



2019 WFO cockle stock assessment

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Introduction

With an annual first-sale value usually between £1-2 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

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 their introduction and have formed the foundation of a new Cockle Fisheries Management Plan, which was introduced in 2019 to update them.

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 determined⁴, 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.

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.

This approach has enabled the fishery to maximise its potential and to minimise the natural losses that would otherwise occur. One of the main revisions in the new Cockle Fisheries Management Plan has been to account for recent changes that influence the fishery, including “atypical” mortality, and detail measures to help manage the fishery around them. To be effective, however, these measures rely on a good understanding of the stocks and the environmental impacts affecting them. The annual spring cockle surveys provide the backbone of this evidence.

This report provides details of the 2019 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 370m x 340m conventional grid, from which the same sample stations are replicated each year⁵.

Samples are collected either at high water using a 0.1m² Day grab deployed from the research vessel, *Three Counties*, or a 0.1m² 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 Until 2019 the stations on the Herring Hill, Holbeach, Mare Tail and Gat sands were surveyed at a higher 280m x 340m resolution, but following a review of survey practices in 2018, these were adjusted to the same resolution as elsewhere in The Wash

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 individually⁶ 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/m². 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

⁶ 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 20th and May 7th. During the course of the surveys, 1,028 stations from a total of 22 sands were sampled, including 100 stations along the offshore edge of the Ferrier sand. This is fewer than the 1,250-1,300 stations that are usually sampled, mainly due to a change in survey regime that saw the removal of the stations that had not contained any cockles during the previous ten years, and the re-aligning of 450 stations in the South West area of The Wash that had formally been sampled at a higher resolution to the rest of the beds. Approximately 40 stations were also lost when poor weather in the final week of the surveys prevented the full planned complement from being completed. Figure 2 shows the locations of the stations that were sampled.

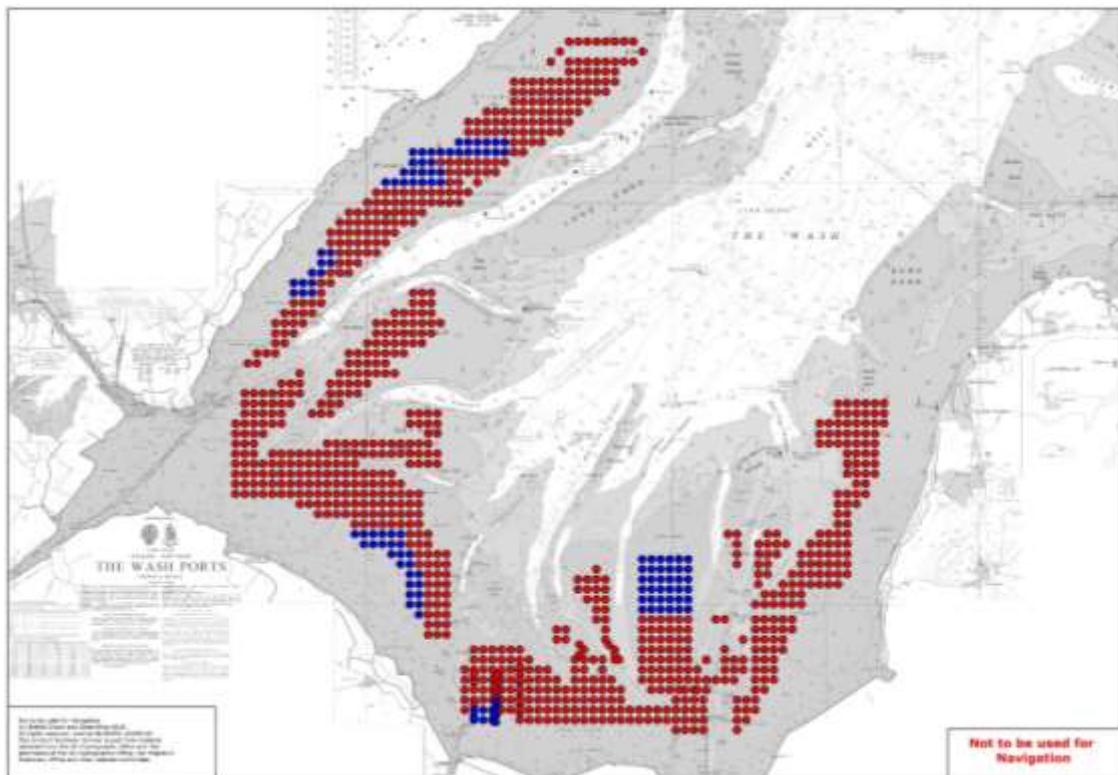


Figure 2 – Chart showing the positions of the stations sampled during the 2019 spring cockle survey (Red stations sampled using Day grab, blue stations sampled on foot with quadrat).

Table 1 provides a summary of the cockle stocks identified during the surveys, while figures 3 to 11 show the distributions of ≥ 14 mm width, < 14 mm width and Year-0 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 2019

SAND	ADULT				JUVENILES				Total Biomass	%Adult
	Area (ha)	Mean Density (no/m2)	Mean Weight (t/ha)	Biomass (t)	Area (ha)	Mean Density (no/m2)	Mean Weight (t/ha)	Biomass (t)		
Butterwick	269	40.45	1.70	629	211	451.43	1.04	218	847	74
Wrangle	865	47.10	2.18	1889	673	451.25	0.88	594	2483	76
Friskney	259	20.00	1.37	355	441	662.33	2.50	1103	1458	24
Butterwick Ext	107	32.86	1.24	133	144	890.00	1.94	280	413	32
Wrangle Ext	0	0.00	0.00	0	0	0.00	0.00	0	0	0
Friskney Ext	35	10.00	0.89	31	67	10.00	0.07	5	36	86
Boston Main Total	1535			3037	1536			2200	5237	58
Roger/Toft	491	53.75	2.80	1373	273	800.14	1.85	505	1878	73
Gat	216	87.78	4.86	1050	136	304.17	0.77	104	1154	91
Longsand									0	
Herring Hill	157	23.84	0.80	126	274	122.73	0.42	116	242	52
Black Buoy	149	46.67	1.92	285	208	1501.18	3.86	803	1088	26
Mare Tail	358	85.56	3.58	1281	420	318.39	1.35	568	1849	69
Holbeach	630	54.34	2.28	1434	658	200.18	0.65	424	1858	77
IWMK	210	51.72	2.27	475	251	1004.24	1.98	496	971	49
Breast	598	57.37	2.30	1374	665	182.62	1.69	1125	2499	55
Thief	131	22.14	1.62	213	43	182.50	0.43	18	231	92
Whiting Shoal	10	50.00	3.29	32	0	0.00	0.00	0	32	100
Daseley's	524	36.74	1.50	786	259	28.57	0.40	105	891	88
Styleman's	30	76.67	4.22	126	41	75.00	0.26	11	137	92
Pandora	52	20.00	0.87	45	87	71.25	0.24	21	66	68
Blackguard	35	13.33	0.51	20	11	10.00	0.05	0.5	21	98
Peter Black	283	32.61	1.25	354	260	75.71	0.60	157	511	69
TOTAL	5409			12011	5122			6653.5	18665	64
Outer Ferrier	0	0	0	0	12	410	1.77	20	20	0
Inner Ferrier	343	58.57	2.83	969	207	191.77	0.74	154	1123	86
TOTAL	343			969	219			174	1143	85

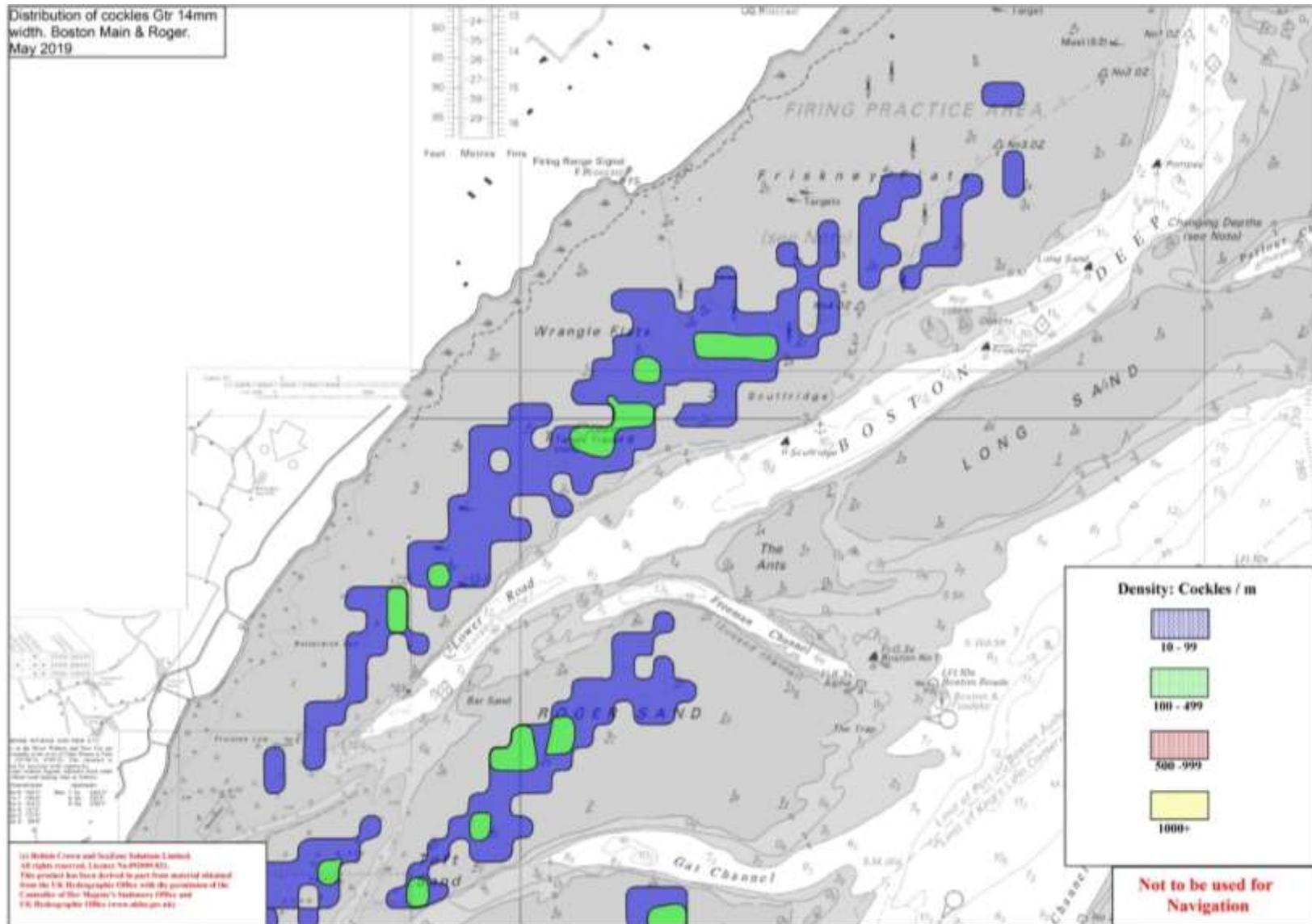


Figure 3 – Chart showing the stocks of cockles ≥ 14 mm width on the Butterwick, Wrangle, Friskney and Roger/Toft sands

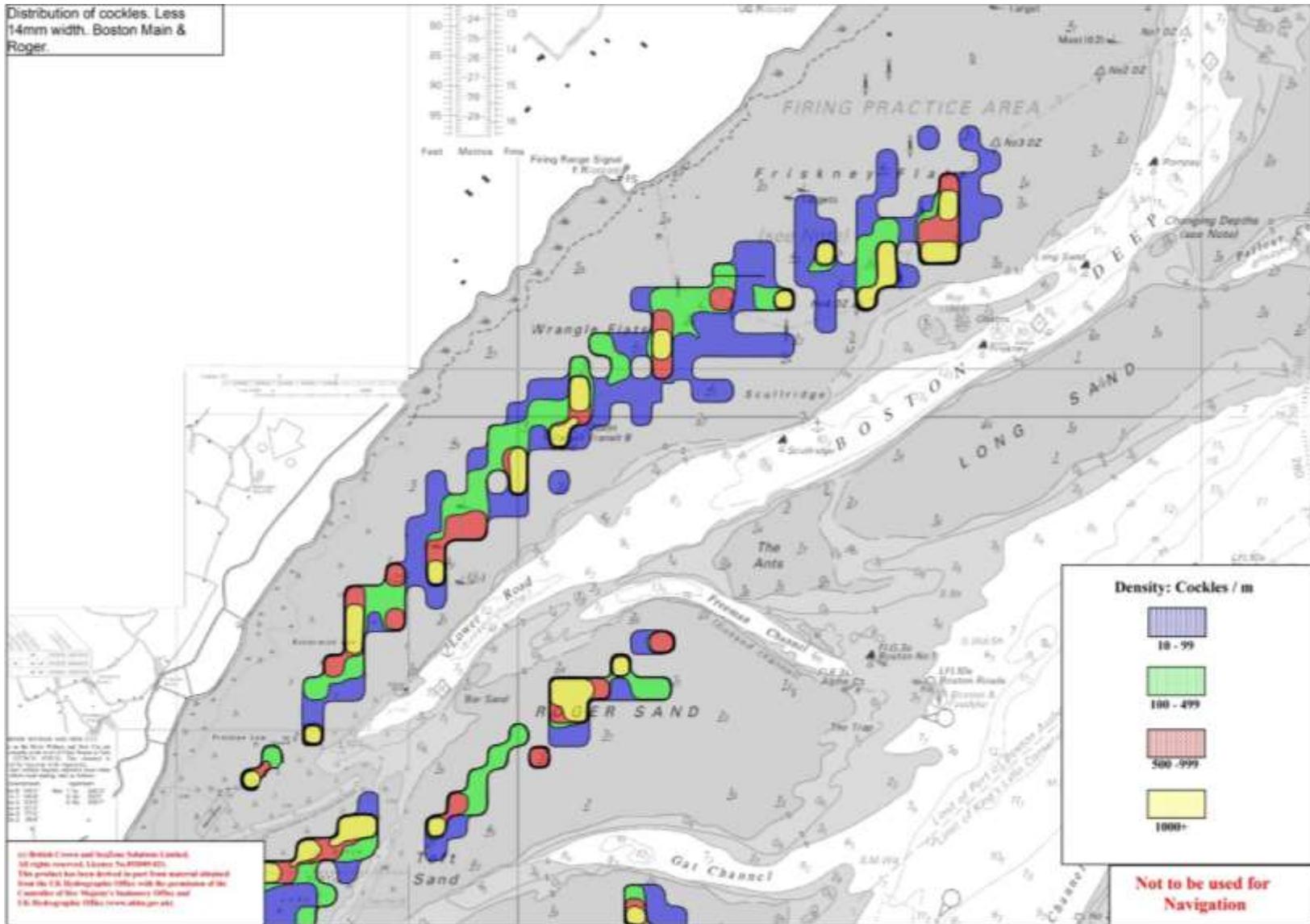


Figure 4 – Chart showing the stocks of cockles <14mm width on the Butterwick, Wrangle, Friskney and Roger/Toft sands

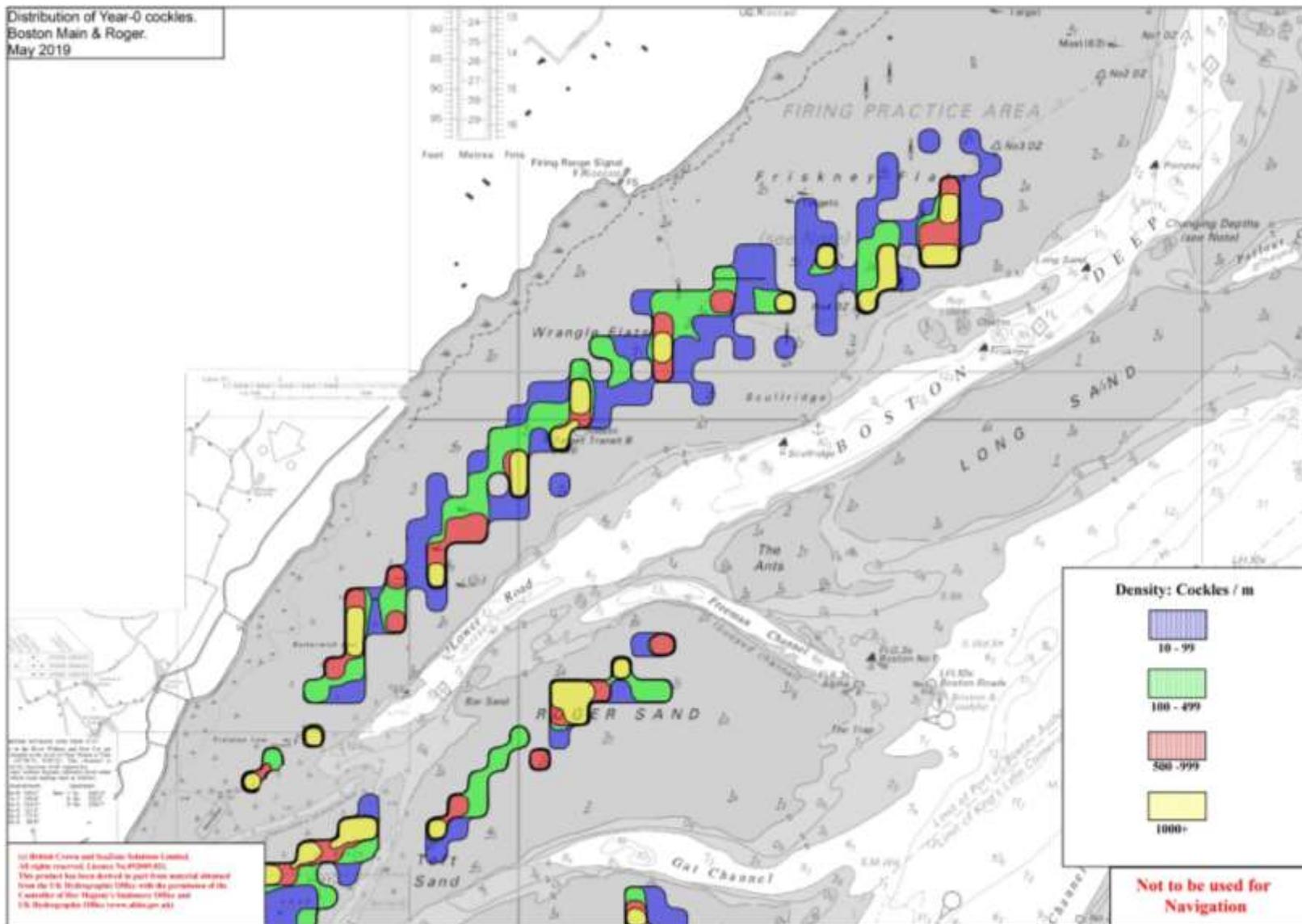


Figure 5 – Chart showing the stocks of Year-0 juvenile cockles on the Butterwick, Wrangle, Friskney and Roger/Toft sands

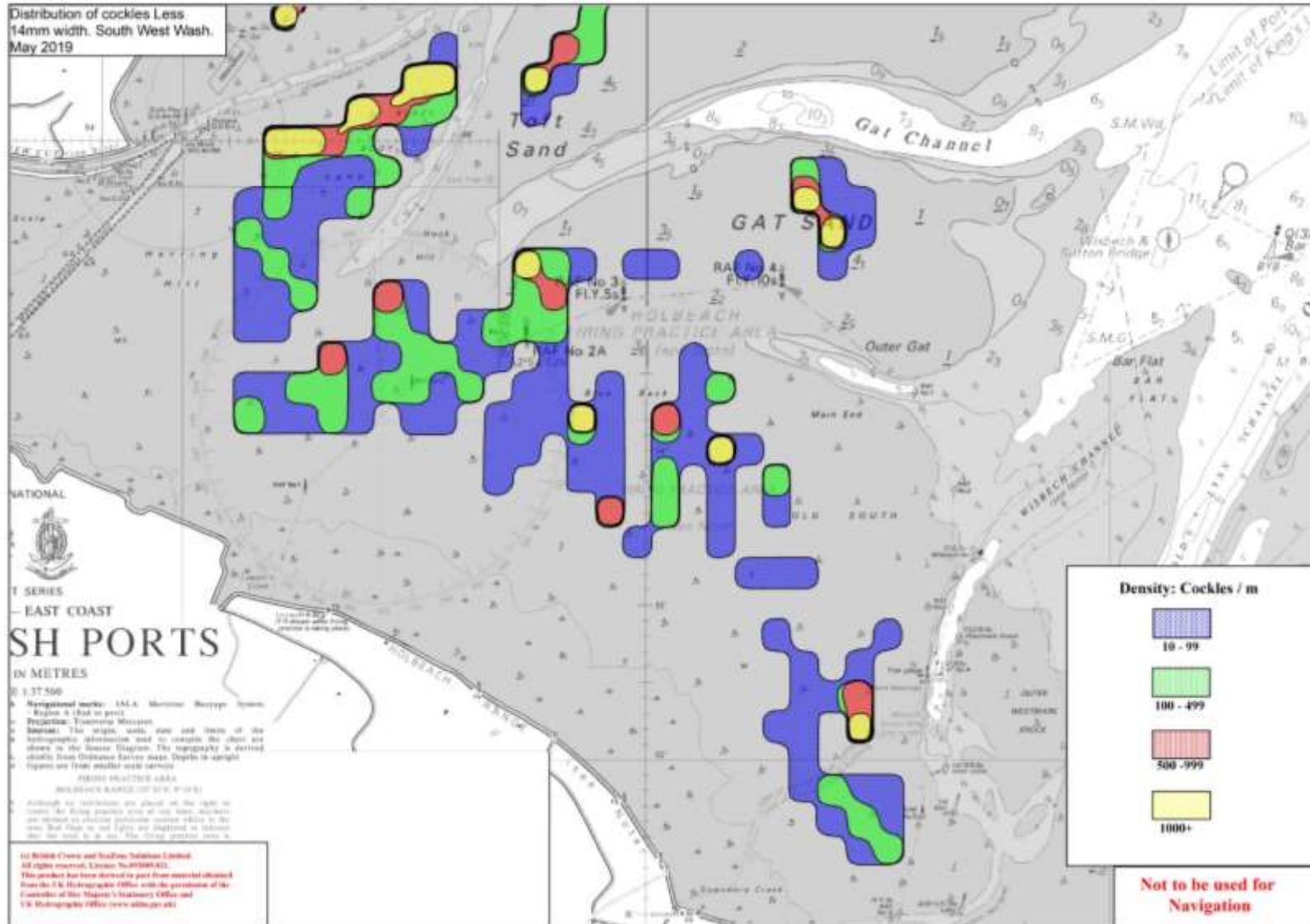


Figure 7 – Chart showing the stocks of cockles <14mm width on the Black Buoy, Dills, Herring Hill, Mare Tail, Gat and Holbeach sands

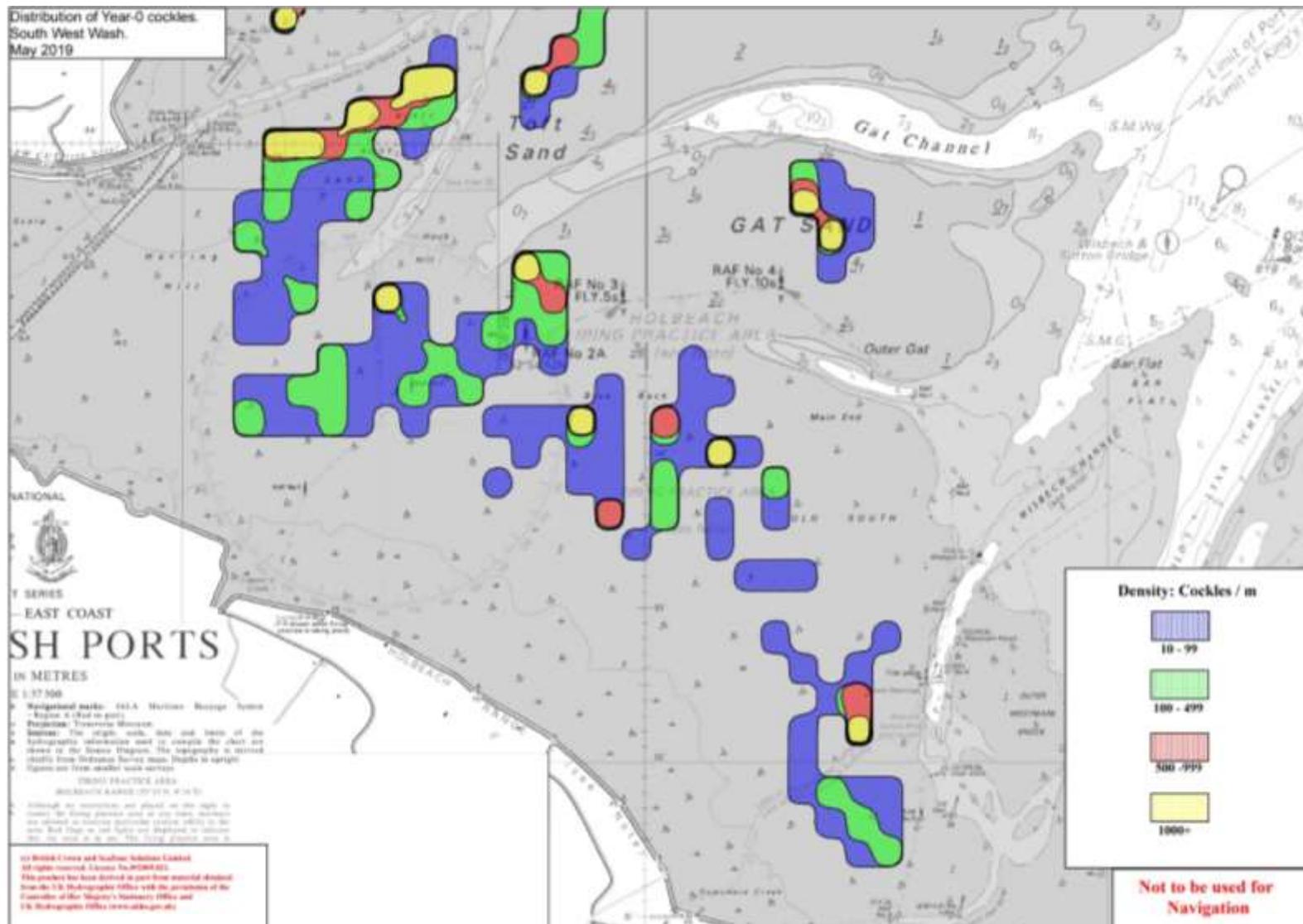


Figure 8 - Chart showing the stocks of Year-0 juvenile cockles on the Black Buoy, Dills, Herring Hill, Mare Tail, Gat and Holbeach sands

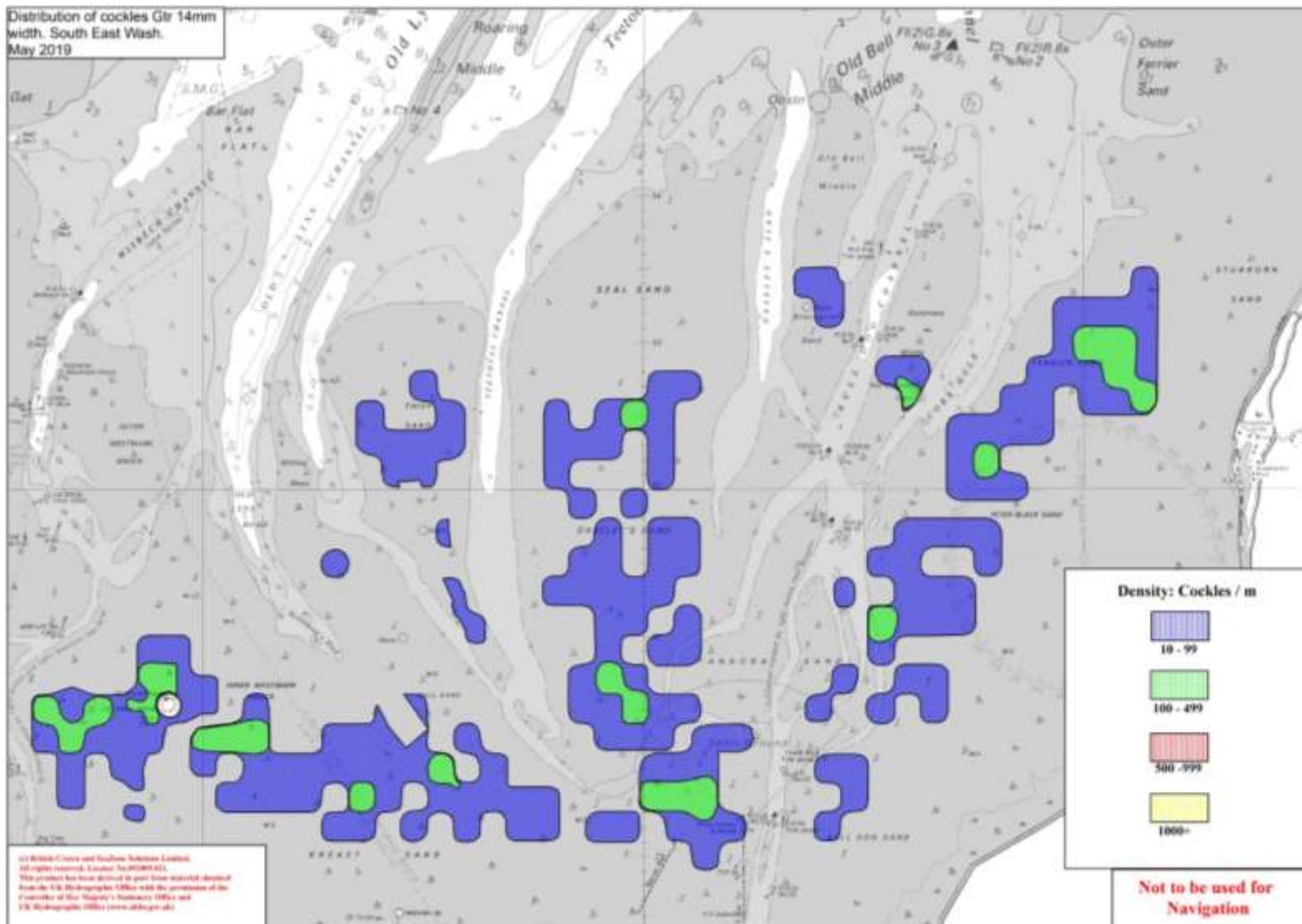


Figure 9 – Chart showing the stocks of cockles $\geq 14\text{mm}$ width on the IWMK, Breast, Thief, Daseley's, Pandora, Peter Black and Outer Ferrier sands

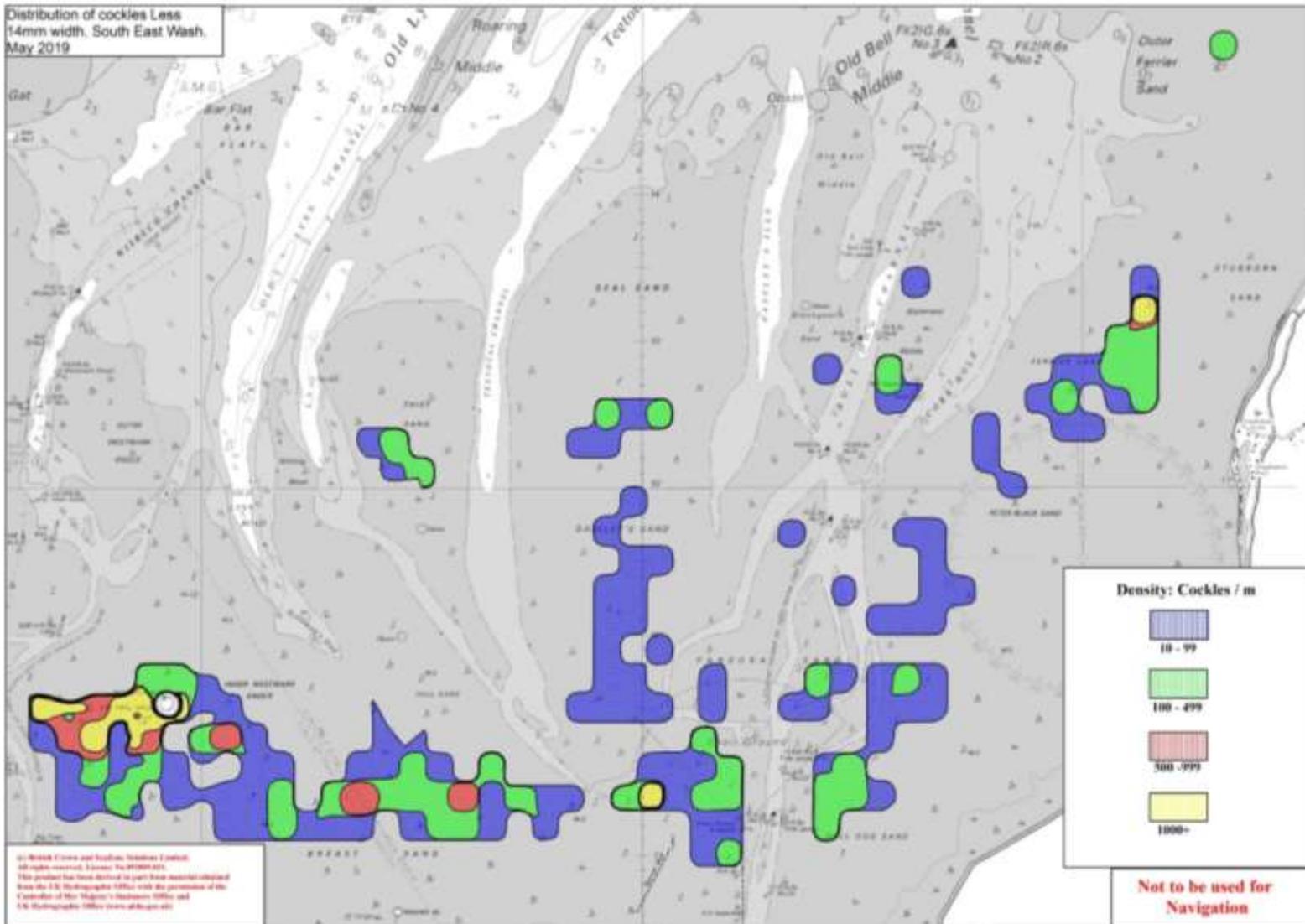


Figure 10 – Chart showing the stocks of cockles <14mm width on the IWMK, Breast, Thief, Daseley's, Pandora, Peter Black and Outer Ferrier sands

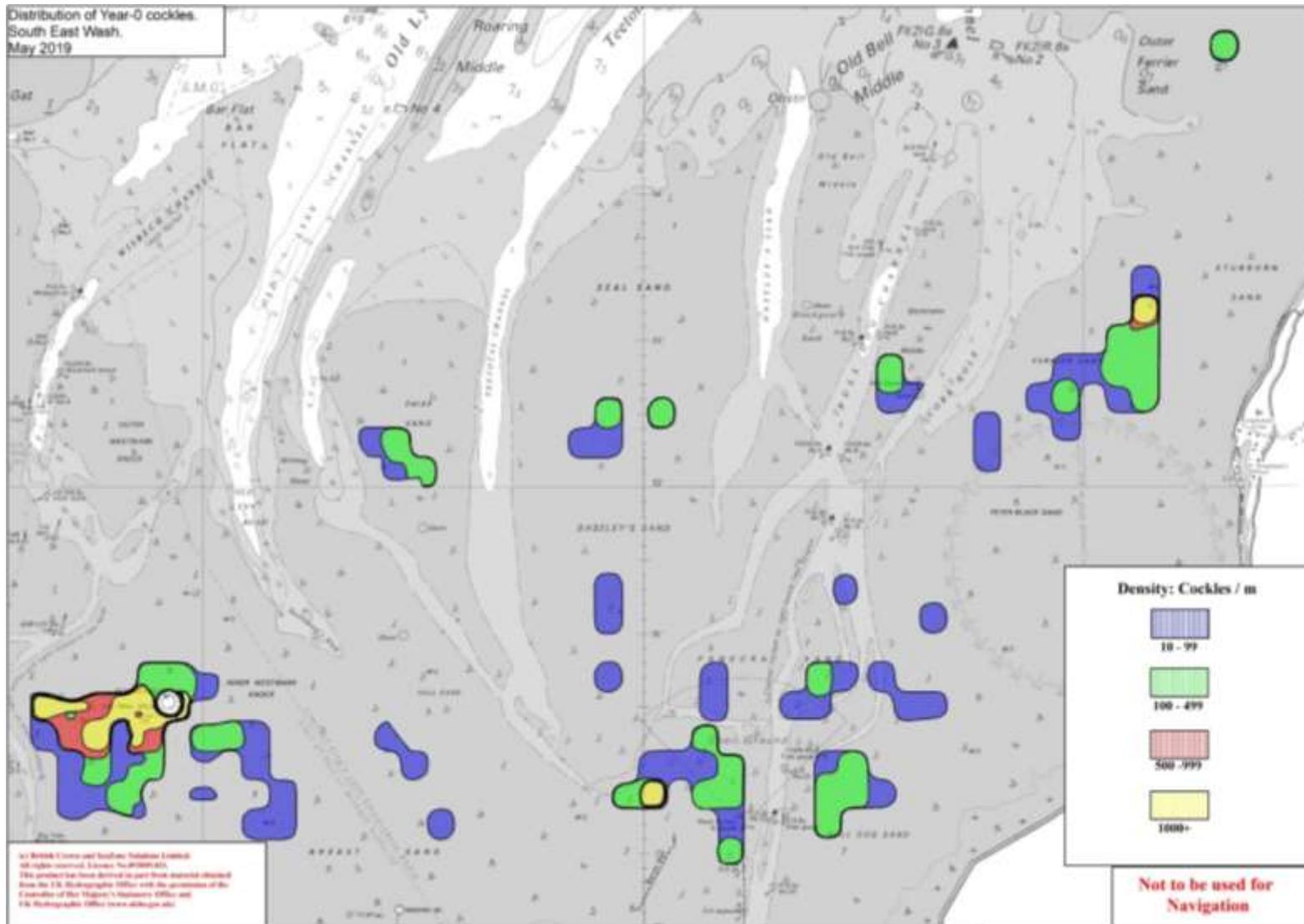


Figure 11 – Chart showing the stocks of Year-0 juvenile cockles on the IWMK, Breast, Thief, Daseley's, Pandora, Peter Black and Outer Ferrier sands

Figure 12 - Cocker Size Frequency. Butterwick. April 2019

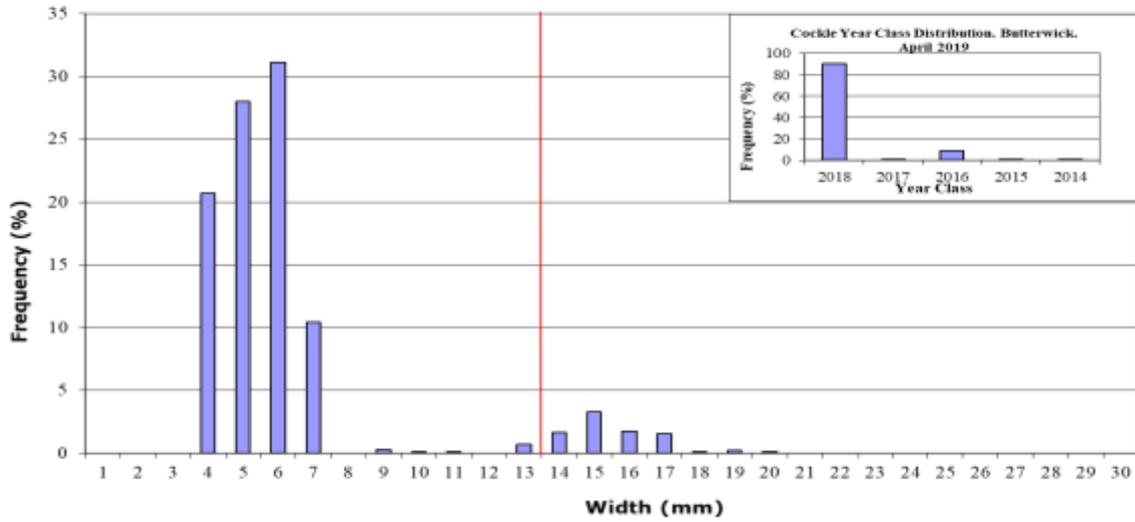


Figure 13 - Cocker size distribution. Wrangle. April

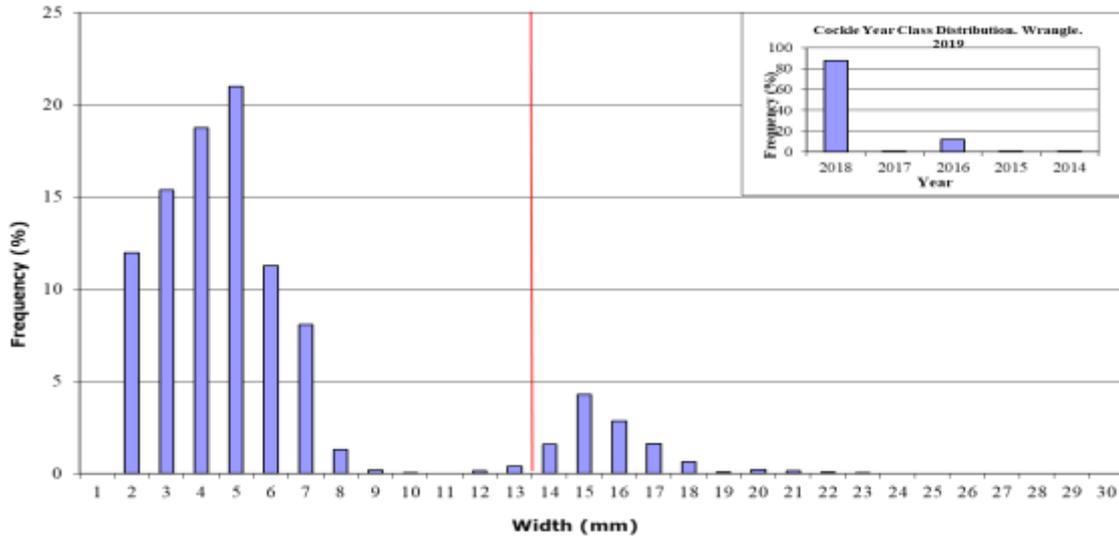


Figure 14 - Cocker Size Frequency. Friskney. April 2019

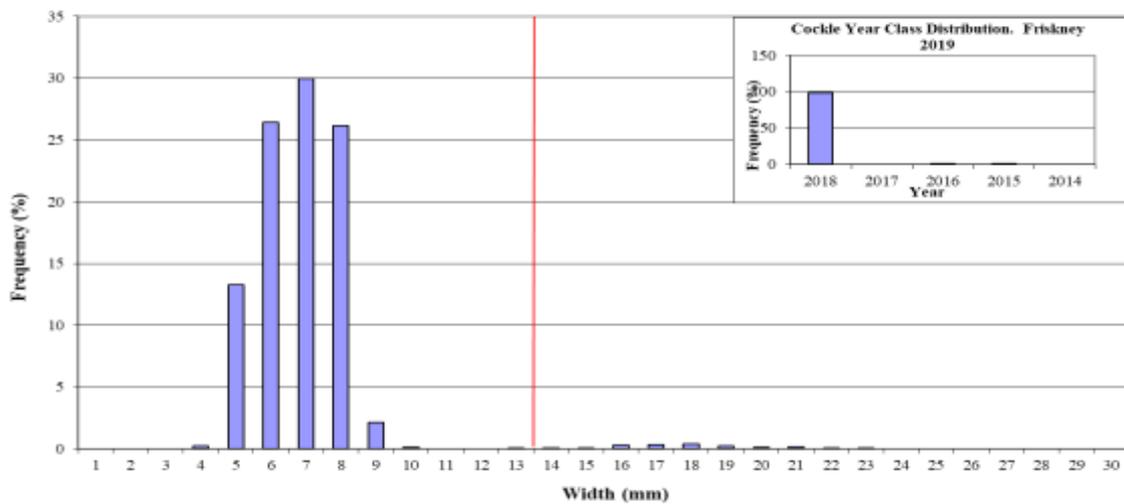


Figure 15 - Cockle Size Distribution. Roger/Toft. April 2019

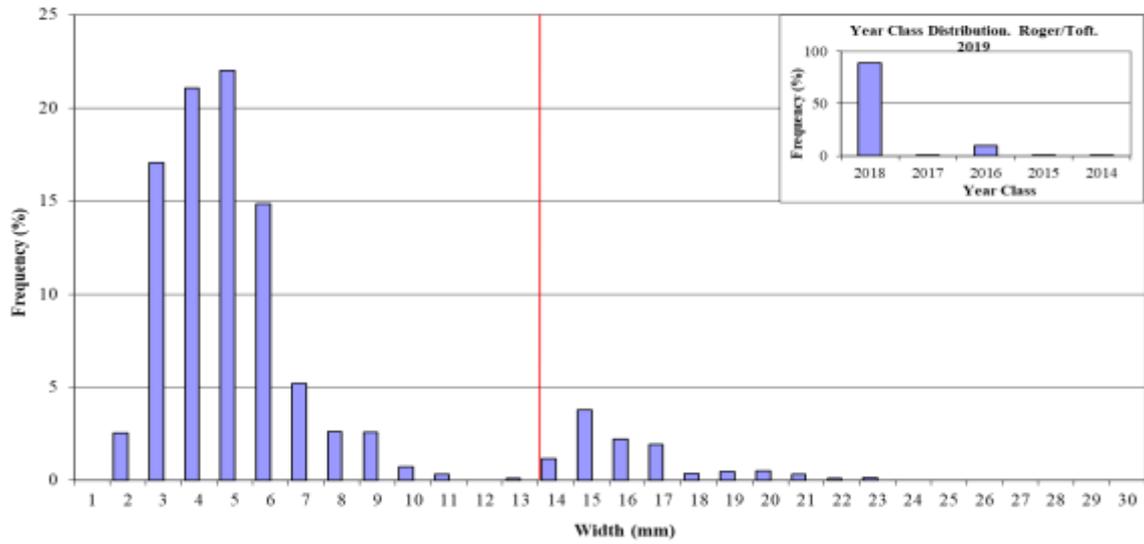


Figure 16 - Cockle Size Frequency. Gat Sand. April 2019

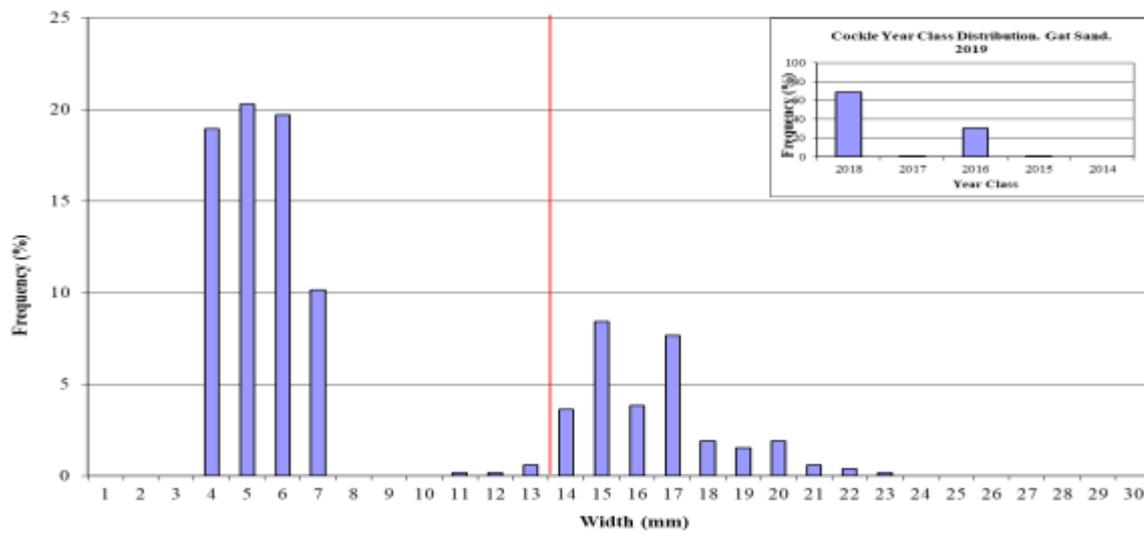


Figure 17 - Cockle Size Frequency. Black Buoy. April 2019

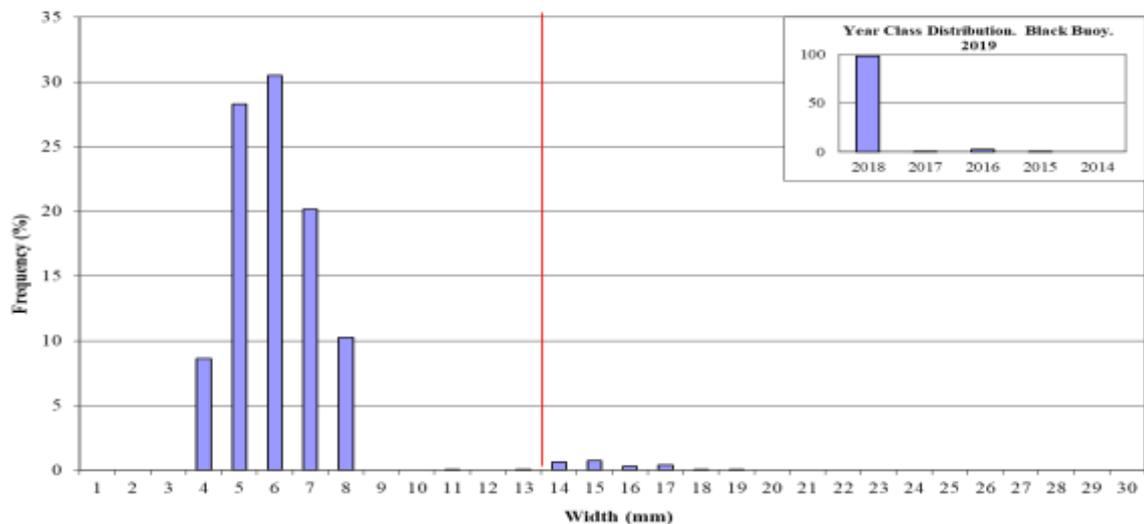


Figure 18 - Cockle Size Frequency. Herring Hill. April 2019

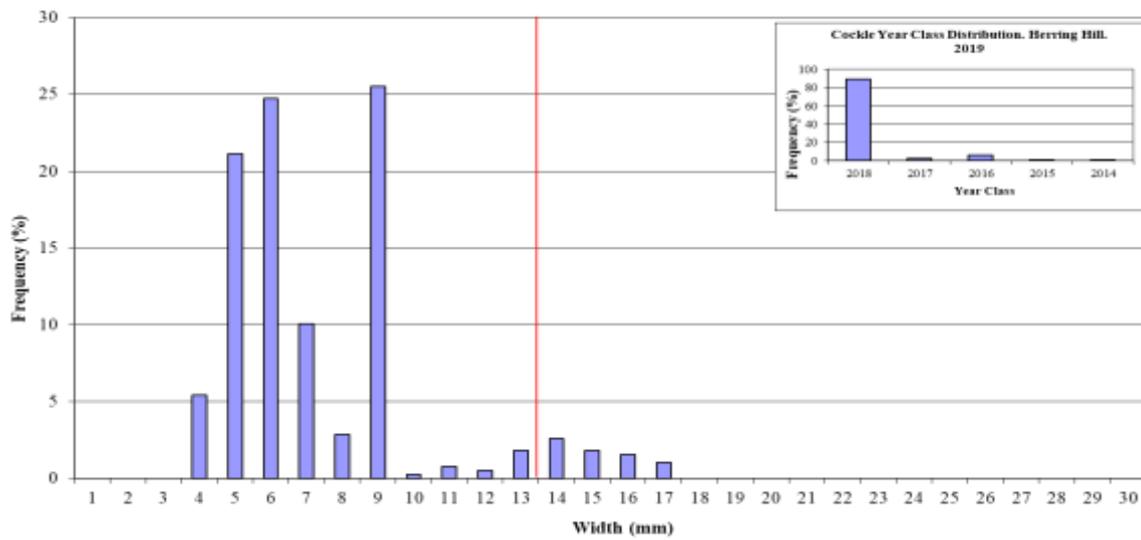


Figure 19 - Cockle Size Frequency. Mare Tail. April 2019

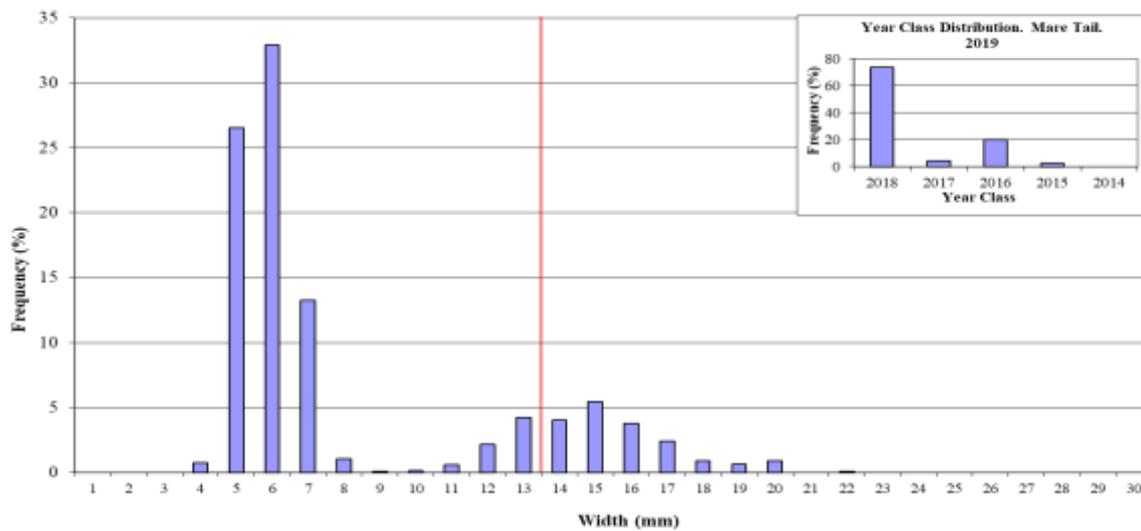


Figure 20 - Cockle Size Frequency. Holbeach. April 2019

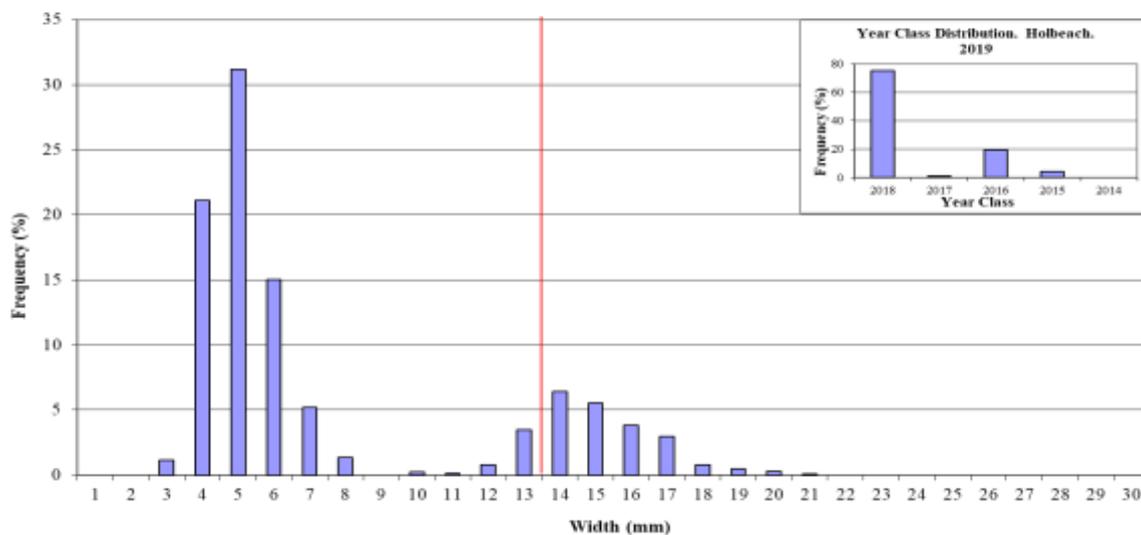


Figure 21 - Cockle Size Frequency. IWMK. April 2019

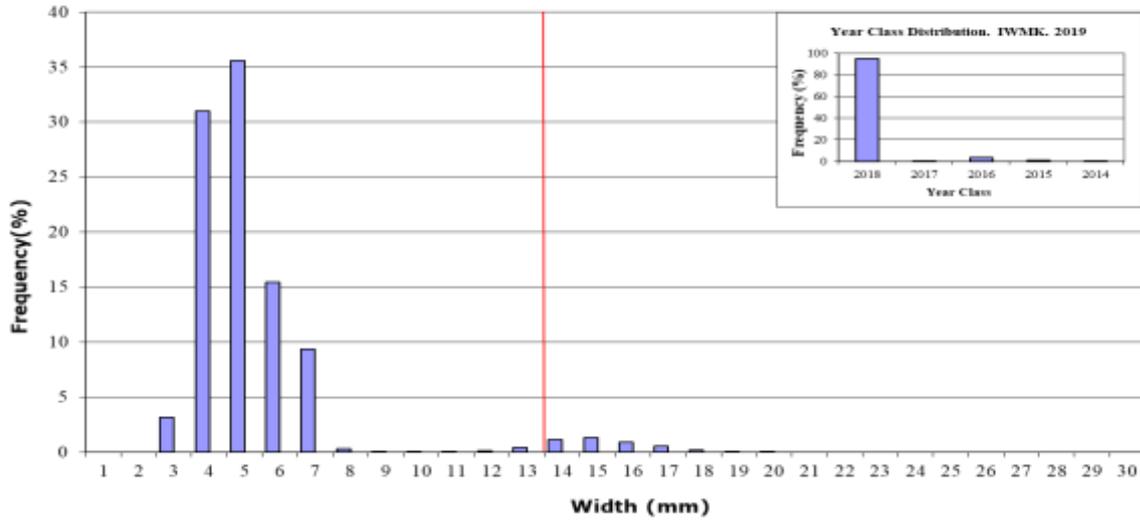


Figure 22 - Cockle Size Frequency. Breast Sand. April 2019

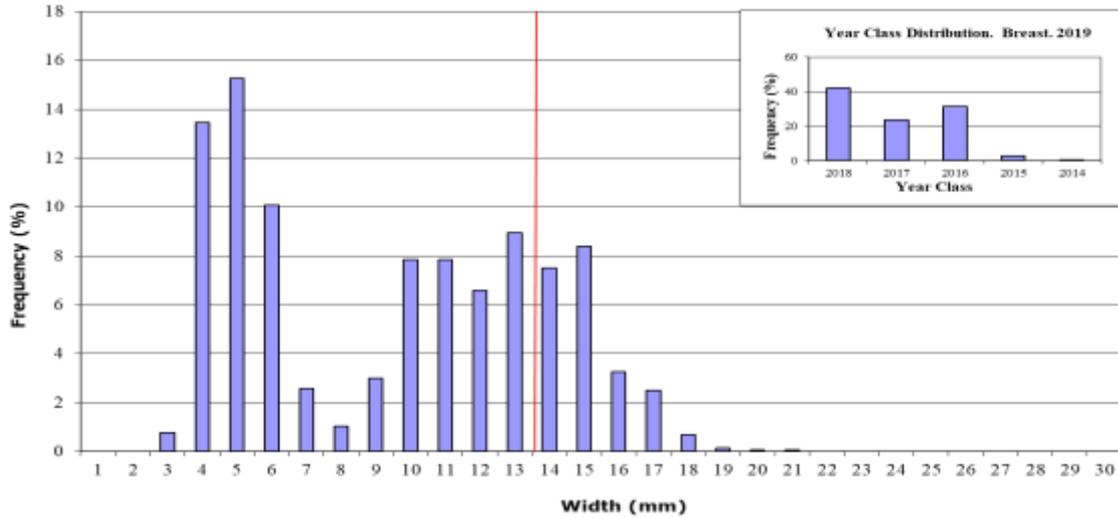


Figure 23 - Cockle Size Frequency. Daseley's. April 2019

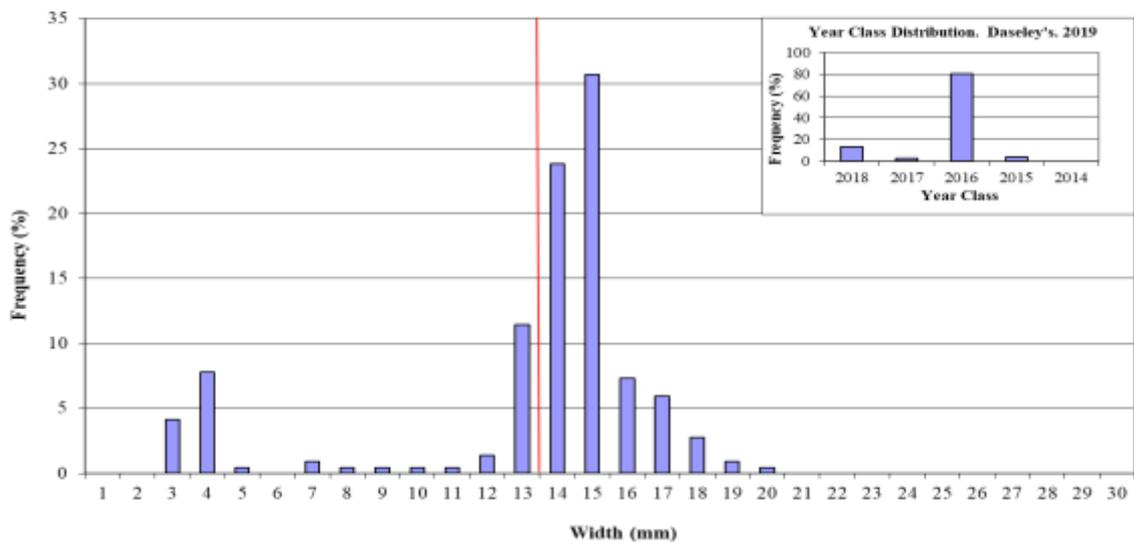


Figure 24 - Cockle Size Frequency. Thief. April 2019

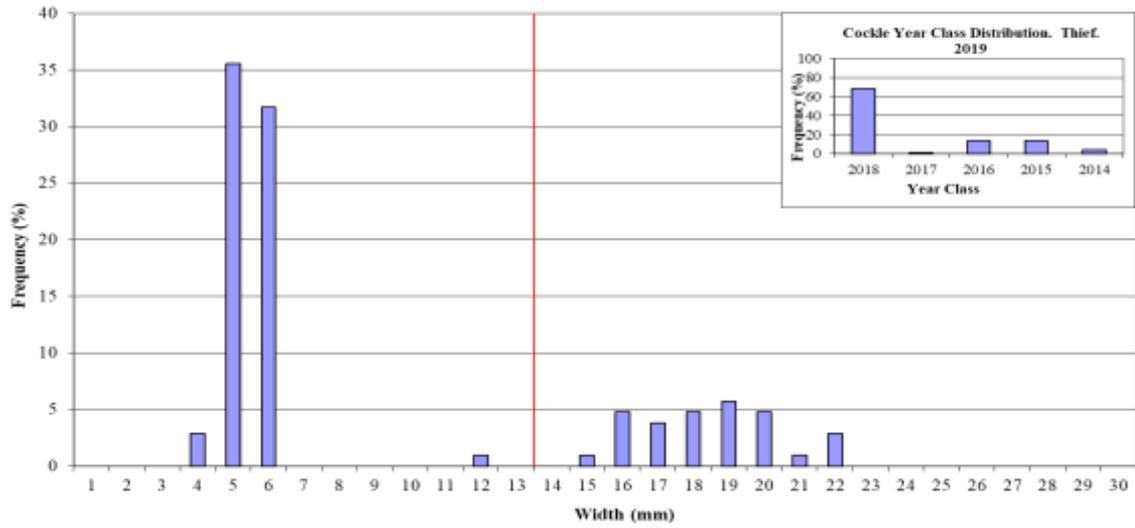


Figure 25 - Cockle Size Frequency. Styleman's. April 2019

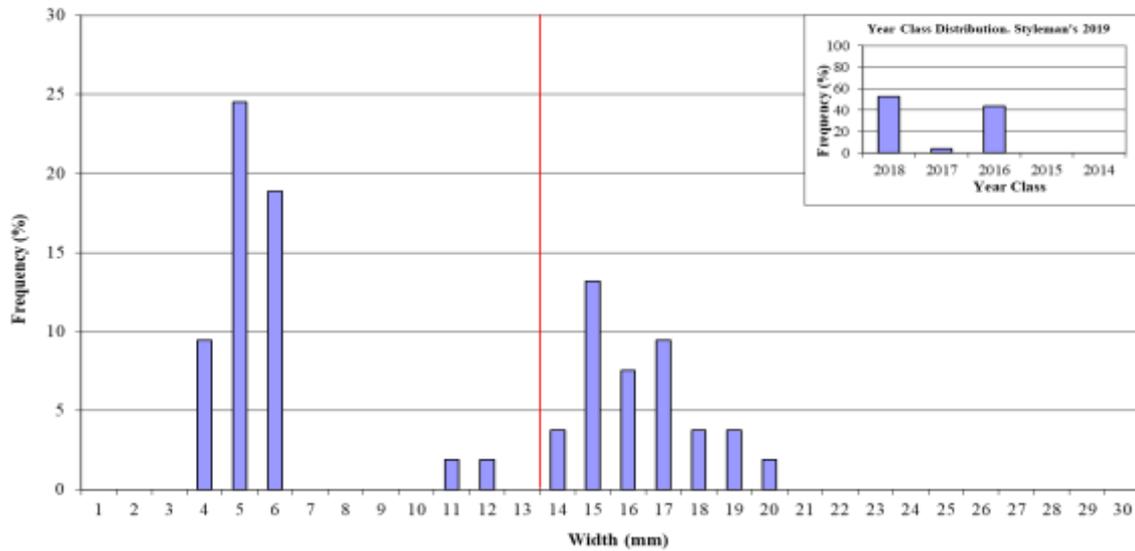


Figure 26 - Cockle Size Distribution. Peter Black. April 2019

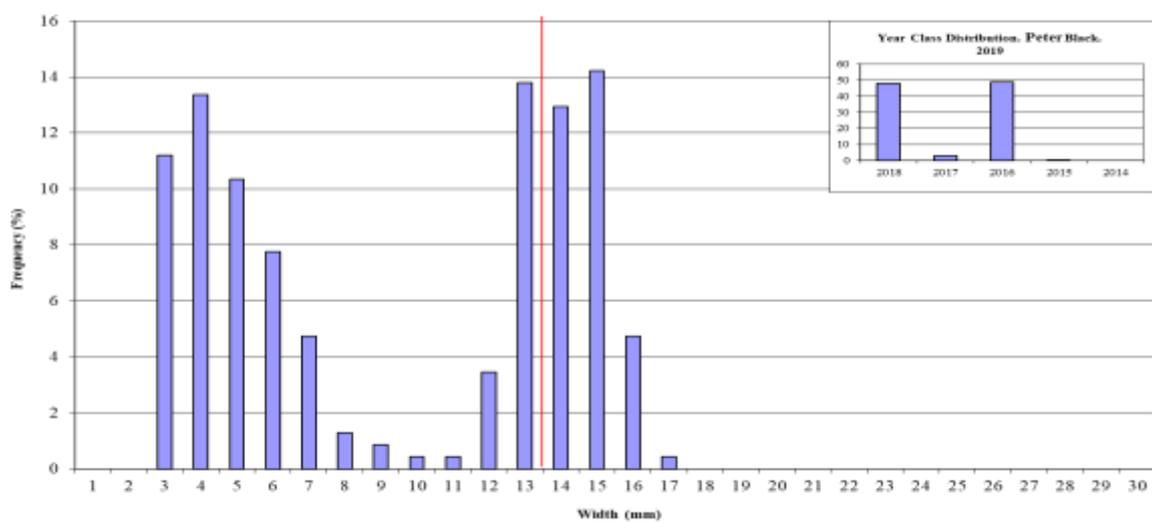


Figure 27 - Cockle Size Frequency. Whiting Shoal. 2019

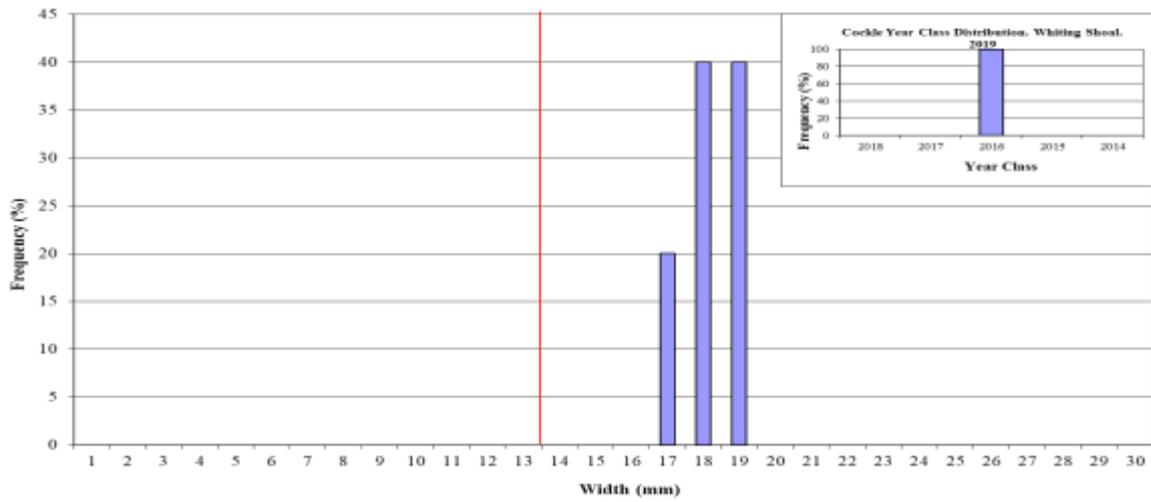


Figure 28 - Cockle Size Distribution. Pandora. 2019

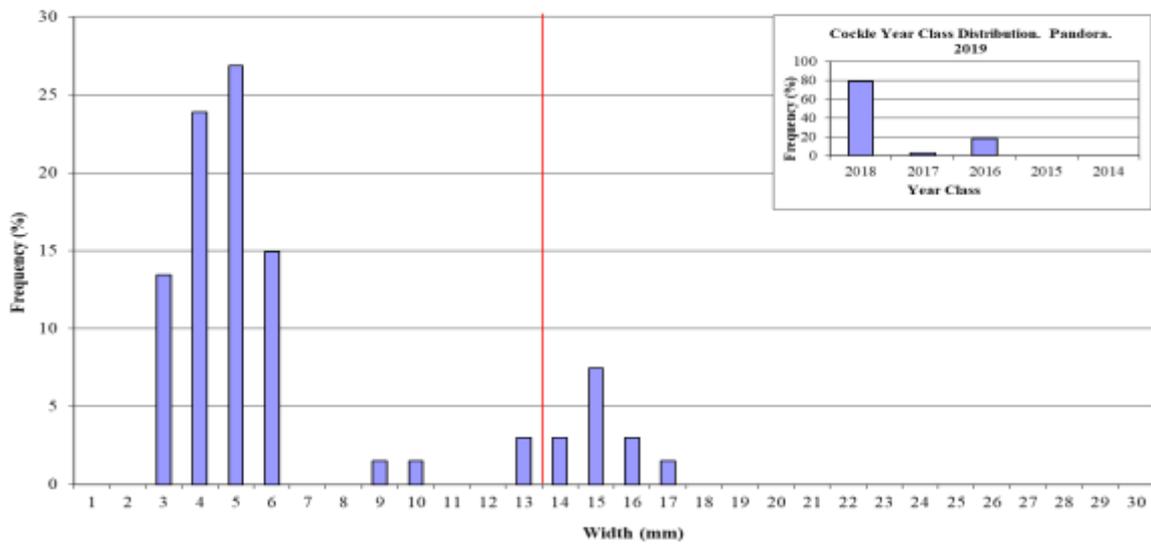


Figure 29 - Cockle Size Distribution. South Ferrier. August 2019

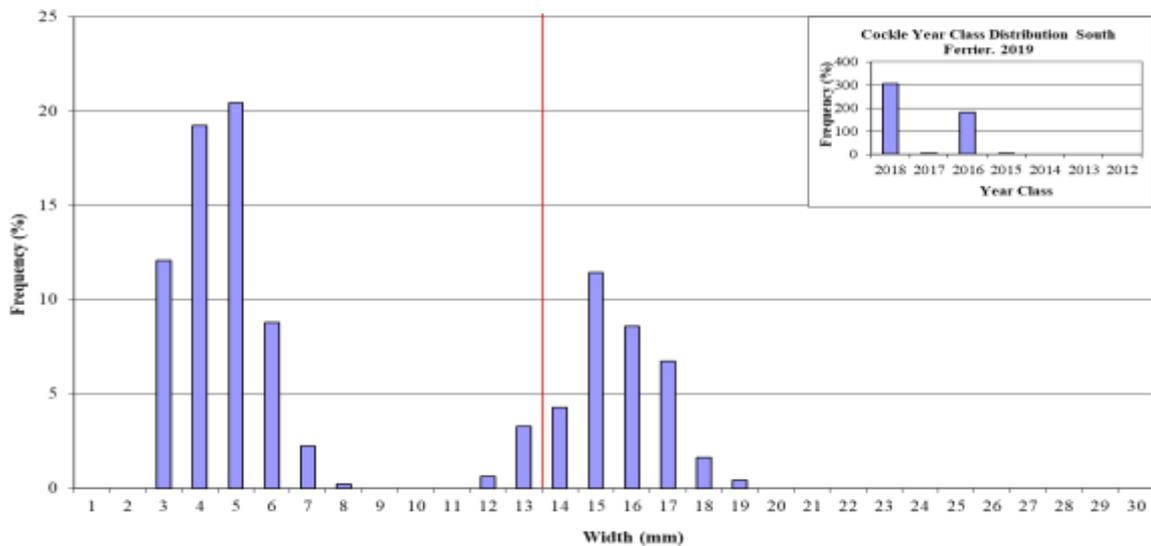


Figure 30 - Cockle Size Distribution. Outer Ferrier. August 2019

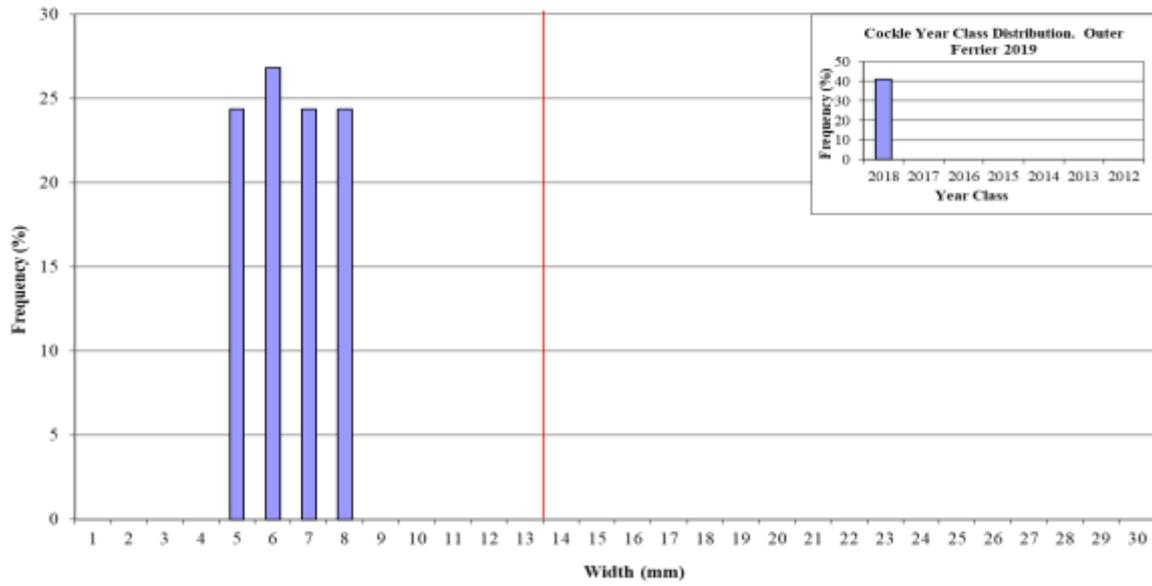
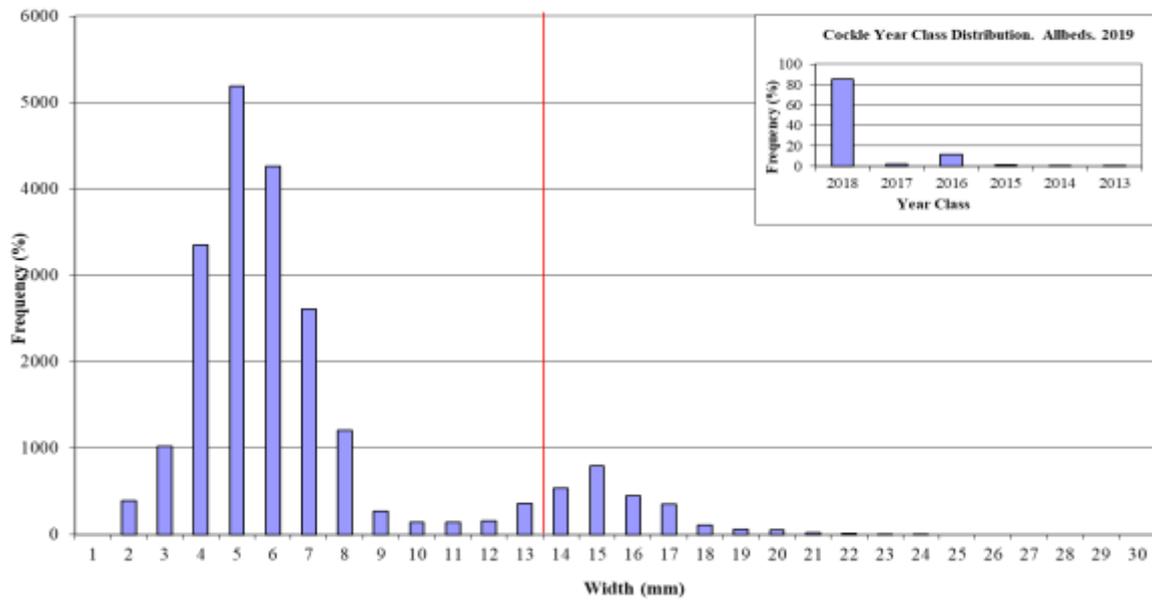


Figure 31 - Cockle Size Frequency. All beds. April 2019



Discussion

At the time of the surveys, the stocks on the WFO 1992 and the Wash Restricted Area (The Outer Ferrier) beds were at the following levels:

WFO 1992 regulated beds

Total Adult Stock ($\geq 14\text{mm}$ width)	12,011 tonnes
Total Juvenile Stock ($< 14\text{mm}$ width)	6,654 tonnes
Total Stock (all sizes)	18,665 tonnes

Wash Restricted Area (Ferrier)

Total Adult Stock ($\geq 14\text{mm}$ width)	969 tonnes
Total Juvenile Stock ($< 14\text{mm}$ width)	174 tonnes
Total Stock (all sizes)	1,143 tonnes

The results from the survey show the cockle stocks on the regulated beds have declined for the third successive year since their recent peak in 2016. As can be seen from figure 32, however, which shows the state of the cockle stocks since 2000, this is part of a cyclic pattern of recovery and decline driven by successful spatfalls, fisheries and natural mortality.

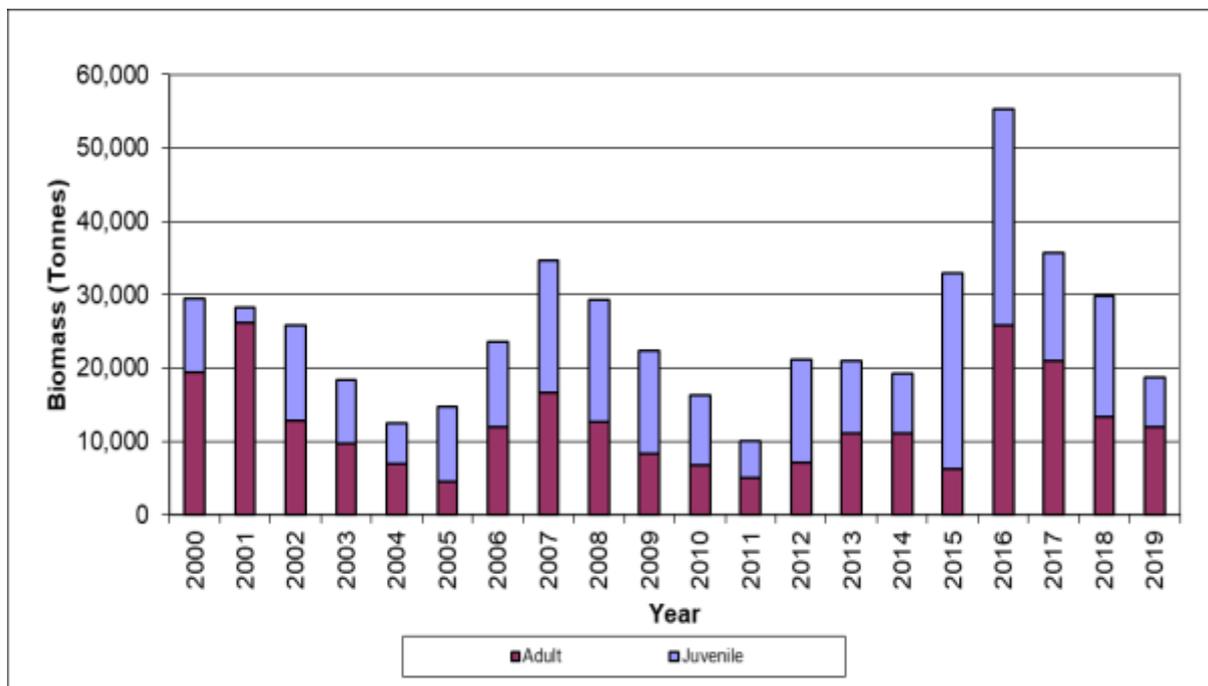


Figure 32 – Adult and juvenile cockle stock levels between 2000 and 2019 on the WFO 1992 regulated beds

In terms of biomass, the stocks were composed primarily of larger 2016 year-class cockles and Year-0 juveniles that settled in 2018. Following the previous year's fishery, which had mainly targeted the cockles from the 2016 year-class, the quantity of surviving cockles from this cohort was surprising, contributing towards a TAC for the fishery that was larger than most of the fishers were anticipating (total TAC 4,327 tonnes). Having been thinned out in 2017, however, these larger cockles were spread sparsely over a wide area, making them difficult to harvest by hand-working. At the start of the season 24 closed areas (including the whole of Friskney) had been put in place to protect the densest patches of Year-0 juvenile stocks. Together, these closures and the sparsity of adult stocks limited the fishing opportunities, resulting in many fishers landing high proportions of shell in their catches. As such, catch values were low at the start of the season. Advocates of the dredge fishery suggested that due to these low prices, the hand-worked fishery was not financially viable for many of the fishermen. The majority of those responding to an industry-wide consultation expressed a preference for the fishery to remain hand-worked, however.

Further assessments on the Gat and Friskney beds

Two of the closed areas that were implemented at the start of the season were on the east side of the Gat sand, where the Year-0 juvenile cockles had a size range predominantly between 4-7mm width (figures 16 and 33). During July and August several complaints were received from fishermen regarding small juvenile cockles that were being landed from the Gat beds, threatening the sustainability of the following year's fishery. These reports were collaborated with observations made by officers conducting landings, in which samples of cockles that had been landed from the Gat sand had average size frequencies between 11.4mm and 12.7mm. An assessment of the cockles on the east side of the Gat was conducted on August 20th. At the time of this assessment, approximately ten vessels were fishing close to the southern and western edges of the southern closed box. Figure 34 shows the numbers of Year-1⁷ cockles found at the 16 stations sampled in August and their remodelled distribution based on these data.

⁷ Note – due to their time of settlement, the 2018 year-class of cockles that were Year-0 in April were classed as being Year-1 in August

Figure 34 shows the distribution of Year-1 cockles modelled from the August survey data was more extensive than originally modelled from the April data (figure 33). This updated model highlighted that the closed boxes were only partially protecting the high-density patches of juvenile cockles, which by the time of the assessment had grown to a mean size of 10.6mm.

On August 16th a further assessment was also conducted on the cockles located at Friskney. The April surveys had identified five discrete high-density patches of Year-0 cockles on this bed, in which they had a size range between 5-8mm width (figure 14). Because cockles tend to grow rapidly on this sand, it was agreed with the industry to keep the whole of Friskney closed at the start of the fishery with the potential to open it again if the cockle were found to have reached harvestable size (figure 35).

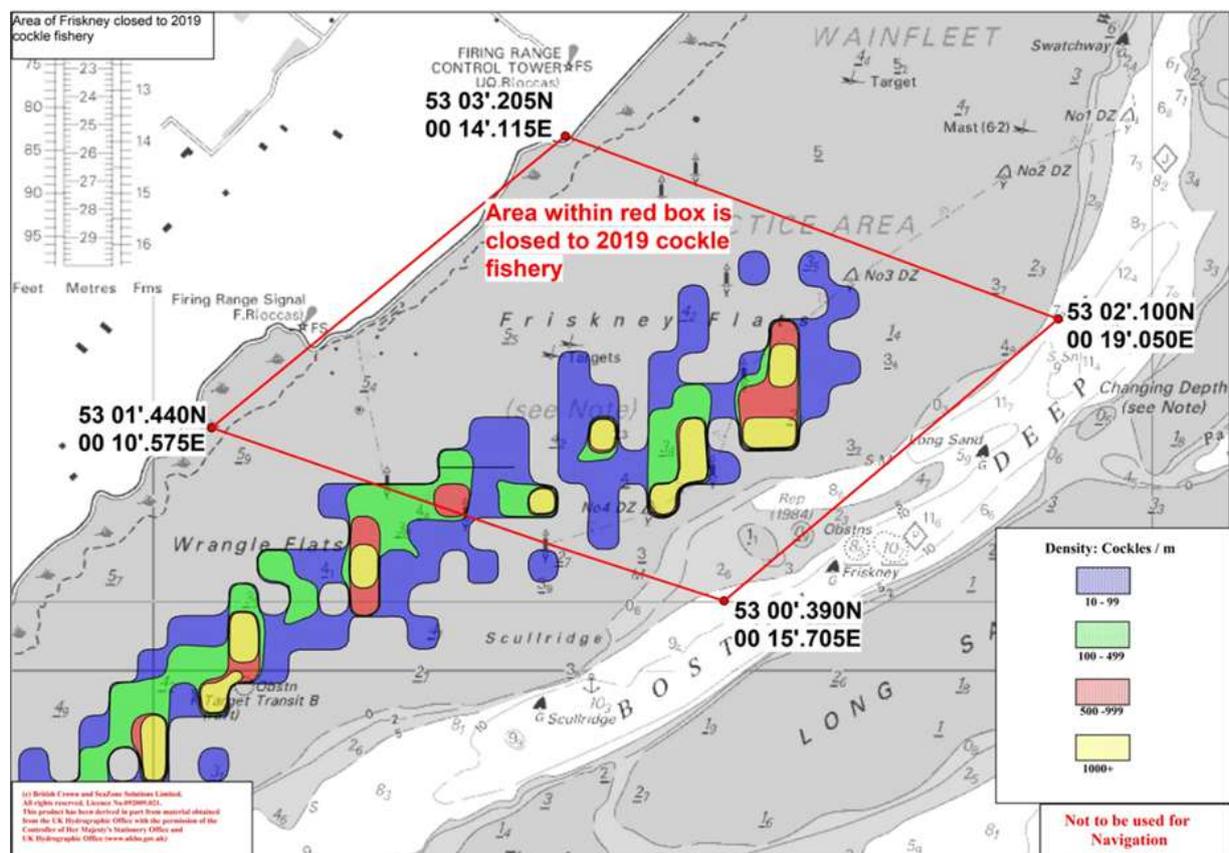


Figure 35 – Chart showing closed area protecting Year-0 juvenile cockle stocks in Friskney

The cockle numbers found in the samples collected in August correlated well with those sampled in April, but as had been the case with the Gat sand, the patches in which juvenile cockle numbers exceed 1,000/m² were found to be slightly larger than previously estimated, extending further towards the sand edge (figure 36). The mean

size of the Year-1 cockles in these patches was 11.4mm width. This was smaller than had been expected given the usual rapid growth found on this bed, but was possibly due to the higher than usual densities that the cockles were present in.

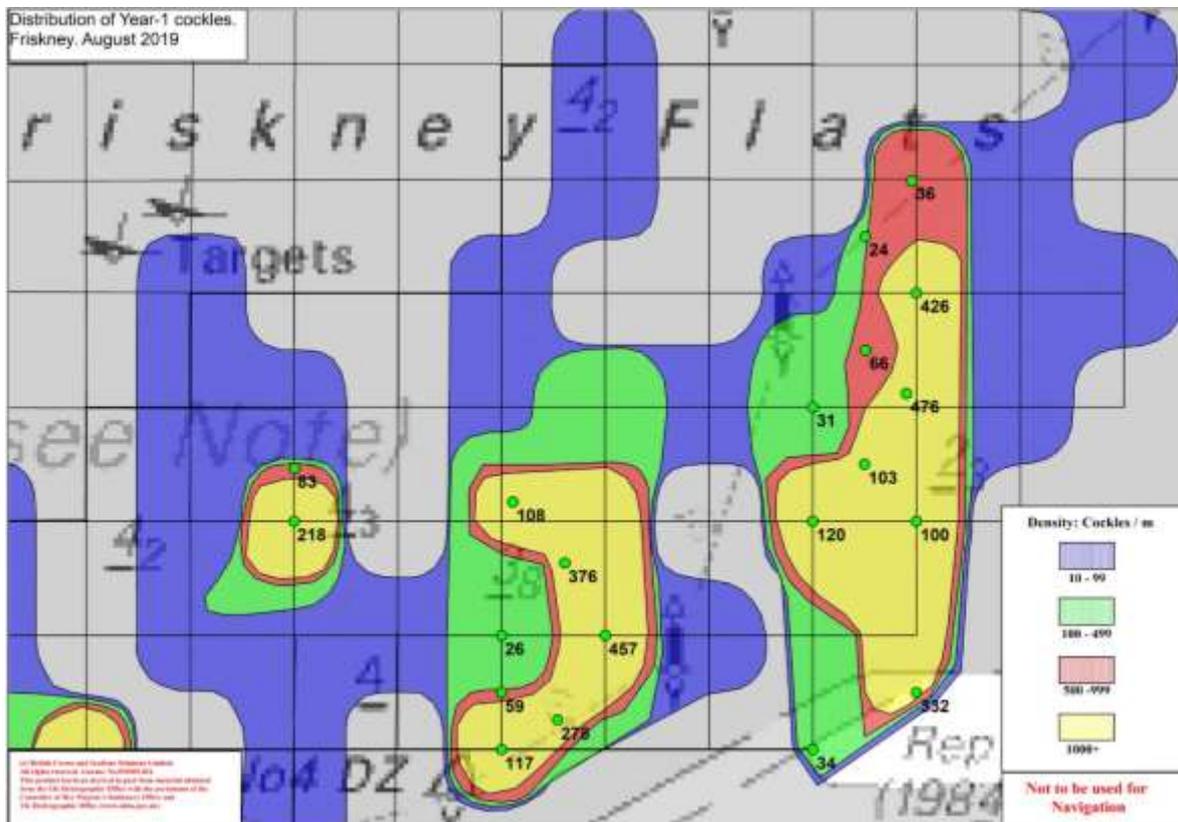


Figure 36 – Chart showing numbers of Year-1 cockles present at survey sites in August and their adjusted modelled distribution taking into account these data

Following the August assessments on the Gat and Friskney beds, the industry was consulted further to capture their opinions on how they would like to see these beds managed. Responses were mixed, with approximately half of the industry wanting to see Friskney opened, while the other half felt both the Gat and Friskney should be closed. Because it was felt the suite of closures elsewhere would ensure the sustainability of the following year’s fishery, a decision was made to keep Friskney closed but to allow fishing to continue around the edges of the closed areas on the Gat.

Following the assessment on August 16th, information was received from a number of fishermen that the cockles at Friskney had grown fairly rapidly and were approaching 14mm width. There were also reports that they were beginning to ridge out. A further assessment was conducted, therefore, on September 19th, in which samples were

collected both on foot and with a Day grab. These new data were combined with those from the August survey to remodel the cockle distribution charts (figure 37).

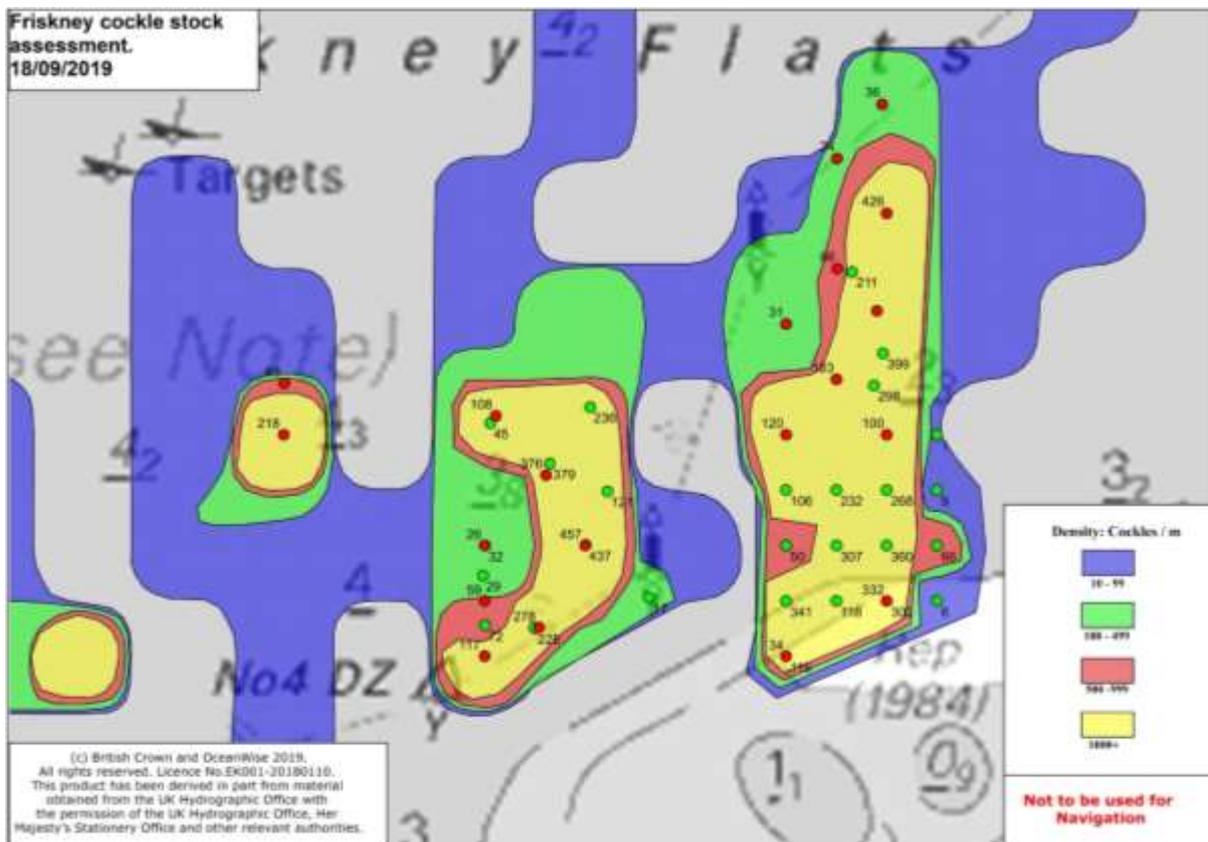


Figure 37 – Chart showing the densities of cockles found at each survey station in August (red dots) and September (green dots)

During this assessment the Year-1 cockles were found to have a mean size of 12.0mm width, but where their densities were lower, or where they were situated lower on the sand's edge, their sizes were slightly larger. At the time of the assessment the cockles appeared to be well established in the ground and showed no signs of ridging out. When placed flat in 0.1m² quadrats, however, the cockles in some of the higher-density patches were found to be occupying approximately 90% of the available space, indicating they wouldn't have much more room for growth before ridging would begin to occur. Those closest to the sand's edge, where the slope of the sand was greater than further up the sand, were considered to be the most vulnerable.

Although there was no evidence of ridging out within the beds, several ridges of cockles were found that had been washed out further upstream by a wide fast-flowing run that flowed along the eastern edge of the bed. The largest of these ridges (figure

38) was estimated to contain approximately 6 tonnes of cockles, with several smaller ridges containing about 0.5 to 1 tonne in each. While these patches could potentially have been mistaken for ridging-out, the mechanism causing them is more localised and less damaging than if widespread ridging out was to occur.



Figure 38 – Photograph of accumulation of cockles washed out by run

Following the September assessment, a decision was made to open a limited fishery on Friskney, whereby the more vulnerable cockles on the lower sand edges were opened, while the high-density patches further up the sand remained closed. With approximately a third of the TAC remaining, this open area provided a good late-season resource for about 20 vessels until it was closed on November 14th.