacent Mare Tail bed. Table 1 shows the number of stations within each survey area and the percentage of the ≥14mm and <14mm cockle biomass from each bed that were represented by these areas. As can be seen from this table, 24.5% of the adult cockle biomass and 34.3% of the juvenile cockle biomass from all of the regulated beds are represented by these survey stations.

Table 1 – Sample stations within each survey area and percentage of each bed's adult and juvenile stock biomass represented by survey areas.

Survey Area	Stations sampled	% adult	% juvenile
Black Buoy	22	100.0	100.0
Daseleys	23	14.3	62.1
Gat/Mare Tail	18	32.1	13.4
IWMK	33	100.0	100.0
Roger	20	21.2	60.0
Thief	23	100.0	100.0
Total	139	24.5 all Wash	34.3 all Wash

The distribution of the survey stations are displayed in figures 4 and 5.

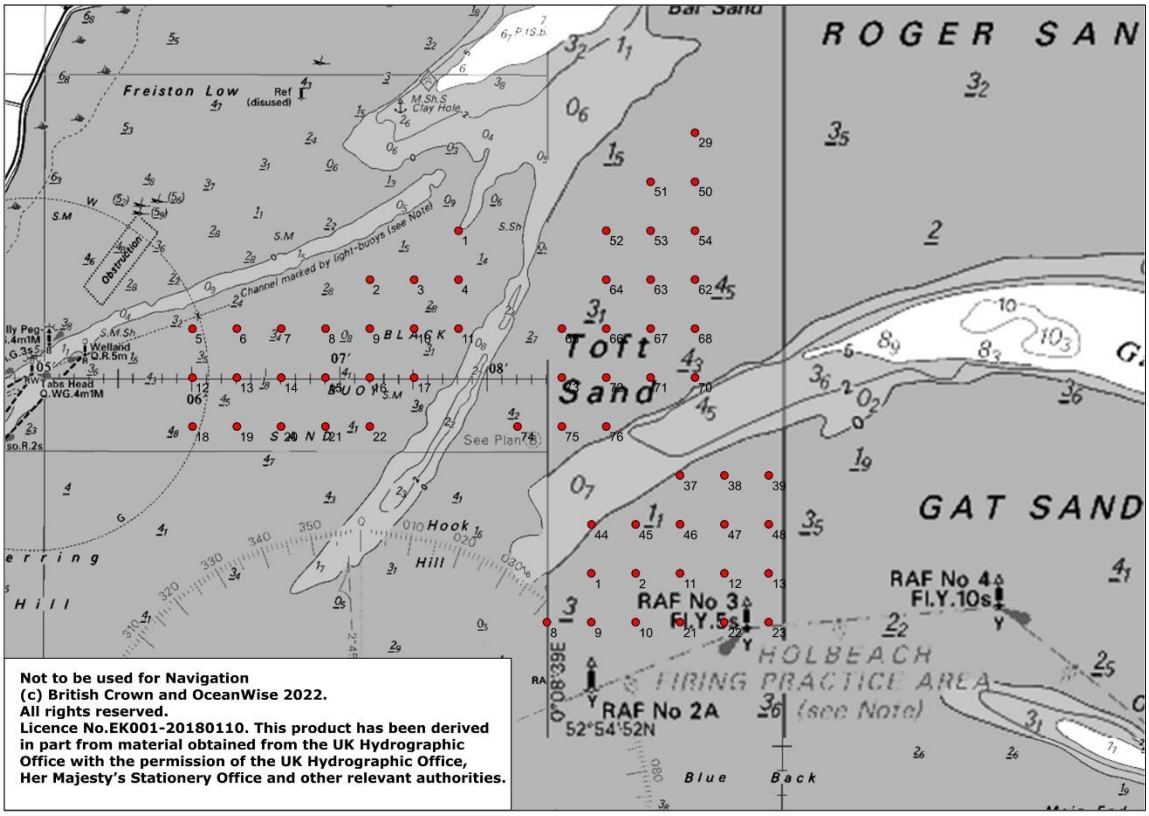

Figure 4 – Distribution of sample stations on Black Buoy, Roger and Gat/Mare Tail

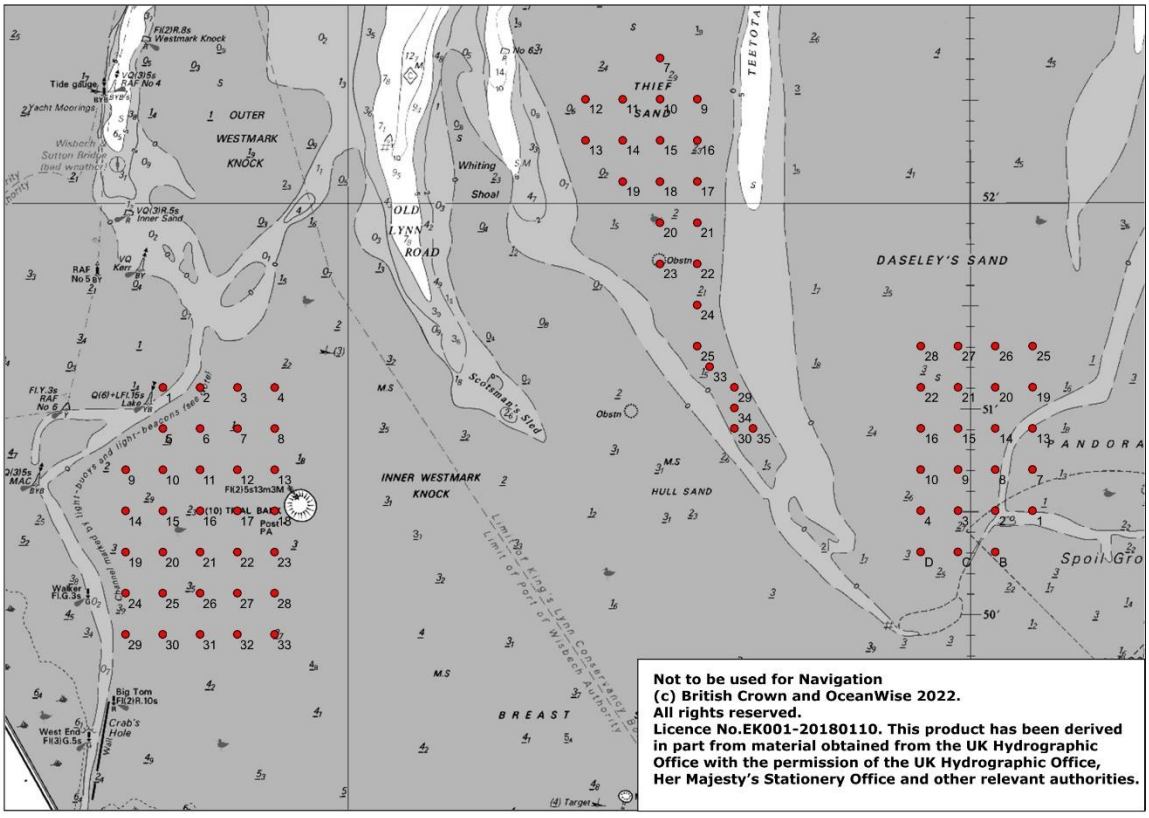

Figure 5 – Distribution of sample stations on IWMK, Thief and Daseley's

Each station was sampled in a similar manner during both surveys, using a Day grab deployed from the research vessel, *Three Counties*, to collect a 0.1m^2 sample from the seabed. Each sample was washed over a 2mm sorting grid to separate any cockles from the surrounding sediment and any cockles present were stored in labelled bags for measuring. The samples were measured at low water once the vessel was aground to ensure the weighing scales were recording a steady weight. Each cockle was measured by length and width to the nearest 1mm and grouped by year-class cohort and by size (≥14mm and <14mm width). The combined weight of cockles in each group were then weighed to the nearest 0.01g.

Sample data were recorded directly into an Access database and transposed into Excel for analysis.

For reference, the results refer to the following age and year-class cohorts interchangeably:

- 2022 settlement – Year-0
- 2021 settlement – Year-1
- 2020 settlement – Year-2
- 2019 settlement – Year-3

Results

Cockle numbers in samples

Tables 2 and 3 show the numbers of cockles from each cohort and size group found in the samples from each survey area.

Table 2 – Total cockle numbers found in samples during April survey

Bed	Year-0	Year-1	Year-2	Year-3	Year-4	Gtr 14	Less 14	Total
Black Buoy	20	993	6	2	0	8	1013	1021
Daseleys	228	278	1	1	0	3	505	508
Gat/Mare Tail	39	101	14	1	2	46	111	157
IWMK	771	442	22	2	0	47	1190	1237
Roger	55	87	4	0	0	10	136	146
Thief	951	69	6	0	0	61	965	1026
Grand Total	**2064**	**1970**	**53**	**6**	**2**	**175**	**3920**	**4095**

Table 3 – Total cockle numbers found in samples during July survey

Bed	Year-0	Year-1	Year-2	Year-3	Year-4	Gtr 14	Less 14	Total
Black Buoy	79	675	1	0	0	158	597	755
Daseleys	455	263	1	1	0	52	668	720
Gat/Mare Tail	5	66	1	5	2	71	8	79
IWMK	840	372	24	11	3	219	1031	1250
Roger	4	286	0	0	0	107	183	290
Thief	565	49	0	1	0	134	481	615
Grand Total	**1948**	**1711**	**27**	**18**	**5**	**741**	**2968**	**3709**

From these tables, it can be seen that the total number of cockles found in the samples had declined from 4,095 in April to 3,709 in July, a reduction of 9%. Atypical mortalities have been observed to be occurring since the beginning of June on several of the beds, so a reduction in cockle numbers was expected. Although mortality is likely to have occurred within all the beds surveyed during this study, not all areas showed a net reduction in cockle numbers, however. This is most likely due to the fact that cockles do not settle homogeneously and in some areas there can be wide localised variability of cockle densities within short distances. During surveys, the impacts of such anomalies are reduced by taking large numbers of samples that smooth out these artefacts.

Despite localised anomalies, what is clear from the overall dataset is that there has been a 25% reduction in the numbers of juvenile cockles and a four-fold increase in the number of adult cockles, indicating a proportion of the <14mm cockles have grown to 14mm and recruited into the adult population

Cockle weight in samples

Tables 4 and 5 show the weight of the cockles found in the samples from each survey during the April and July surveys.

Table 4 – Total weight (g) of cockles found in samples during April survey

Bed	Year-0	Year-1	Year-2	Year-3	Year-4	Gtr 14	Less 14	Total
Black Buoy	5.8	1115.9	16.8	10.7	0.0	32.3	1116.9	1149.2
Daseleys	66.6	376.7	5.9	4.1	0.0	13.0	440.3	453.4
Gat/Mare Tail	33.9	228.5	53.2	5.2	17.4	179.5	158.7	338.2
IWMK	642.2	708.1	91.7	16.6	0.0	180.9	1277.6	1458.5
Roger	44.5	136.8	20.0	0.0	0.0	39.4	161.9	201.3
Thief	708.7	231.9	41.0	0.0	0.0	237.1	744.4	981.5
Grand Total	**1501.7**	**2797.8**	**228.6**	**36.5**	**17.4**	**682.2**	**3899.8**	**4582.0**

Table 5 – Total weight (g) of cockles found in samples during July survey

Bed	Year-0	Year-1	Year-2	Year-3	Year-4	Gtr 14	Less 14	Total
Black Buoy	128.0	1553.1	5.9	0.0	0.0	635.6	1051.4	1687.0
Daseleys	567.4	596.5	5.6	4.9	0.0	172.4	1002.0	1174.4
Gat/Mare Tail	9.8	278.5	8.0	32.1	20.4	330.2	18.6	348.8
IWMK	1230.8	1035.3	132.4	66.5	20.7	855.8	1630.0	2485.7
Roger	4.1	674.2	0.0	0.0	0.0	404.7	273.5	678.3
Thief	1237.0	253.7	0.0	10.7	0.0	536.2	965.1	1501.4
Grand Total	**3177.1**	**4391.2**	**151.9**	**114.2**	**41.1**	**2934.9**	**4940.6**	**7875.5**

From these tables it can be seen that despite the reduction in cockle numbers seen between tables 2 and 3, there has been a 70% increase in the overall total weight of cockles collected between the two surveys. This is primarily due to the growth exhibited by the Year-0 and Year-1 cohorts exceeding losses incurred through mortality. The increase in average weight of the individual cockles is shown in table 6.

Tables 4 and 5 show there has been a more than four-fold increase in the weight of adult sized cockles collected in the samples between the two surveys. Increases to this group occurred in all of the survey areas and ranged from an almost two-fold increase on the Gat/Mare Tail to a twenty-fold increase on Black Buoy (despite this bed having been fished for 3 days by 16 vessels prior to the July survey, during which approximately 96 tonnes were harvested). It can be seen from table 6, however, that there has been very little change in the average weight of individual adult cockles between the two surveys. The increase in biomass of this population, therefore, is due to the numbers of juvenile cockles that have recruited into this population between surveys.

Table 6 – Average weights of individual cockles found in the samples

	Year-0		Year-1		Gtr 14	
Bed	April	July	April	July	April	July
Black Buoy	0.29	1.62	1.12	2.30	4.03	4.02
Daseleys	0.29	1.25	1.36	2.27	4.34	3.32
Gat/Mare Tail	0.87	1.96	2.26	4.22	3.90	4.65
IWMK	0.83	1.47	1.60	2.78	3.85	3.91
Roger	0.81	1.02	1.57	2.36	3.94	3.78
Thief	0.75	2.19	3.36	5.18	3.89	4.00
Grand Total	0.73	1.63	1.42	2.57	3.90	3.96

Cockle growth on Black Buoy, IWMK and Thief sands

Because these three beds were completely surveyed in both April and July, their respective size distributions can be compared (figures 6-8).

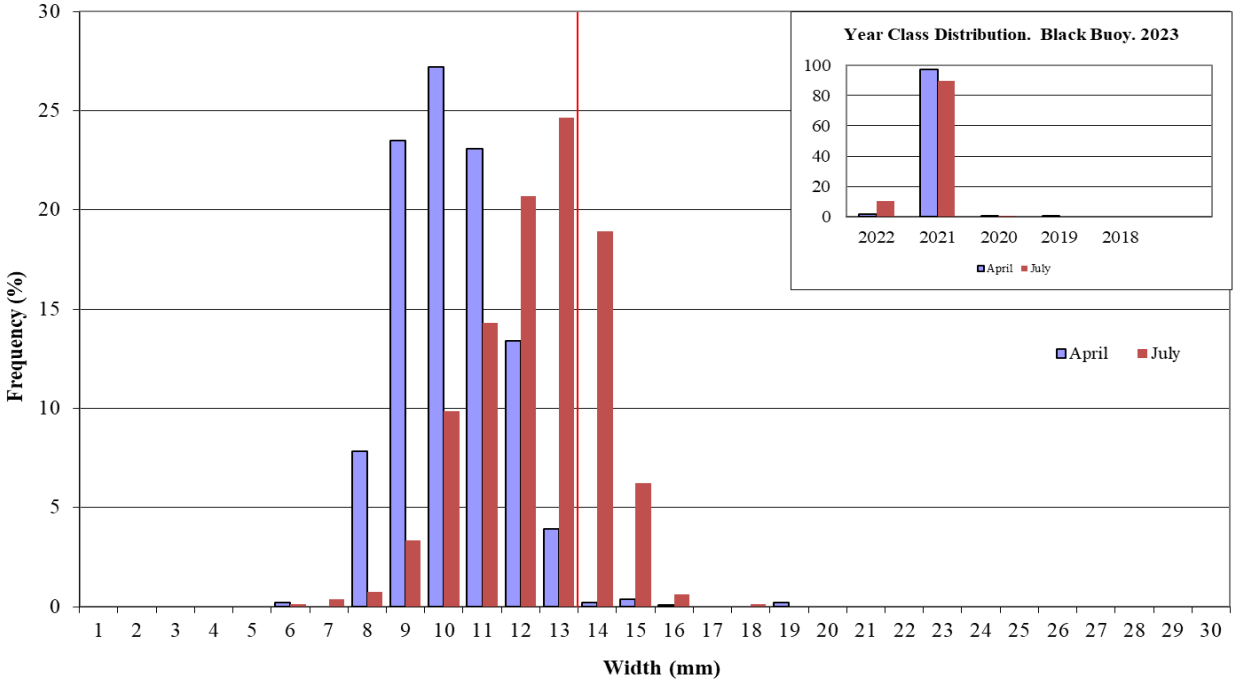

Figure 6 – Cockle size and age frequency on the Black Buoy sand – April and July 2023

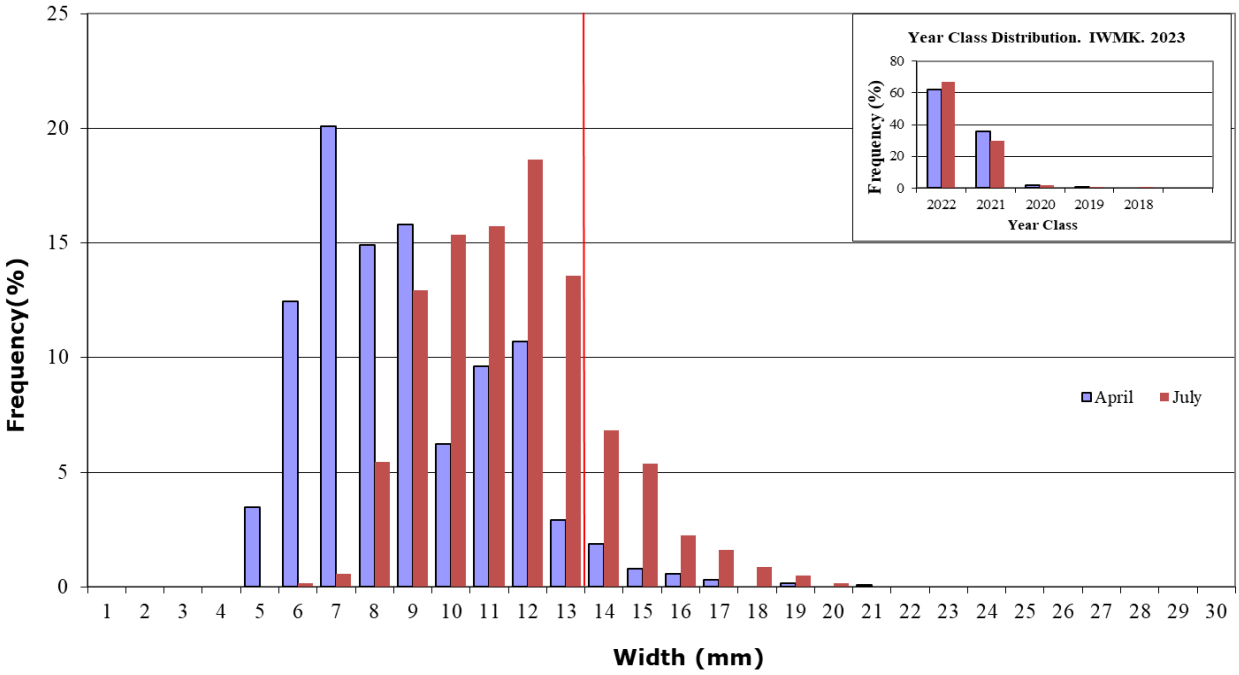

Figure 7 – Cockle size and age frequency on the IWMK sand – April and July 2023

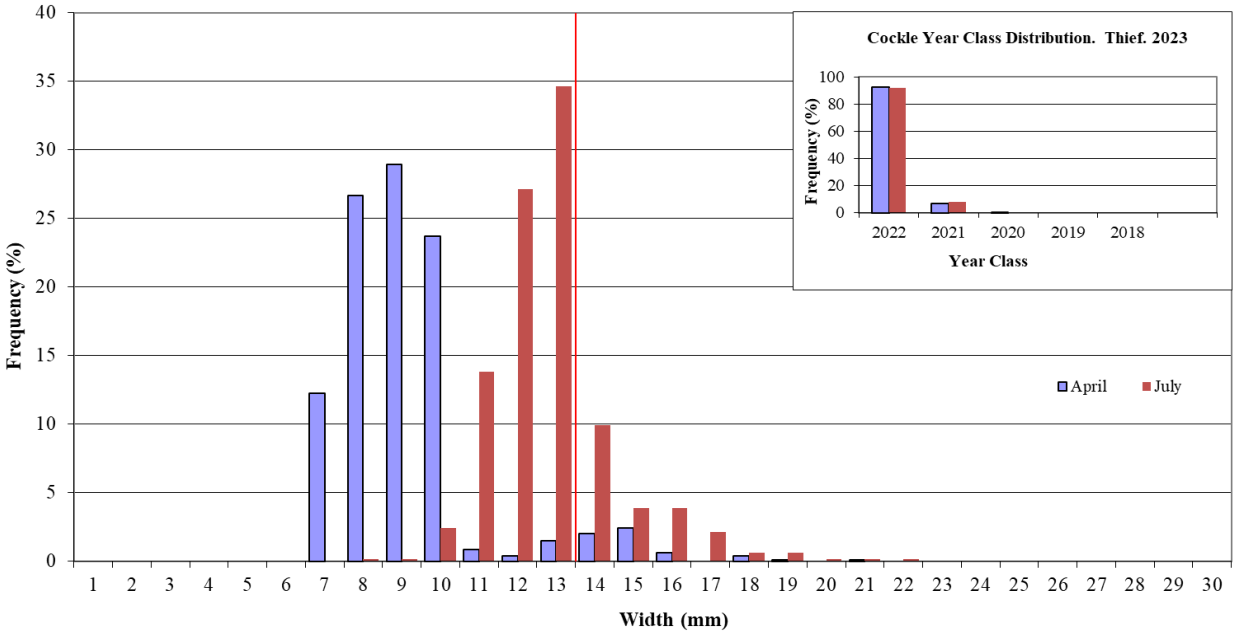

Figure 8 – Cockle size and age frequency on the Thief sand – April and July 2023

The charts above show the juvenile cockles on the Black Buoy and IWMK beds have grown 3mm in width between the two surveys, while those on the Thief sand have grown 4mm. This faster growth on the Thief sand is consistent with previous survey data that has shown the Thief to be a fast growing area, as is also evidenced by the dominant cohort on this bed being a year younger than the dominant cohort on Black Buoy, yet of a similar size. In April each bed only supported small populations of ≥14mm width cockles but this growth has helped boost those numbers. Further, the

charts show the peak size on each bed is currently 12-13mm. Given similar growth rates to those seen between April and July, these individuals will also recruit into the adult population before winter.

Conclusion

The surveys found that overall there had been a reduction in cockle numbers between the surveys, as would be expected following ongoing mortality (and some fishing activity on the Black Buoy bed). However, localised variability in cockle densities mean such losses can only be reliably seen over a relatively short period when large numbers of stations are sampled in order to smooth out local variations. Unless mortalities are particularly high, they are difficult to detect in this type of survey at an individual bed level, where 18-33 stations are insufficient to smooth out localised variability.

Individual cockle growth was evident from the data, particularly among the Year-0 and Year-1 cohorts. Increases in cockle biomass as a result of this growth more than compensated for that lost through ongoing mortality and helped the total cockle biomass in the samples increase by 70%.

Although the average individual weights of the adult cockles barely changed between the surveys, recruitment of juveniles into this population helped both the numbers of adult sized cockles and the total biomass of this population within the samples to increase by a factor of 4.3. In terms of cockles on the beds, the 848 tonnes of adult cockles that were calculated to be present within these 6 survey areas in April have increased to 3,651 tonnes.

Because multiple factors influence growth and the rate at which juvenile cockles recruit to the adult population, the results from this study cannot be used to accurately extrapolate how the cockles on beds outside of the study area performed. It is likely, however, that they would fall within the ranges seen within this study, where at the lowest rate of increase, the adult populations on the Gat and Thief sands increased two-fold, and at the greatest, those on Black Buoy increased almost twenty-fold. Applying those margins to the 2,609 tonnes of adult cockles present outside of these study areas, their biomass could have increased to anything between a conservative 5,218 tonnes and an unlikely 52,180 tonnes but would more likely be around 10-11,000 tonnes. Including the 3,651 tonnes present within the study area, therefore, the total adult cockle stock currently most likely falls between a conservative 8,869 tonnes and 14,651 tonnes. Figures 6-8 suggest there will be further recruitment into the adult population before winter, but as cockles of this size range are vulnerable to “atypical” mortality, losses are also anticipated to be high.

References

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Eastern-IFCA, 2023 - Review of the cockle fishery Total Allowable Catch and rationale for potential changes https://www.eastern-ifca.gov.uk/wp-content/uploads/2023/06/2023_06_02_Review_of_Cockle_TAC_online_version.pdf