RESEARCH REPORT

2017 WFO COCKLE STOCK ASSESSMENT

R.W. JESSOP

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CONTENTS

Introduction

With an annual first-sale value of over £1 million, the intertidal cockle stocks in The Wash provide an important resource for the local fishing industry, particularly to the ports of Boston and King's Lynn. In addition to supporting the fishery, these stocks also provide an essential food resource for the internationally important communities of birds that reside or over-winter in The Wash. It is important, therefore, for both the wildlife communities and the sustainability of the fishery, to ensure the fishery is managed and targeted in a responsible manner that does not result in a crash in the stocks.

Traditionally, the cockle fishery was a hand-worked, artisanal fishery that mainly supplied local markets. However, modernization of the fleet and expansion of the markets into Europe have greatly changed the fishery over the past forty years. Innovations during that time have included techniques to improve the efficiency of hand-working, such as "blowing out"[1] in the 1970s and "prop washing"[2] since 2004. Technological changes include the evolution of larger, more efficient vessels into the fleet and the introduction of hydraulic suction dredges in 1986. The greater efficiency that these methods and technology have brought, however, has on occasions been detrimental to the stocks. When management measures have been slow to react to the changing trends, over-fishing has occurred, resulting in declining stocks and "boom and bust" fisheries.

In 1993 the Fishery Order 1992 was introduced to strengthen the management of the shellfisheries in the Wash. Based mainly on controlling daily quotas and temporal and spatial closures, however, the efficiency of suction dredge equipment, meant cockle stocks remained low through most of the 1990s. In 1998, an annual Total Allowable Catch (TAC) quota for the cockle fishery was

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[1] A technique whereby an anchored vessel is manoeuvred in concentric circles during the ebbing tide, using the wash from the propeller wash cockles out of the ground into easy to harvest piles. This method was prohibited in 1986.

[2] A similar technique to "blowing-out", but without the use of an anchor. Because the vessel is not fixed to the seabed, the precise concentric rings created during "blowing-out" cannot be created. "Prop washing", therefore, is less efficient and creates less disturbance to the ground.

introduced to limit exploitation to sustainable levels. This, together with the subsequent evolution of other management measures, has helped to stabilise the fishery and facilitate a stock recovery through the 2000s. This period has also seen a growing environmental awareness introduced into the management of the fisheries, whereby the fisheries are not just limited to ensure their sustainability, but to protect designated environmental features and communities. This has resulted in the need to submit detailed Habitat Regulations Assessments to Natural England before fisheries can be consented, to ensure they will not have a detrimental impact on the site's Conservation Objective targets. In 2007 a suite of Management Policies was developed and agreed between Eastern Sea Fisheries Joint Committee (ESFJC)[3], Natural England and the fishing industry. These management policies have guided the management of the cockle fishery since then.

Irrespective of how effective the management measures used, there is little that can be done to control natural events. Since 2008, the stocks have suffered unusually high mortality rates, undoing much of the progress that the management measures had helped to achieve. Although a causal factor has yet to be officially determined[4], this "atypical" mortality has had a major impact on the fishery since then, resulting in far more cockle deaths than have been harvested. Such challenges have placed even more importance on having accurate survey information, so that the fishery can continue to harvest cockles without hazarding the sustainability of the stocks. In recent years, information gathered from the annual stock surveys and a number of specific cockle mortality studies, have enabled us to understand the dynamics of "atypical" mortality sufficiently to confidently adopt flexible contingency measures, designed to target harvesting into areas considered most vulnerable to losses. This approach has enabled the fishery to maximise its potential and to minimise the natural losses that would otherwise occur. The suite of management

[3] The predecessor of Eastern IFCA.
[4] Although not positively identified as being the causal factor in the die-offs, samples collected from The Wash and analysed by Cefas in 2008, found strong circumstantial evidence to suggest three species of Haplosporidian parasite were responsible.

measures that were agreed in 2008 are currently being reviewed, to account for recent changes that influence the fishery, including “atypical” mortality.

This report provides details of the 2017 spring cockle surveys and briefly summarises the subsequent fishery. Although there is no Minimum Landing Size (MLS) applied to cockles in The Wash, the results presented in this report divide the stocks into two size groups (cockles that are 14mm width and over and those that are under 14mm width). These groups are sometimes referred to in the report and management measures as “adult” and “juvenile” stocks, but these definitions are not strictly accurate - cockle size being influenced by a number of factors in addition to age. These size categories do, nevertheless, play an important role in the management of the fisheries, as to protect juvenile stocks, no cockles under 14mm width, irrespective of age, currently contribute towards the annual TAC.

Method

The intertidal cockle surveys are preferably conducted during spring tide periods (>6.5m). These allow best access to the beds either using a boat at high water or when walking the beds at low water. During neap tides some of the higher sites are inaccessible to the research boat at high water, while the lower sites may not drain adequately at low water to be accessible on foot. Timing of the high-water periods during neap tides is also problematic, in that the night time high water period is usually between midnight and 03:00hrs, usually resulting in the loss of one of the two high water sampling periods.

Samples are collected at regular intervals on a predetermined conventional grid, from which the same sample stations are replicated each year. The majority of the stations on this grid are 370m x 340m apart, with a slightly higher resolution grid of 280m x 340m being used on the Herring Hill, Holbeach, Mare Tail and Gat sands.

Samples are collected either at high water using a 0.1m^2 Day grab deployed from the research vessel, *Three Counties,* or a 0.1m^2 quadrat during low water foot surveys. Once collected, the samples are washed over a 3mm mesh washing table (or using a 0.5mm sieve in the case of foot surveys), allowing any cockles present in the sample to be separated from the surrounding sediment. During the washing process the following data are recorded on the survey summary sheet (see figure 1):

Station –Station number of the sample

Sed –Sediment number using the following graduated scale:

1 – Sand (clean sand)

2 – Silty Sand (mainly sand, but contains some finer material)

3 – Sandy Silt (mainly fine silt but contains some coarser sand grains)

4 – Silt (Fine silty mud, generally soft to walk on)

5 – Clay with a thin top veneer of Sand (The clay sediments are more compact and solid than silt).

6 – Clay with a thin top veneer of Silt (The clay sediments are more compact and solid than silt).
7 – Clay (The clay sediments are more compact and solid than silt).

Cockle – The approximate number of cockles present in each sample

A1, A2 and A3 –Number of *Arenicola* casts found in each of three quadrats taken at each station during foot surveys. As casts are disturbed in a Day grab sample and cannot be identified, these three columns are not filled in during Day grab surveys.

Lan – During foot surveys record how many of the three quadrats contain *Lanice* tubes. As only one Day grab sample is taken at each station the presence or absence of *Lanice* tubes is recorded as Y/N during grab surveys.

Mac –Number of *Macoma* present in the sample.

SAND							
DATE							
STATION	SED	COCKLE	A1	A2	A3	LAN	MAC
1							
2							
3							
4							
5							
6							
7							
etc							

Figure 1 - Example of the survey summary sheets used to record additional environmental data collected during cockle surveys

Once cleaned, any cockles present in the sample are retained in labelled bags for later analysis (one bag/station). Samples are stored in a cool place out of the sun.

At low water the cockles in the retained samples are individually[5] measured to the nearest millimetre by length and width. These cockles are separated into three groups:

1. Those of width equal or greater than 16mm
2. Those of width 14 to 15mm
3. Those smaller than 14mm width.

The cockles within each group are then further separated into age classes using their annual growth rings to age them (taking care to identify whether outer ring is the current or previous year's growth). The number of cockles in each age-size group is recorded and the total weight of cockles in each group measured to the nearest 0.01g. Due to the sensitivity of the scales used (200g/0.01g), the weighing of these samples can only take place ashore or once the vessel is aground.

The data acquired from these surveys are recorded in a bespoke Access database. These are later transferred to a MapInfo GIS database from which charts of the beds showing cockle densities can be interpolated. The minimum density used to determine the extent of the coverage on the bed is 10 cockles/m^2. The biomass of cockles on the bed is calculated by multiplying the mean weight of the samples to attain a weight per hectare, and applying this figure to the area of coverage. The biomass of fishable stock is determined by using the mean weight of those individuals having reached a width of 14mm or greater.

The additional environmental data collected during the surveys is also transferred to a MapInfo GIS database. This data is used to create models

[5] For samples containing large numbers of spat <8mm width, that cannot realistically be measured individually, a size range of the spat is determined by measuring the largest and smallest individuals, and the total number of spat recorded. This number is then averaged between the various sizes within the size range.

showing the distribution of *Lanice conchilega* and *Macoma balthica* using Vertical mapper software with a Nearest Neighbour interpolation methodology.

Results

The annual spring cockle surveys were conducted between March 27th and April 28th. During the course of the surveys, 1,296 stations from a total of 21 sands were sampled. Figure 2 shows the coverage of these stations.

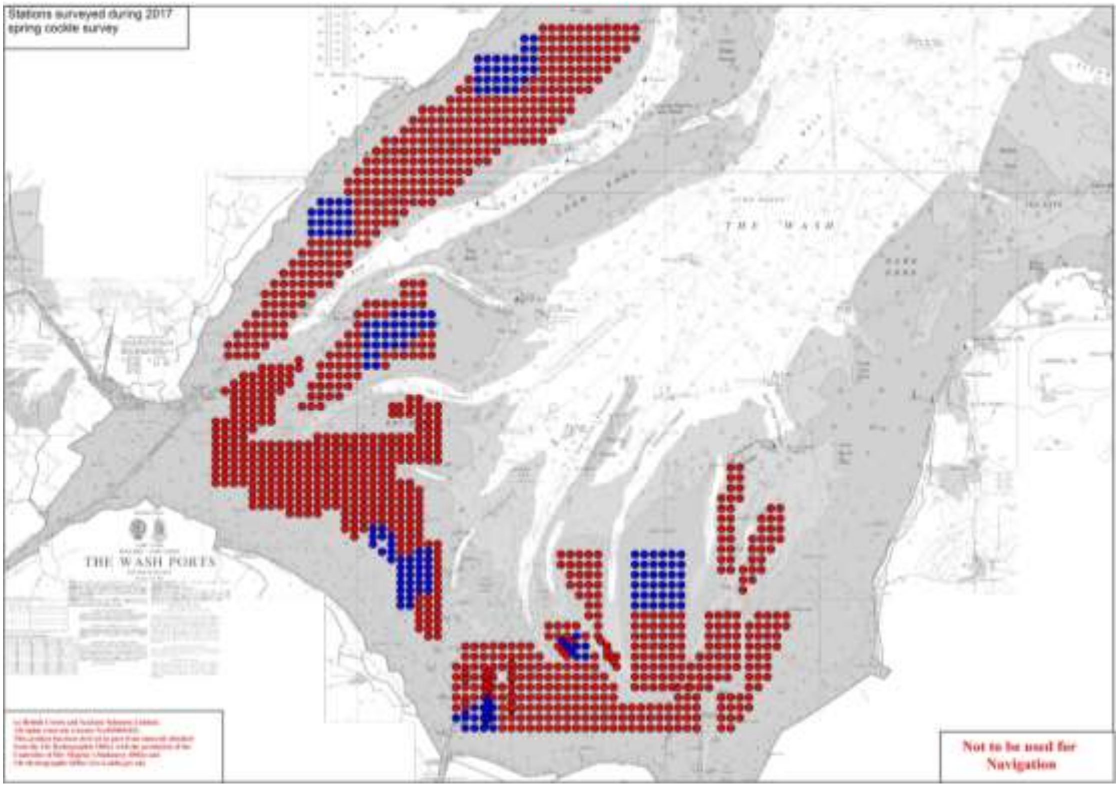


Figure 2 – Chart showing the positions of the stations sampled during the 2017 spring cockle survey (Red stations sampled using Day grab, blue stations sampled on foot with quadrat).

Table 1 provides a summary of the cockle stocks identified during the surveys, while figures 3 to 8 show the distributions of adult and juvenile stocks on the beds. Figures 9 to 23 show the cockle size frequencies and age frequencies of the cockles sampled from each bed.

Table 1 - Summary of cockle stocks on the Wash intertidal beds - April 2017

	ADULT				JUVENILES					
SAND	Area (ha)	Mean Density (no/m2)	Mean Weight (t/ha)	Biomass (t)	Area (ha)	Mean Density (no/m2)	Mean Weight (t/ha)	Biomass (t)	Total Biomass	%Adult
Butterwick	238	43.64	1.83	437	232	1418.64	3.73	868	1305.00	33
Wrangle	697	47.42	3.09	2155	730	1368.48	2.65	1933	4088.00	53
Friskney	586	32.46	2.87	1684	532	108.55	0.81	431	2115.00	80
Butterwick Ext	238	55.71	2.10	500	271	536.25	2.39	648	1148.00	44
Wrangle Ext	127	10.00	0.49	63	127	17.50	0.21	33	96.00	66
Friskney Ext	436	14.33	0.99	432	337	28.00	0.40	133	565.00	76
Boston Main Total	2322			5271	2229			4046	9317.00	57
Roger/Toft	589	149.38	7.78	4578	381	534.84	2.16	824	5402.00	85
Gat	69	25.00	2.50	171	128	1416.43	5.16	660	831.00	21
Longsand									0.00	
Herring Hill	215	23.04	1.05	224	325	223.71	2.13	692	916.00	24
Black Buoy	129	168.57	6.41	824	147	346.25	4.47	656	1480.00	56
Mare Tail	323	101.29	4.42	1427	447	614.42	4.19	1874	3301.00	43
Holbeach	858	58.75	2.42	2079	839	223.33	1.35	1133	3212.00	65
IWMK	250	73.00	2.46	615	356	664.29	3.78	1346	1961.00	31
Breast	685	67.19	2.61	1790	980	175.36	2.05	2006	3796.00	47
IWMK/Breast Total	935			2405	1336			3352	5757.00	42
Thief	184	185.00	10.70	1969	45	50.00	0.34	15	1984.00	99
Whiting Shoal	0	0.00	0.00	0	43	382.50	1.03	44	44.00	0
Daseley's	548	59.55	2.78	1524	593	260.85	0.91	540	2064.00	74
Styleman's	60	80.00	5.54	331	110	132.00	0.54	59	390.00	85
Pandora	39	90.00	3.47	136	100	139.00	0.36	35	171.00	80
Blackguard	12	10.00	1.86	23	24	410.00	1.50	36	59.00	
Peter Black	151	16.43	0.57	86	399	402.86	1.62	644	730.00	12
TOTAL	**6434**			**21048**	**7146**			**14610**	**35658.00**	59

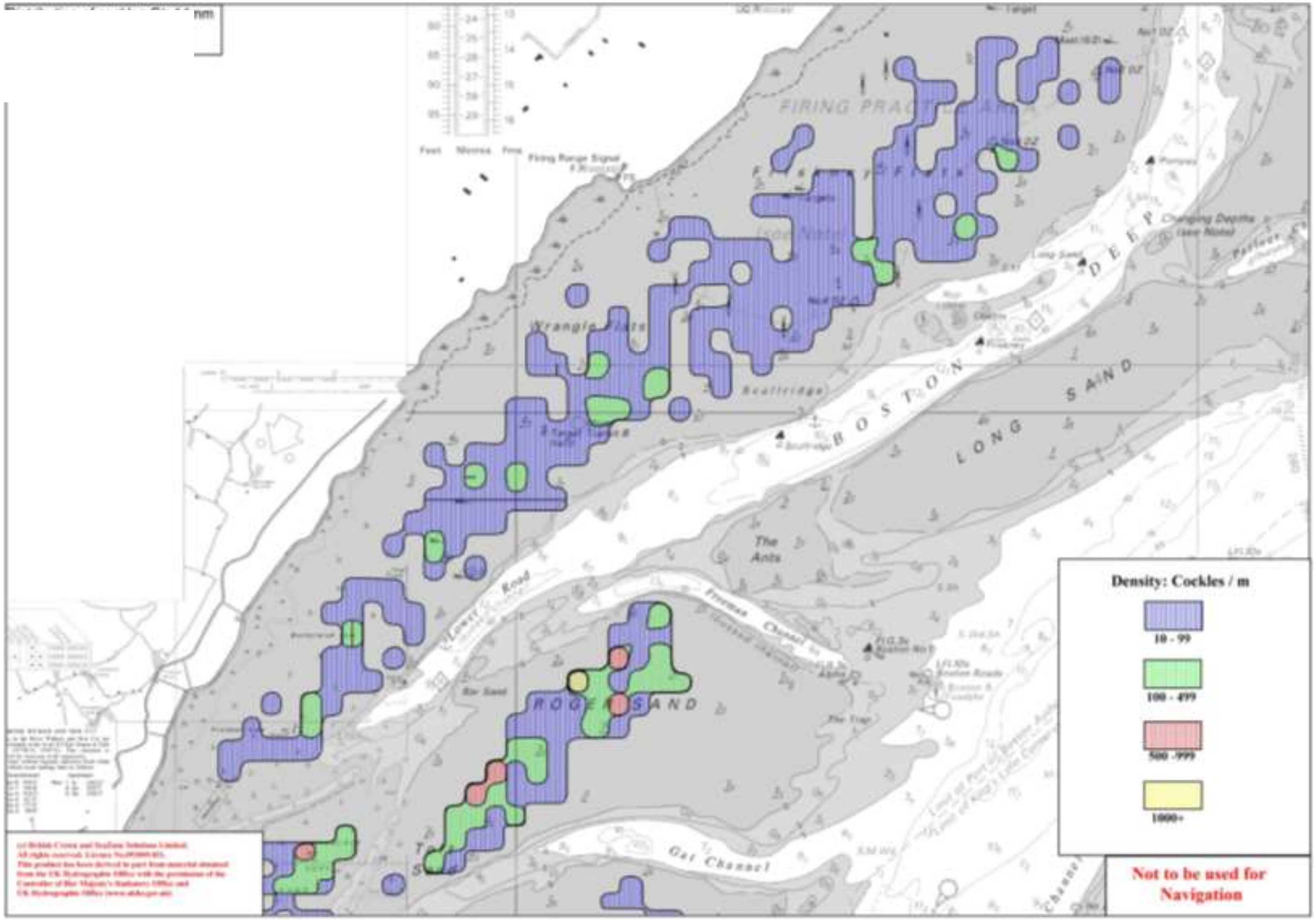


Figure 3 – Chart showing the stocks of cockles ≥14mm width on the Butterwick, Wrangle, Friskney and Roger/Toft sands

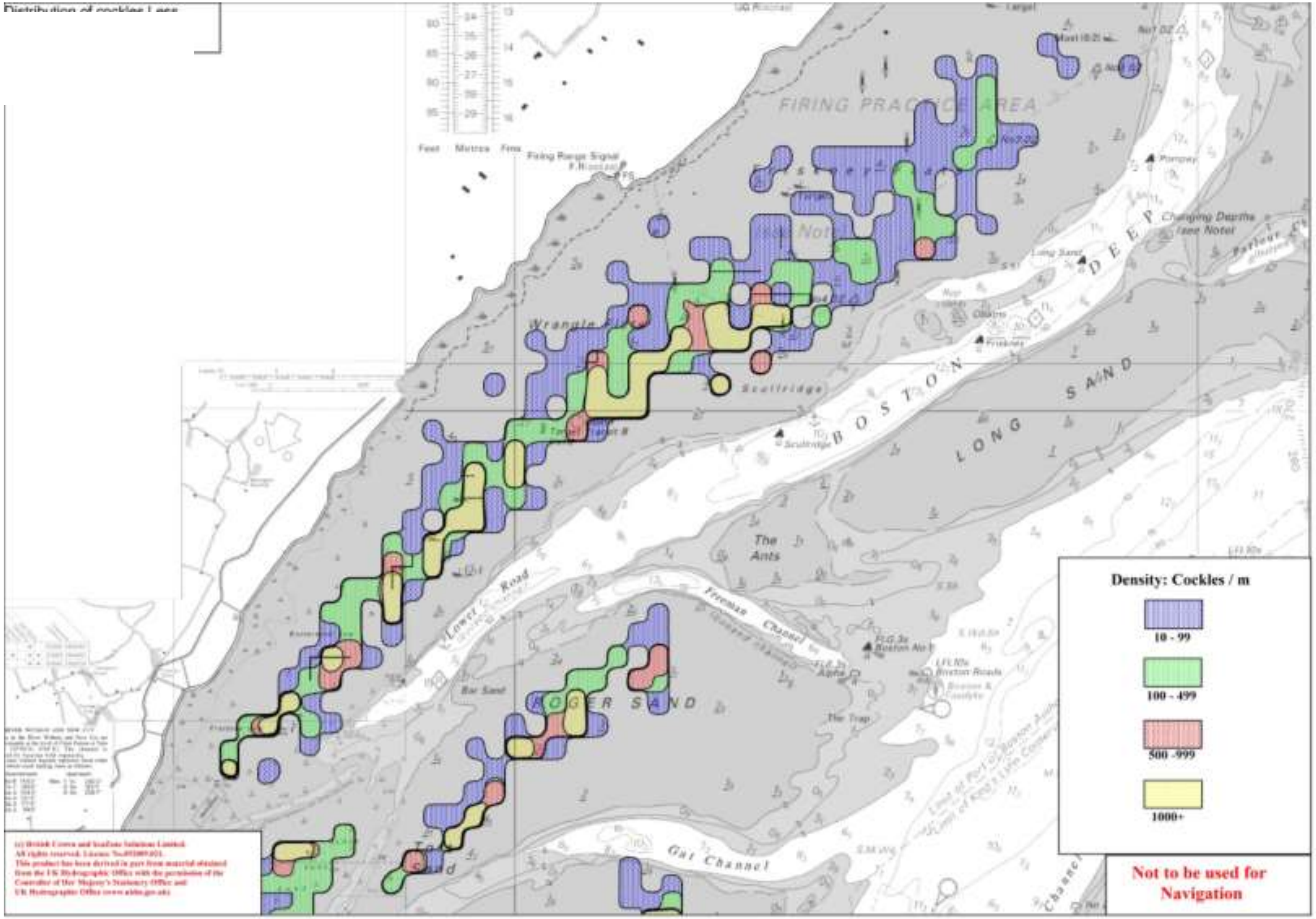


Figure 4 – Chart showing the stocks of cockles <14mm width on the Butterwick, Wrangle, Friskney and Roger/Toft sands

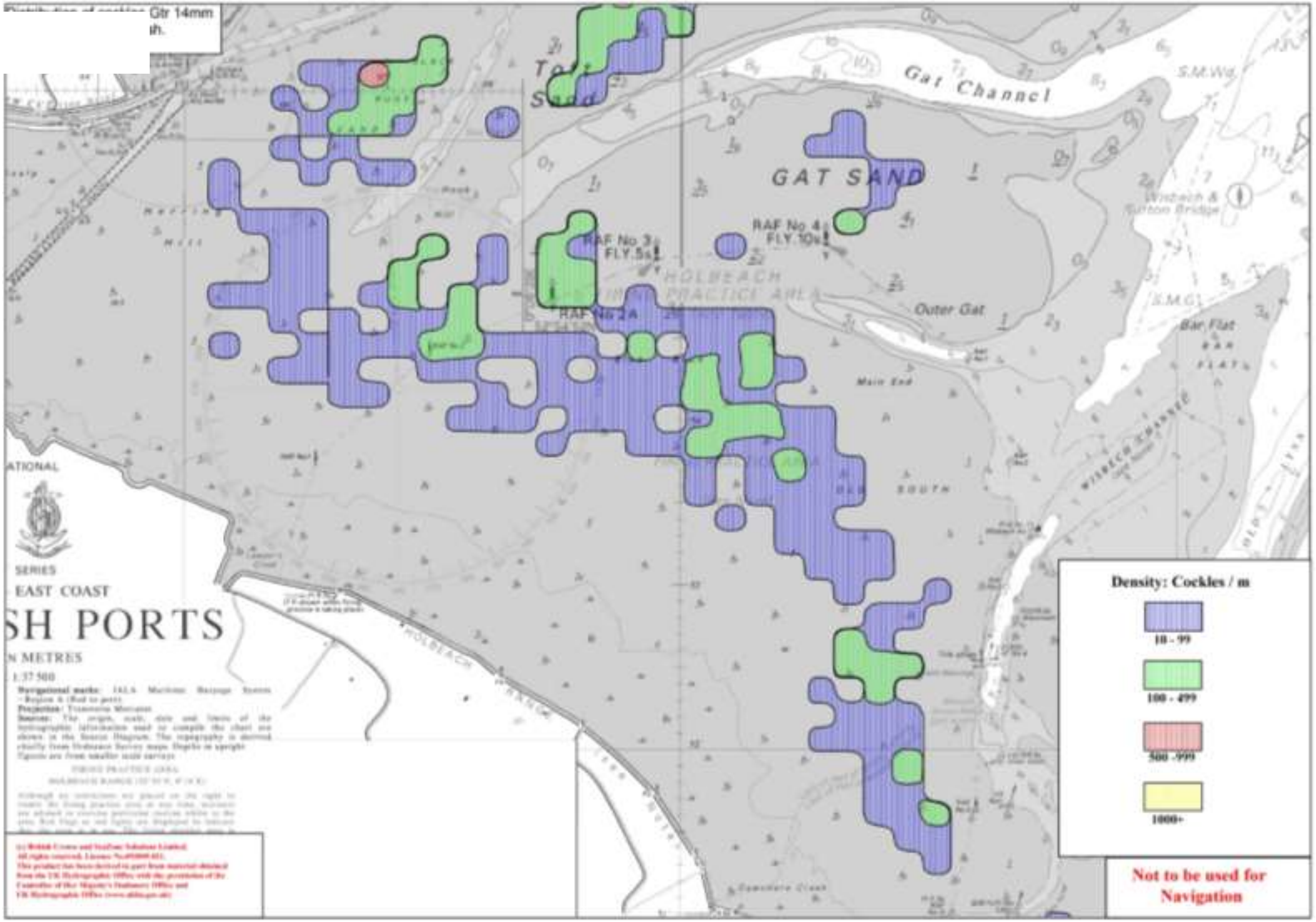


Figure 5 – Chart showing the stocks of cockles ≥14mm width on the Black Buoy, Dills, Herring Hill, Mare Tail, Gat and Holbeach sands

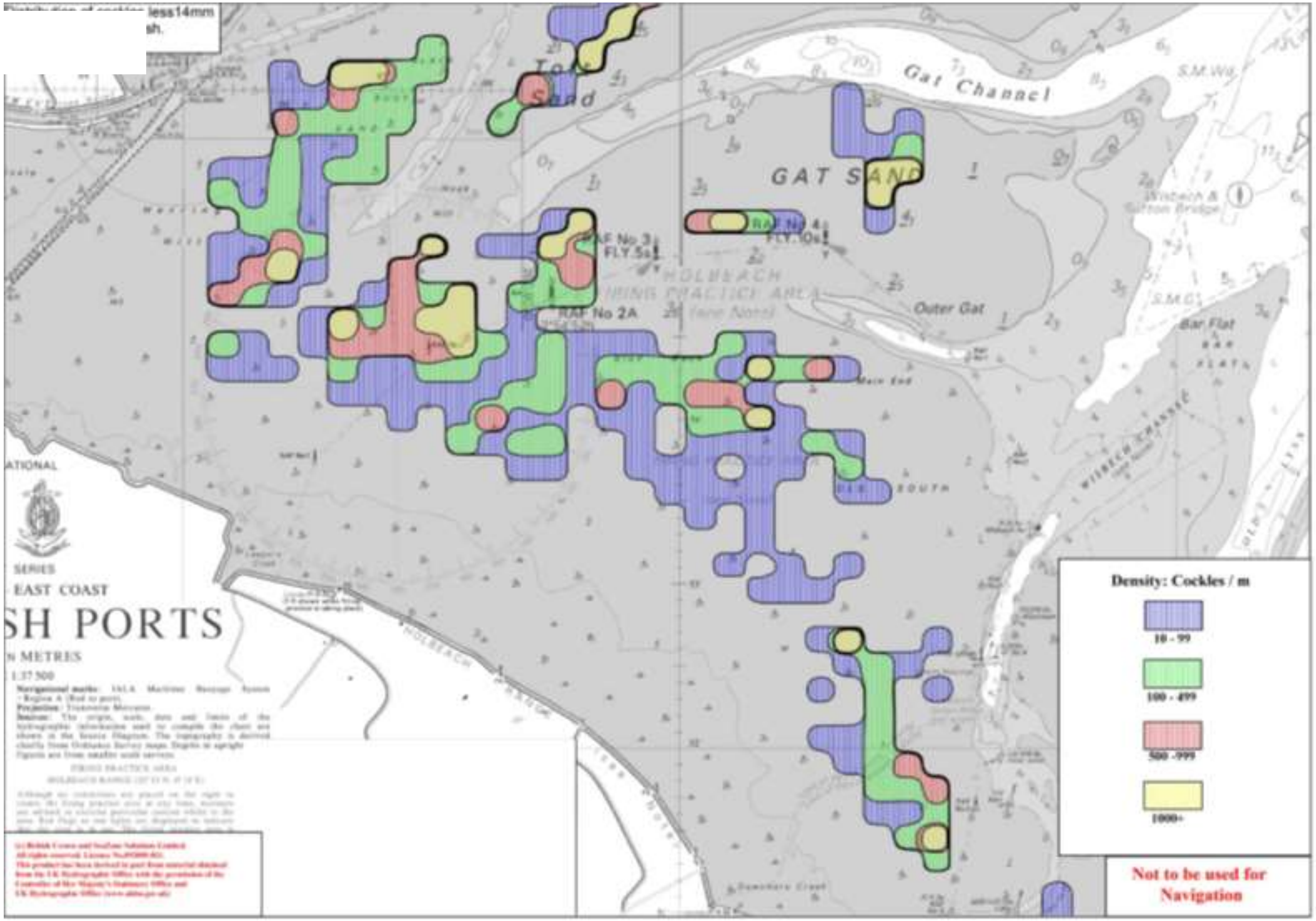


Figure 6 – Chart showing the Stocks of cockles <14mm width on the Black Buoy, Dills, Herring Hill, Mare Tail, Gat and Holbeach sands

Figure 7 – Chart showing the stocks of cockles ≥14mm width on the IWMK, Breast, Thief, Daseley's, Pandora and Peter Black sands

Figure 8 – Chart showing the stocks of cockles <14mm width on the IWMK, Breast, Thief, Daseley's, Pandora and Peter Black sands

Figure 9 - Cockle Size Frequency. Butterwick. April 2017

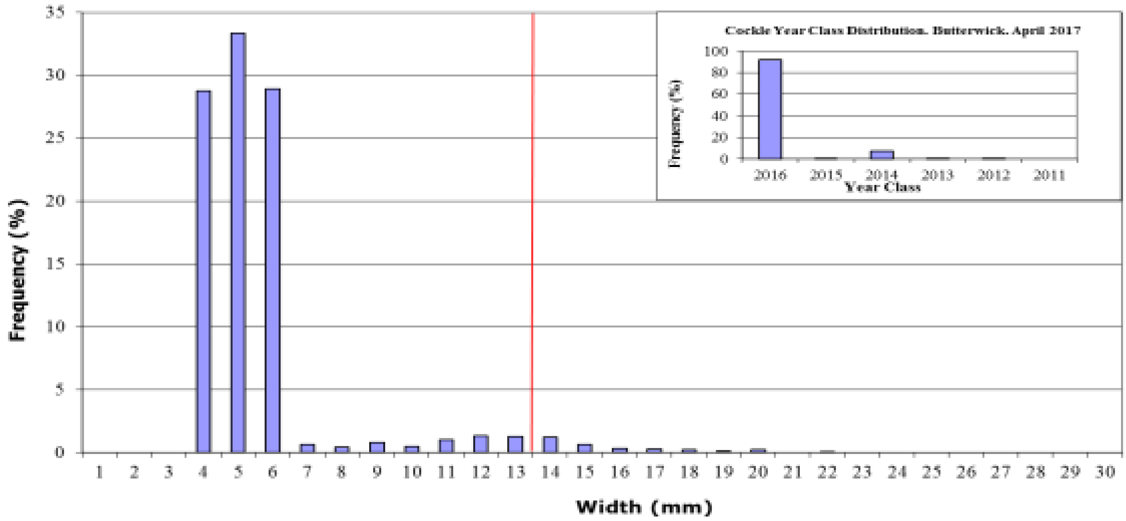


Figure 10 - Cockle Size Distribution. Wrangle. April 2017

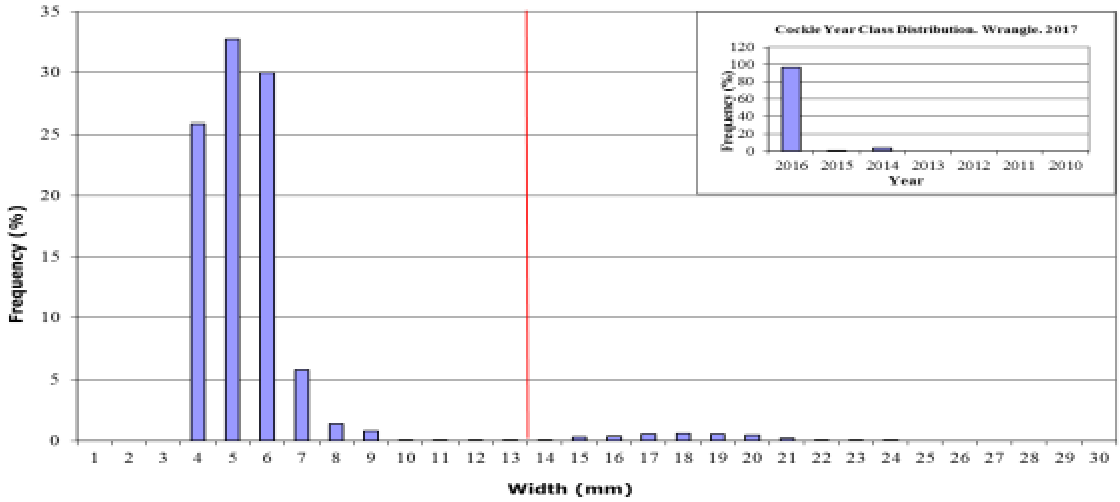


Figure 11 - Cockle Size Frequency. Friskney. April 2017

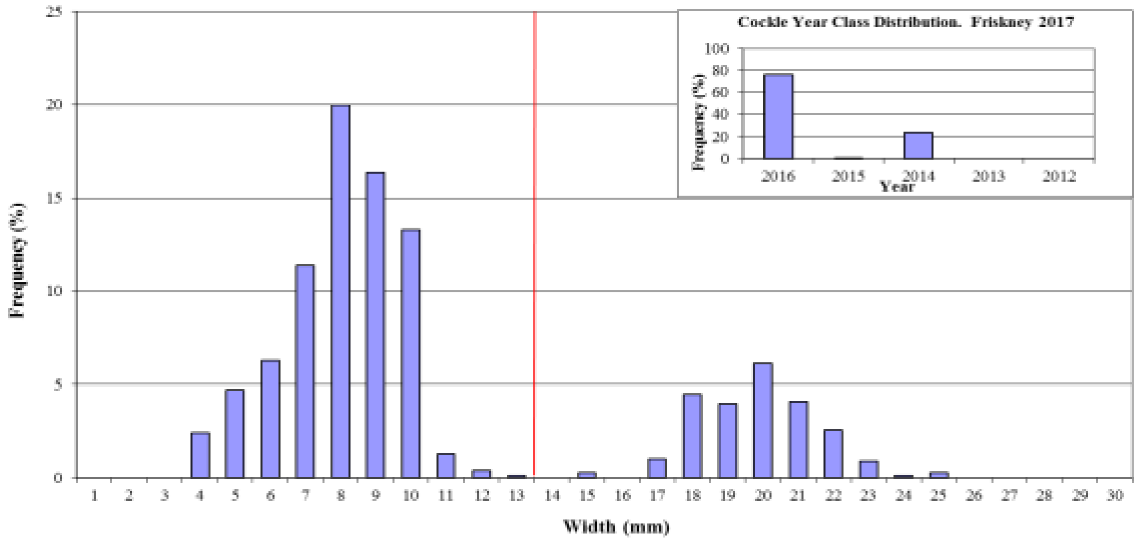


Figure 12 - Cockle Size Distribution. Roger/Toft. April 2017

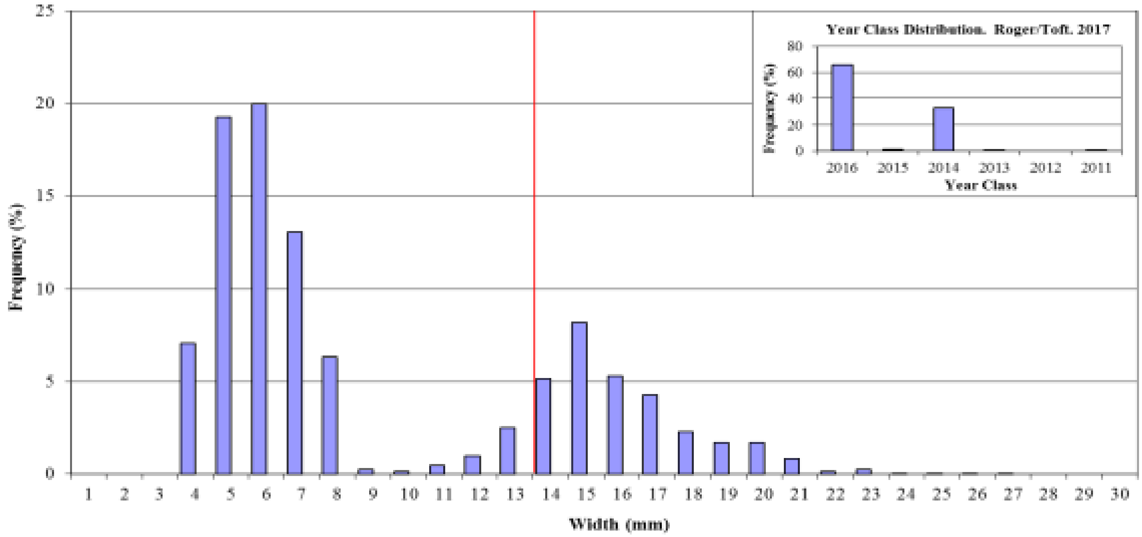


Figure 13 - Cockle Size Frequency. Gat Sand. April 2017

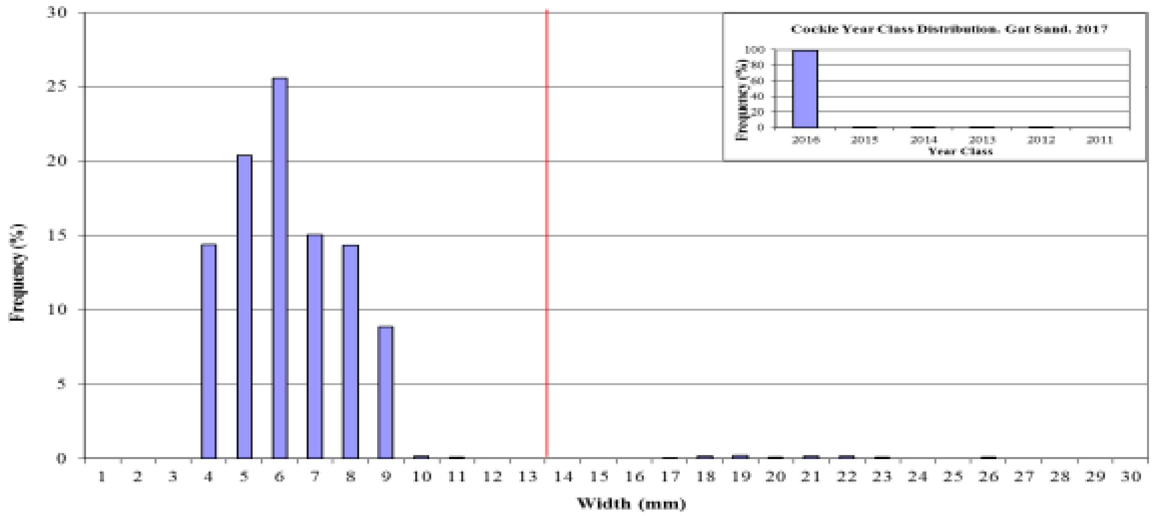


Figure 14 - Cockle Size Frequency. Black Buoy. April 2017

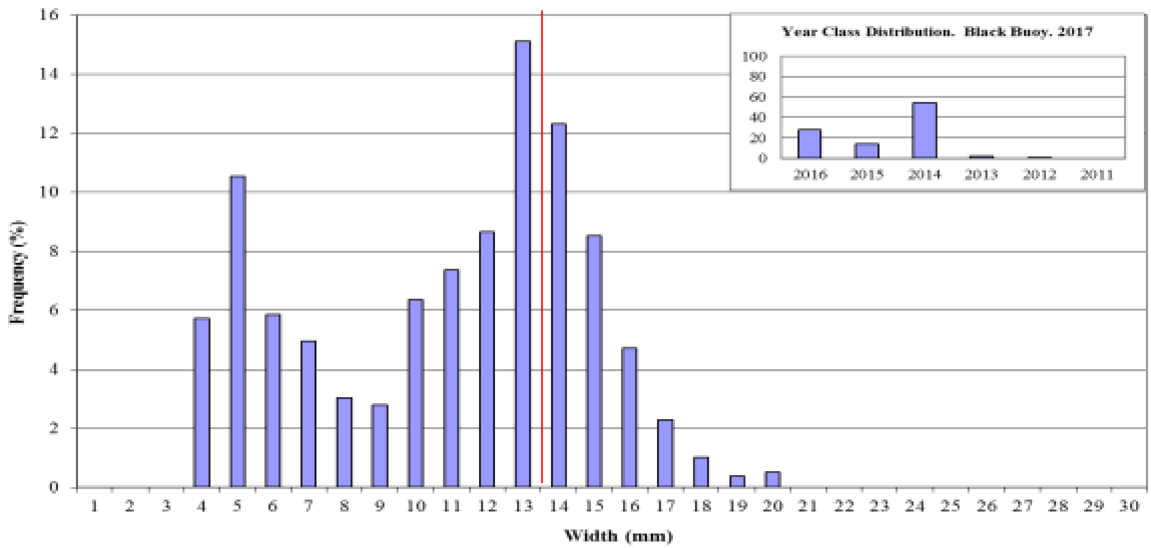


Figure 15 - Cockle Size Frequency. Herring Hill. April 2017

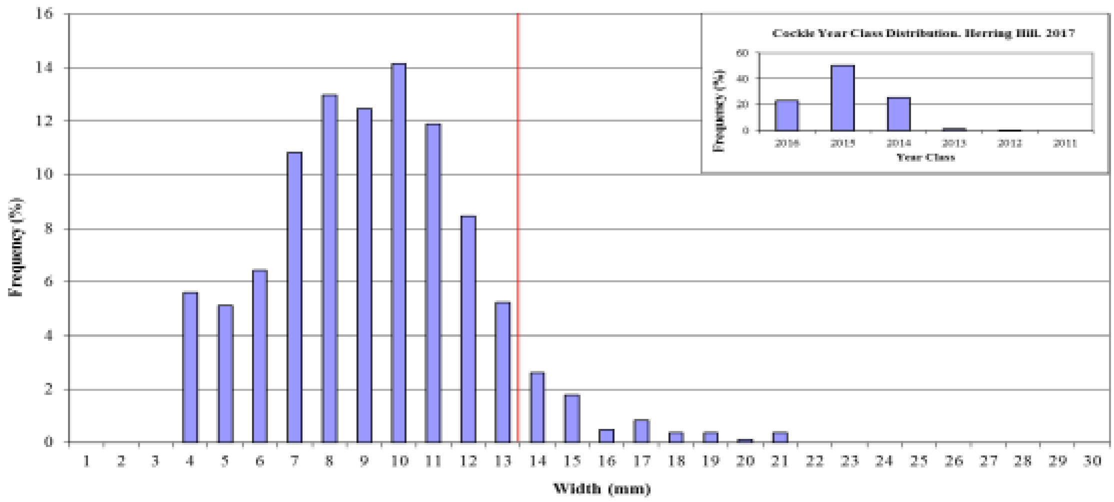


Figure 16 - Cockle Size Frequency. Mare Tail. April 2017

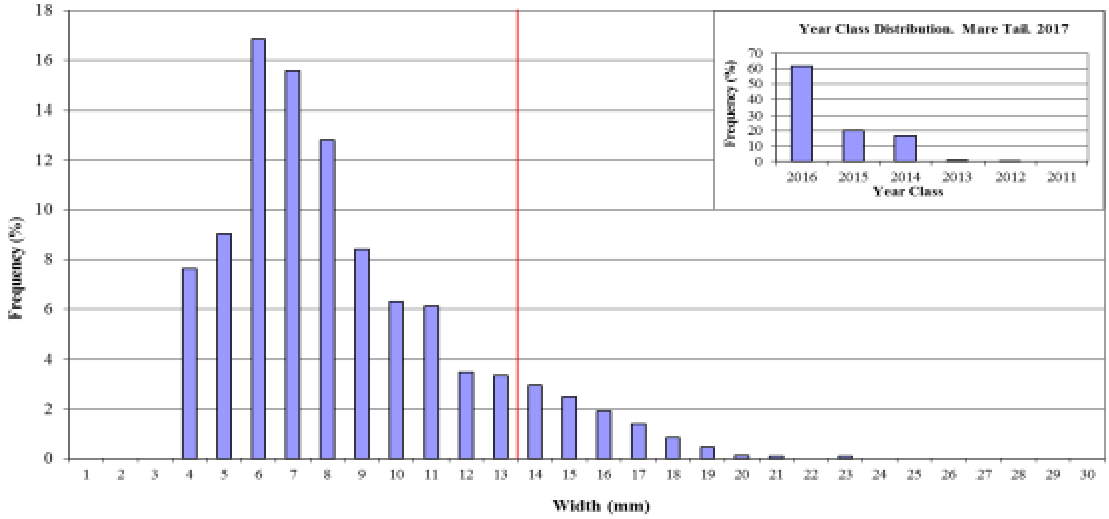


Figure 17 - Cockle Size Frequency. Holbeach. April 2017

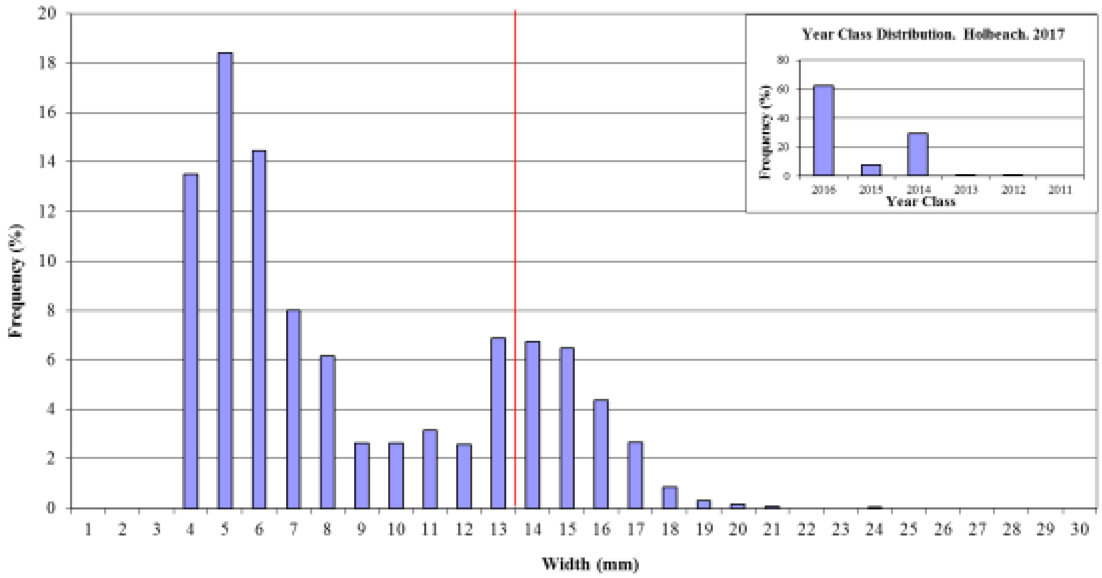


Figure 18 - Cockle Size Frequency. IWMK. April 2017

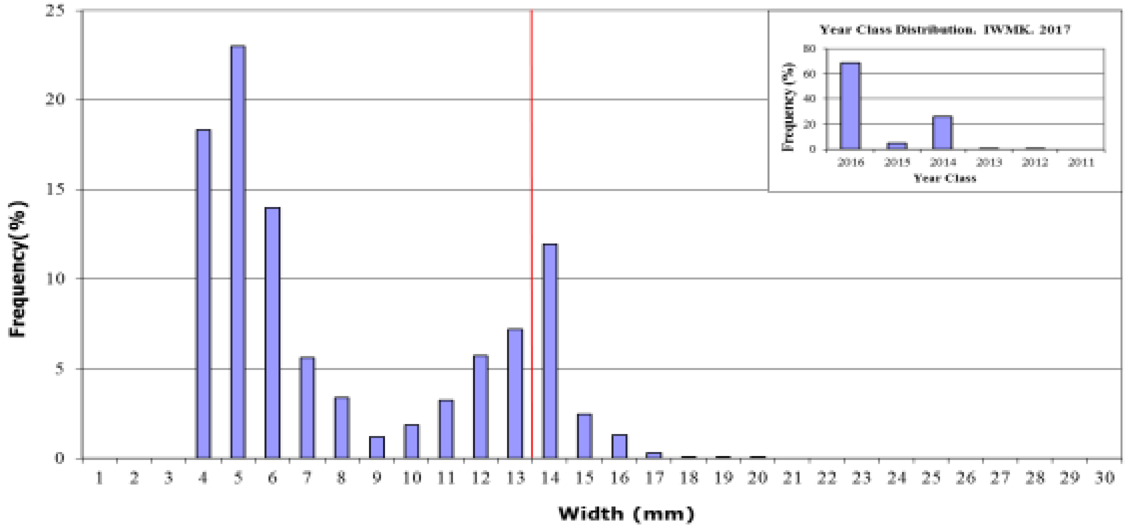


Figure 19 - Cockle Size Frequency. Breast Sand. April 2017

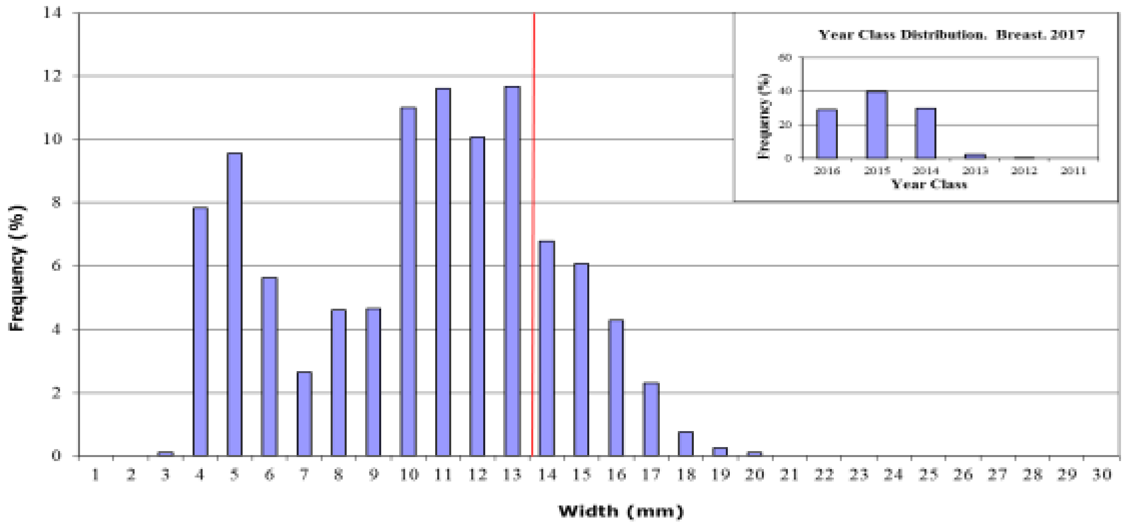


Figure 20 - Cockle Size Frequency. Daseley's. April 2017

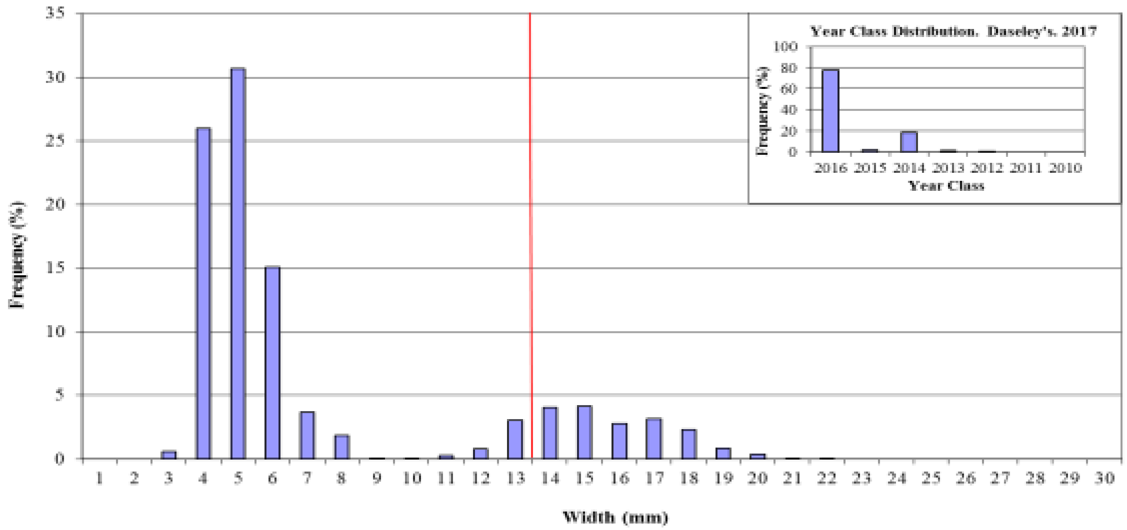


Figure 21 - Cockle Size Frequency. Thief. April 2017

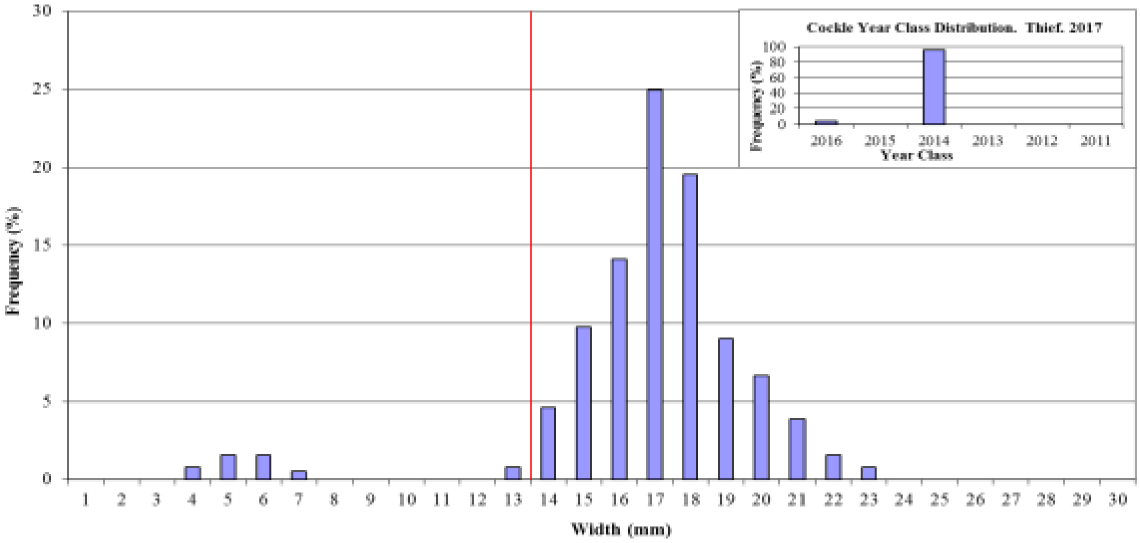


Figure 22 - Cockle Size Frequency. Styleman's. April 2017

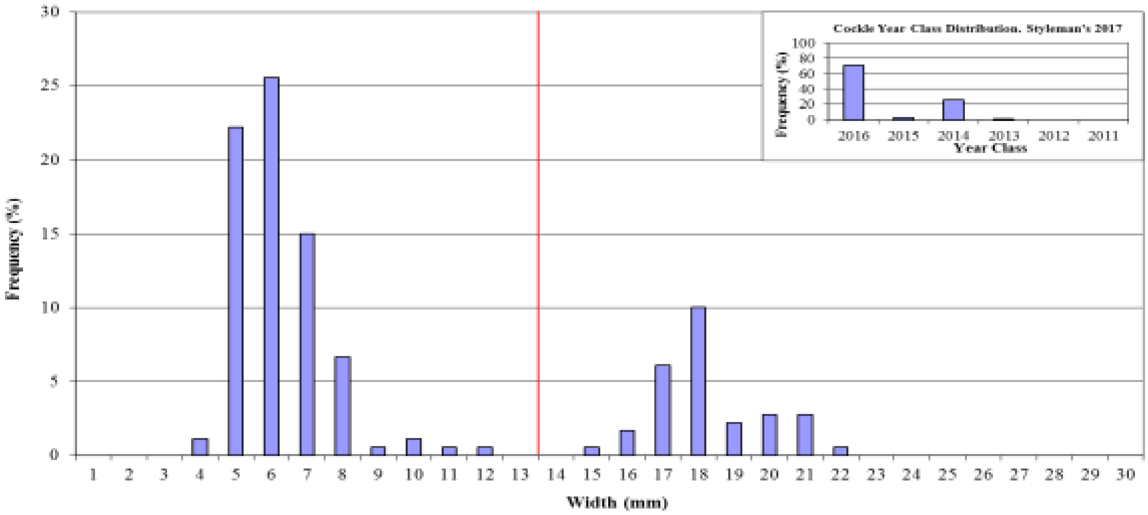
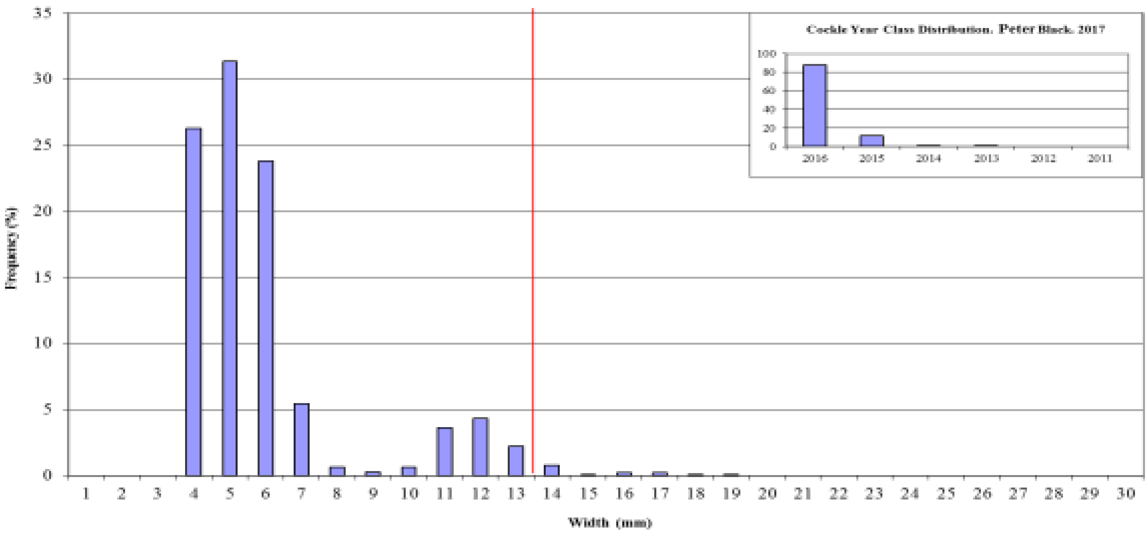


Figure 23 - Cockle Size Distribution. Peter Black. April 2017



Discussion

Table 1 shows the cockle stock biomass at the time of the 2017 surveys to be:

Total Adult Stock (≥14mm width)	**21,048 tonnes**
Total Juvenile Stock (<14mm width)	**14,610 tonnes**
Total Stock (all sizes)	**35,658 tonnes**

Although these were predominantly from the 2014 year-class cohort, another good settlement during 2016 had contributed 7,129 tonnes of year-0 cockles to the juvenile population. While these figures are above average for the inter-tidal beds in The Wash, they are a significant decline on the previous year's stocks. This can be seen in figure 24, which shows the biomass of adult and juvenile cockles present on the inter-tidal beds since 2000.

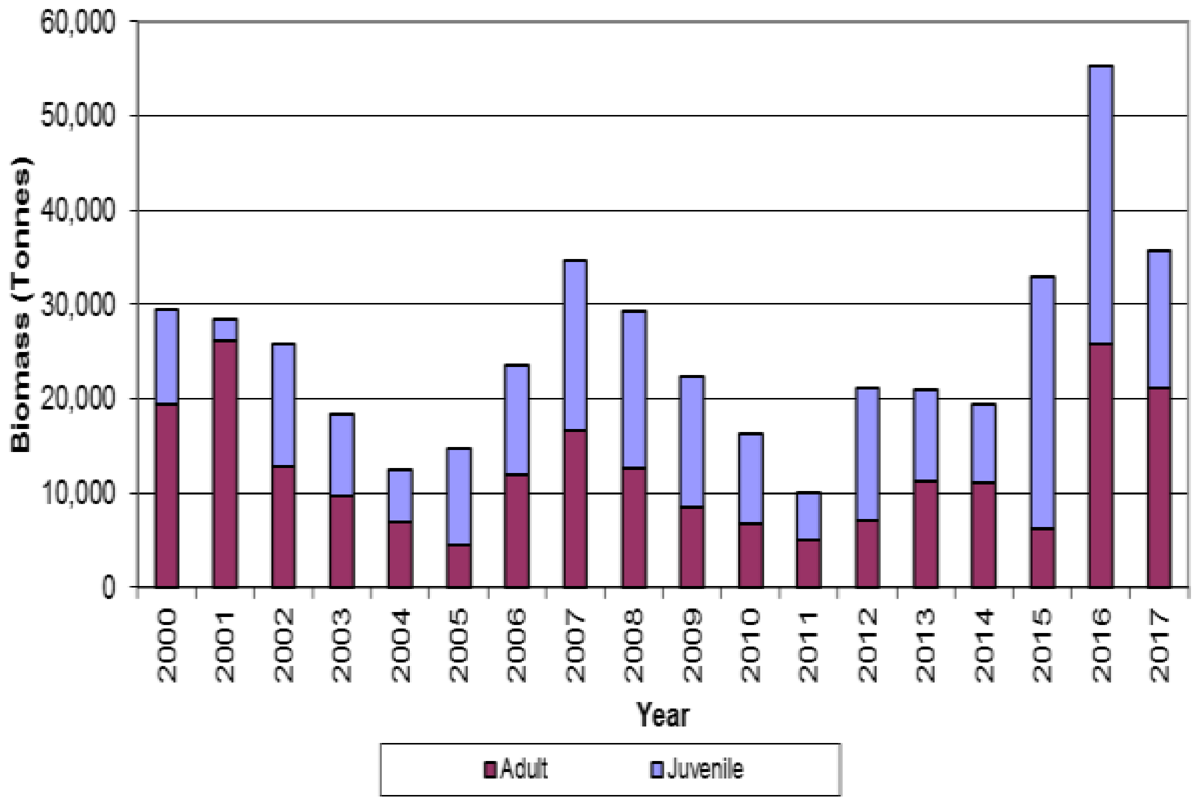


Figure 24 – Biomass of cockles on the WFO regulated beds between 2000 and 2017

The losses experienced during 2016 had been anticipated. An exceptionally good settlement of spat in 2014 had resulted in one of the highest stocks on record in 2016, when the inter-tidal beds supported an estimated 55,349 tonnes of cockles. The survey results had indicated, however, that a high proportion of these 2014 year-class cockles were in danger of being lost, either through "atypical" mortality or ridging-out. Although the management of the 2016 fishery focused on targeting the most vulnerable stocks before they were lost, mortalities were, nevertheless, still high. The 2017 surveys found that between the fishery, which had harvested approximately 8,600 tonnes, and natural losses, the cockle stock had declined by almost 20,000 tonnes. These losses can be seen in figure 25, which shows the percentage decline in biomass of 2014 year-class cockles between the 2016 and 2017 surveys.

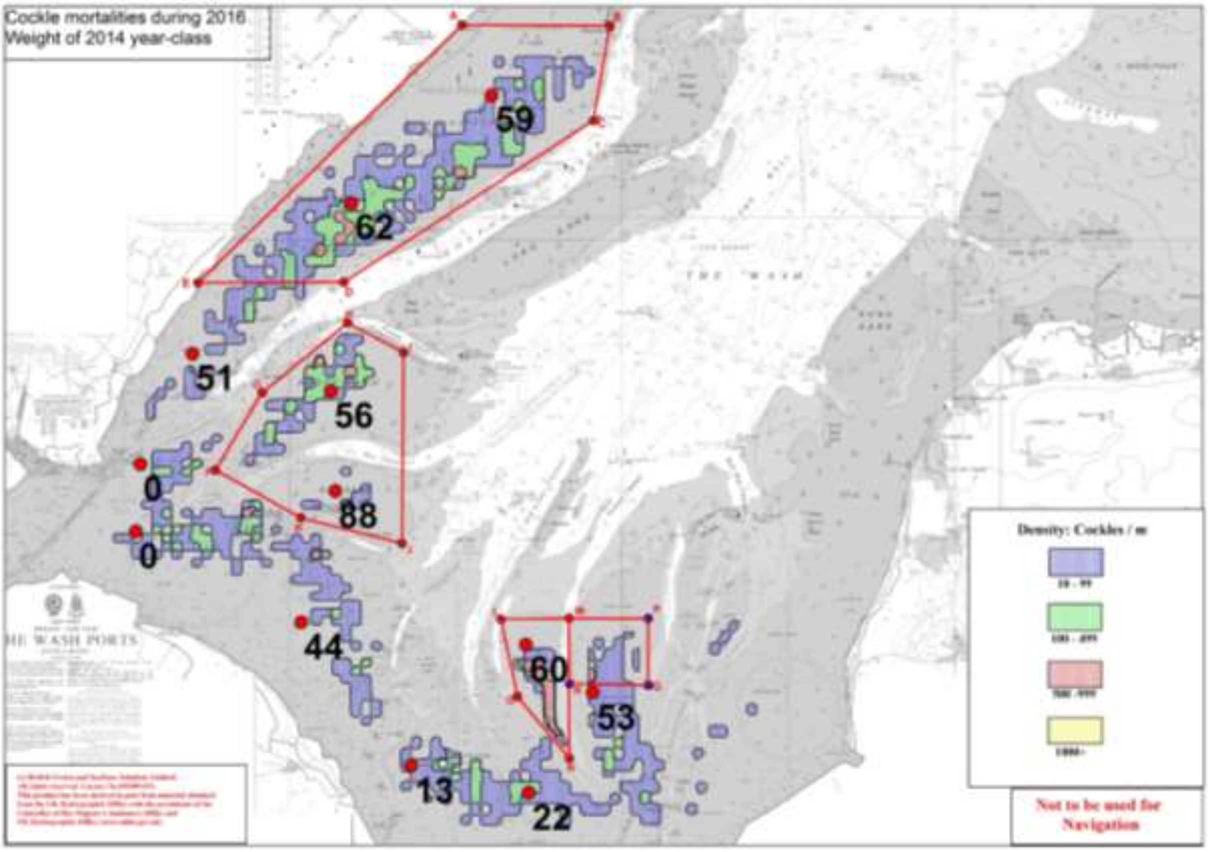


Figure 25 – Chart highlighting the percentage decline in biomass of 2014 year-class cockles between the 2016 and 2017 surveys. Areas within red boxes were open to the 2016 cockle fishery.

Although these losses were significant, based on what had been experienced in previous years, when loss of biomass on some of the faster-growing beds had exceeded 95%, they were not as high as had been anticipated. These better than expected survival rates are possibly due to the relatively cool summer we had in 2016, which lacked long periods of hot days associated with high mortalities. Although measures were taken to target the more vulnerable stocks, and the daily quota was increased from 2 tonnes to 3 tonnes to facilitate the large TAC to be taken, there was nevertheless criticism from some members of the fishing industry concerning the scale of the die-off. Although it would have been difficult to harvest more cockles with a hand-worked fishery than were actually taken, advocates of the dredge fishery argued the vulnerable stocks should have been opened to dredges with a larger TAC. The situation is more complicated than purely managing a fishery, however. The conservation status of the site needs to be considered, so care needs to be taken that overfishing does not occur. Also, although some areas of cockles were anticipated to be more vulnerable than others, figure 25 shows the situation is not clearly defined. Mortalities occurred across all the beds[6], and unable to discriminate between cockles which would ultimately die and which would survive, a widespread dredge fishery would not have been able to prevent losses without also harvesting a high proportion of cockles that would otherwise have survived. There was also criticism from a larger group of fishermen, unhappy that the daily quota had been raised. Irrespective of the anticipated losses, they felt the increase resulted in the processors lowering the price of the cockles and also causing fishermen to stop fishing patches of large cockles on Friskney and Wrangle in preference for higher density patches of smaller cockles on the Roger sand. As both of these areas were considered vulnerable to high losses, however, from a management perspective it made little difference which area was ultimately fished. It did highlight, however, a growing tendency for fishermen to target high density patches of small cockles in preference over lower density patches of larger cockles when the financial benefits are similar.

2017 fishery

At the time of the 2016 surveys, less than half of the 2014 year-class cockles had reached 14mm width, so did not contribute towards the TAC. By the time of the 2017 surveys, the majority of the surviving 2014 cockles were found to have grown sufficiently to have reached this size. As a consequence, although the total cockle stock had declined by almost 20,000 tonnes, the stock of cockles that had reached 14mm width had only declined from 25,826 tonnes to 21,048 tonnes. Based on these

[6] Although the chart shows zero losses on Black Buoy and Herring Hill, the figures in the chart show loss of biomass. On most beds, cockle growth will have compensated to some extent for loss of cockle numbers.

figures, the Total Allowable Catch (TAC) for the fishery was 7,016 tonnes, almost double the size of the average TAC seen over the last decade. Although there was a high biomass of ≥14mm width cockles that had contributed towards the TAC, they were spread over a relatively wide area. Their mean density was not only lower than it had been during the 2016 fishery, there were also fewer high-density patches among them.

Because of the high TAC, and the need to harvest vulnerable cockles before they died over the summer, the daily quota was again raised from 2 to 3 tonnes. After the 2017 fishery opened on June 20th, however, it quickly became apparent that fishers were struggling to achieve the increased daily quota. Feedback from the fishers and processors also indicated meat yields were poor[7], large quantities of shell were being landed and several fishers were targeting small juvenile cockles from the 2016 year-class cohort. As the season progressed, an increasing number of fishermen began targeting these smaller cockles, first on the Gat sand and later from the Roger sand. Following concerns raised by some members of the industry, unhappy that some of their colleagues were targeting juvenile stocks, officers conducted assessments of the stocks on the Gat (September 21st) and the Roger (November 21st).

The assessment on the Gat sand found that the fishers were legitimately working along the outside edges of a closed box that had been put in place to protect Year-0 juvenile cockles. Under normal circumstances this box would have remained closed, but the assessment raised concerns that the entire area was vulnerable to storms. The area was opened, therefore, allowing fishers access to these juvenile cockles before they were potentially lost during periods of poor weather. This area was subsequently targeted by up to 22 vessels.

The assessment conducted on the Roger sand found 16 vessels were fishing within an area supporting dense patches of juvenile cockles that had a mean size of 10-11mm width. Samples taken from this area found the average density within the patches of cockles was 2,690 cockles/m^2. Because cockles in these high densities are

[7] The reason for the low meat yields is not known, but personal communication with officers from Kent & Essex IFCA indicated the Thames cockles were suffering similar low yields.

prone to ridging out once the temperature rises and they begin to grow, the fishery was allowed to continue to allow the stocks to be thinned out. It was estimated the removal of approximately 650 tonnes of cockles would reduce the mean density to a less critical level of 1,500/m^2. This assessment found juvenile densities within a nearby closed box were equally as high, and therefore also vulnerable to ridging out. It was felt, though, that by thinning out one area, greater focus could be given to the other area in 2018 should ridging occur.

Shifting trend towards targeting smaller cockles

The "atypical" mortality events that have been causing high cockle die-offs since 2008, have predominantly been affecting larger, faster-growing cockles. This has resulted in only low proportions of cockles surviving beyond their first spawning and an overall reduction in the mean cockle size within The Wash. Prior to 2008, the management of the fishery tended to focus on protecting cockle stocks until they were ≥14mm width and many beds supported stocks with average sizes exceeding 16mm width. "Atypical" mortality, however, has resulted in very short windows between cockles reaching 14mm width and subsequently dying. Recent management has focused on identifying the stocks considered to be most vulnerable, and focusing the fishery in those areas to reduce natural wastage. The overall result has been a shift towards smaller cockles being targeted and landed.

While the management objective has been to target the stocks identified as being vulnerable (eg. those cockles that are approximately 14mm width and have potentially spawned), in recent years an increasing number of fishers have begun targeting even younger stocks. This is potentially a response to the temporary increase in daily vessel quota, where fishers have struggled to achieve their quota when targeting larger cockles, so have begun fishing the denser patches of juvenile stocks. In the past, the processors tended to deter this activity by refusing to buy cockles below a certain size or yield, and by paying better prices for large cockles. This meant there was generally a financial benefit in targeting large cockles. In 2017, however, all sizes of cockles were yielding poorly and several fishers reported being paid more for a bag of small cockles than a similar weight of large ones. There was a definite financial advantage, therefore, in targeting small cockles in 2017.

This shift towards targeting increasingly smaller cockles is a worrying trend. Not only are less vulnerable stocks being targeted, but by doing so, the more vulnerable ones are then being left to die. This reduces the effect of the Authority's objective of reducing natural wastage and also limits the potential to increase the TAC when it can be demonstrated widespread mortalities are predicted. Although from a stock perspective, thinning high density patches of juveniles can reduce the risk of losses from ridging out, a widespread shift towards fishing juvenile cockles will eventually threaten the sustainability of the stocks. Juvenile mortality is high, but by persistently fishing juveniles, the spawning stock will be reduced. Further, by fishing the high-density stocks a year early, there are fewer high-density patches of larger cockles left for the following year. This perpetuates the issue, as unable to find sufficient large cockles to fish, even more fishermen will begin targeting small cockles in future years.

In addition to managing the stocks sustainably, the Authority also needs to take into consideration environmental factors and conservation targets. The Wash is an important site for overwintering bird populations. During prolonged periods of cold weather, it is important bird disturbance is minimal as feeding disturbance can be fatal for them. Most years the cockle fishery finishes before winter, either because the TAC has been exhausted or because the meat yields have fallen. Little management has been required previously to keep disturbance within acceptable limits, therefore. In 2017, however, with approximately 1,600 tonnes of TAC still left and a market for small, low-yielding cockles, there was the potential for the fishery to continue through the winter. Because this winter fishery was anticipated to be higher than the low level highlighted in the HRA mitigation, the decision was made to close the fishery in December, even though TAC remained.