Solent Bivalve Stock Survey

Spring 2019

This report has been produced by the Southern Inshore Fisheries and Conservation Authority.

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1. Introduction

The following report details the bivalve surveys carried out in Southampton Water, Portsmouth Harbour and Langstone Harbour during March - April 2018, October 2018, and March 2019. The report will assess the distribution and abundance of clam and cockle species over time to evaluate the population health and stability of commercially important species for the dredge fishery. In addition, the outcomes from the survey will provide data which can be used as a baseline on which to monitor future trends and potential changes to populations which will feed into the development and monitoring of local management strategies.

1.1. The Fishery

The fishery for bivalves is seasonal in the Solent, to allow protection of important features, with prohibition on the use of a dredge between March 1st and October 31st each year (Solent Dredge Fishing Byelaw 2016). The main commercial species fished via dredging is the Manila clam (minimum size 35 mm) (*Ruditapes philippinarum*), as it is abundant and sells for a high price (Figure 1.1). Other species also taken when in suitable quantities are the common cockle (minimum size 23.8 mm) (*Cerastoderma edule*), American Hard-Shelled clam (minimum size 63 mm) (*Mercenaria mercenaria*) (Figure 1.1) and, occasionally, the Grooved Carpet Shell or native clam (*Ruditapes decussatus*). The dredge fishery uses a type of mechanical dredge, commonly referred to as a 'box clam dredge' (Figure 1.2). The dredge is towed from the stern of the vessel, supported on the seabed by skis. A front

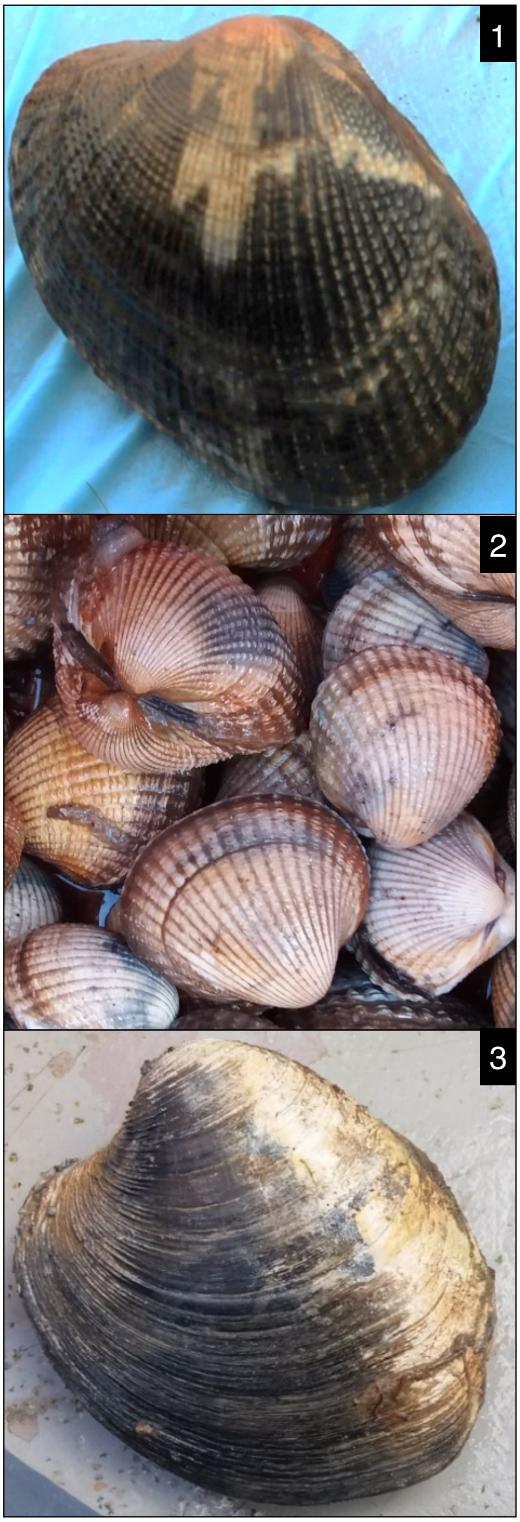

Figure 1.1 - Image displaying (**1**) Manila Clam (*Ruditapes philippinarum*), (**2**) Common Cockle (*Cerastoderma edule*), and (**3**) American Hard-Shelled Clam (*Mercenaria mercenaria*).

opening consists of a row of metal teeth, which dig into the sediment as the dredge is towed, collecting buried bivalves into the metal basket. The basket is designed so that sediment, debris and smaller sized bivalves are washed through whilst retaining the sizeable bivalves.

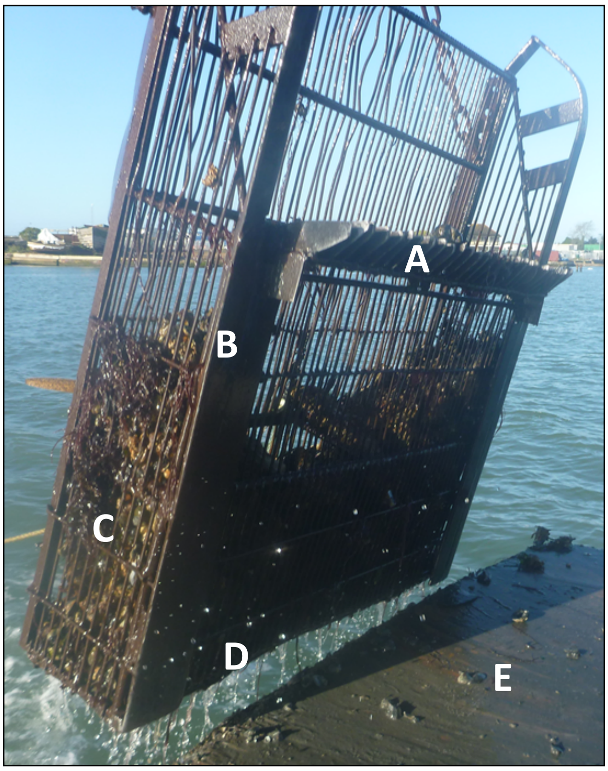

Figure 1.2 - a box clam dredge used in Southampton Water; A) metal teeth defining the front opening of the dredge, B) skis to support the dredge on the seabed, C) dredge basket, D) spring-loaded opening to remove contents onto E) sorting table.

The bivalve beds of commercial importance to the Solent exist primarily in Southampton Water, but there are also fisheries in the areas of Portsmouth Harbour and Langstone Harbour (Figure 1.3). These areas form three distinct bivalve management areas and, as such, these areas are all sampled as part of this survey, allowing data on the stocks of commercially important bivalve species to be gathered and compared across the three main areas of importance for the local dredge fishery.

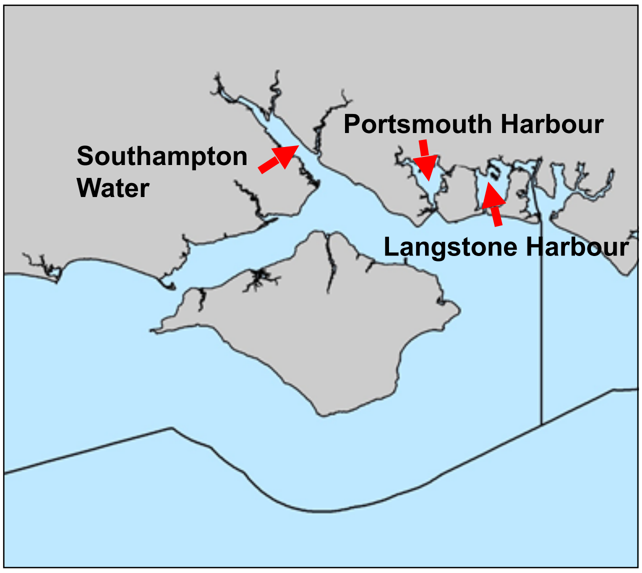

Figure 1.3 - The Solent and adjacent estuaries showing the three locations for the survey. The solid black lines indicate the boundaries of the Southern IFCA District.

1.2. The Solent

The Solent is a strait of water with adjacent estuaries which separates the mainland of England from the Isle of Wight (Figure 1.3). It is a highly protected area with the wider Solent containing two European Marine Sites (EMS), the Solent EMS and the Solent and Isle of Wight Lagoons Special Area of Conservation (SAC). The Solent EMS is a complex site encompassing both Special Areas of Conservation (SACs) designated under the EC Habitats Directive and Special Protection Areas (SPAs) designated under the EC Birds Directive. The EMS is made up of the Solent Maritime SAC, the Solent and Southampton Water SPA, Chichester and Langstone Harbour SPA and Portsmouth Harbour SPA. The Solent EMS is unique in Europe with regard to the complexity of the marine and terrestrial habitats present including mudflats, saltmarsh, eelgrass (Zostera spp.) and natural shoreline transitions to adjacent coastal habitats including grazing marsh, saline lagoons and reedbeds (SEMS, 2017). This variety of habitats supports key species of birds and form rich grazing, breeding and nursery grounds. The mudflat habitat in particular, a key habitat under both the SAC and SPA designations, supports a rich invertebrate fauna which in turn provides a food source for internationally important populations of migratory species and an internationally important assemblage of wildfowl (Gravestock, 2016).

1.3. Current Management

There are a number of management measures currently in place regulating bivalve dredge fishing within the Solent:

- **Fishing Season** - (Solent Dredge Fishing Byelaw 2016).
- **Gear Type** (Bottom Towed Fishing Gear 2016 byelaw, The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004).
- **Vessel Size** ('Vessels Used in Fishing 2012' IFCA byelaw).
- **Minimum Size** (Council regulation (EC) no. 850/98), (Southern IFCA Fishing for Cockles byelaw and American Hard-Shelled Clams - Minimum Size byelaw).

More information regarding fishing regulations around The Solent can be found on the Southern IFCA website at http://www.southern-ifca.gov.uk/byelaws

2. Methodology

2.1. Survey

This report analyses data collected over 3 survey periods at the start and end of the fishing seasons currently set under the Solent Dredge Fishing Byelaw 2016. These survey periods were between the 21st March & 4th April 2018, 23rd & 25th October 2018, and 18th & 20th March 2019. Each survey was carried out across three defined bivalve management areas (Figure 1.3) using a chartered fishing vessel which routinely operates in that area:

- **Southampton Water**, using vessel 'Benjamin Guy'
- **Portsmouth Harbour**, using vessel 'Solent Star'
- **Langstone Harbour**, using vessel 'Sand Julie'

For each area a number of beds were surveyed, which were defined based on fishers' knowledge, covering the major bivalve beds present. For each bed, 3 dredge tows were conducted for a duration of 1 minute, with the aim of keeping the vessel speed as constant as possible throughout the survey. A waypoint was created for the start and end of each tow, and for each waypoint, time, vessel speed, and GPS positioning were also recorded. A box clam dredge was used to collect bivalve samples throughout each tow. Upon tow completion the dredge was brought inboard and the contents emptied onto a sorting table. A photograph was then taken of the dredge contents. Next, the sediment types present in the dredge were recorded based on presence/absence, and scored from 0-5 based on abundance of each sediment type present. Bivalve species were then picked out of the dredge and separated into buckets. For each species, individuals were measured along the widest axis using Vernier callipers to give a length measurement (mm). A maximum of 100 individuals per species were measured, with the remainder counted. Manila clam species were further separated into groups above and below minimum size (35mm) before being weighed. Bivalves were then returned to the tow location from which they were caught, to ensure that they were returned to the appropriate classification area for bivalves as classified according to health standards set out in "European Community Regulations 853/2004 and 854/2004".

2.2. Equipment

The dredge used for all three surveys has spacing between bars large enough to minimise retention of undersized bivalves. This means that the dredge displays a degree of bias towards retention of larger size classes, and so the survey data will not reflect the full spectrum of bivalve populations. In contrast, the use of this type of dredge also allows for a more representative sample of what a fisherman would catch, meaning that the results of this survey will provide useful information on which to monitor the fishery and to base management decisions. Finally, the data does not factor in dredge efficiency. The efficiency of the box clam dredge can vary from 2% to 35%, but there are no comparable studies for the type of dredge used in these surveys therefore it is difficult to determine an efficiency coefficient which could be applied to the data. As a result, the data should therefore be treated with a degree of caution, assuming that it represents an underestimation of the bivalve populations present.

2.3. Data Analysis

Data recorded on log sheets was inputted into an Excel spreadsheet, before being analysed and compared both spatially and temporally across areas and beds. Averages and statistical analyses for significant differences between datasets were calculated using SigmaPlot. To compare temporal differences between bivalve areas, t-tests and Mann-Whitney U tests were used depending on whether the data were normally distributed.

To improve comparison of data between surveys, data was standardised. Firstly data was converted to 'catch per metre of dredge per hour' based on either count or weight, depending on the data available. This gave a measure of catch per unit effort (CPUE). Weight per metre of dredge per hour was used for Portsmouth Harbour and Langstone Harbour, however for Southampton Water weight data from Spring 2018 was not available due to poor weather conditions preventing the scale from working properly, so comparisons between survey periods had to be made using count data.

3. Results

A full summary of the Spring 2019 data from all three areas can be found in Annex 1. A full breakdown of each area and the beds surveyed can be found in Annex 2.

The results of this survey are centred primarily around the Manila clam due to its economic importance in the Solent bivalve fishery. Results are also presented for common cockle and the American Hard-Shelled clam.

3.1. Southampton Water

Total catch of Manila clam and cockle in Southampton water has been sporadic. In Spring 2018, 1384 clams and 876 cockles were caught respectively. In Autumn 2018 however, clam catch more than doubled to 3070, and cockle catch increased to 1905. Further fluctuations were observed in Spring 2019, whereby clam catch decreased to 2529, and cockle catch rose to 3040 individuals.

Manila clam average sizes (mm) in Southampton Water were mostly under minimum size, with the smallest observed at bed 11 (Figure 3.1). Only beds 7 and 8 showed an average size of Manila clam above minimum size.

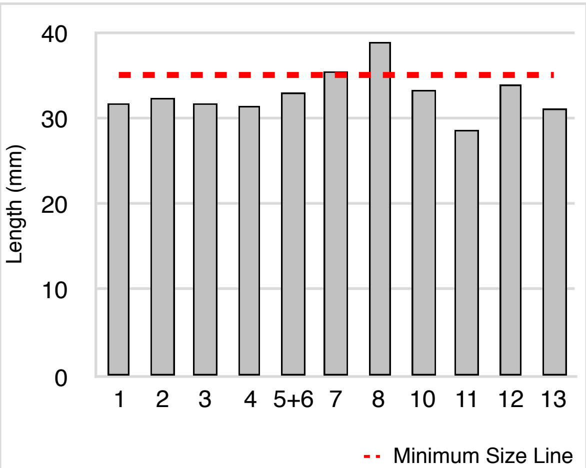

Figure 3.1 - Average length of Manila clam (mm) for each bed surveyed in Southampton Water. A minimum size line (red dash) is included for visualisation of average length in relation to minimum size.

Manila clam weight data for Spring 2019 indicated that at the end of the closed season, the majority of beds in Southampton Water were comprised of a greater biomass of clams under minimum size than over. This was true for all beds with the exception of beds 7, 8, and 12 (Figure 3.2). Bed 10 showed the highest overall biomass in Southampton Water.

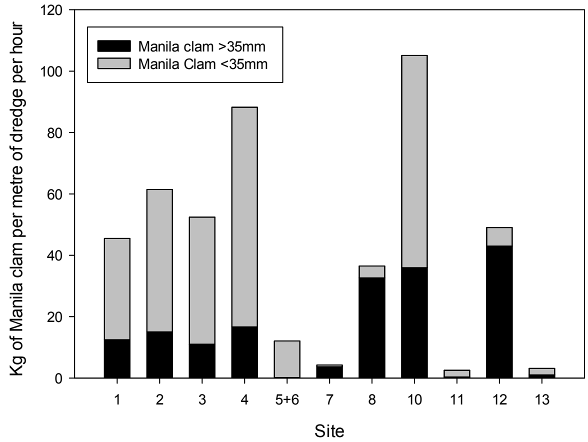

Figure 3.2 - Weight (kg) per metre of dredge per hour for Manila clam above and below minimum size in each bed surveyed in Southampton Water.

CPUE data based on Manila clam count highlighted some significant differences between open and closed fishing seasons (Figure 3.3). The count of Manila clam in Autumn 2018 is significantly higher than in Spring 2018 ($P<0.05$) (1), reflecting the time when the fishery is seasonally closed for dredging. Upon further investigation into the size of individuals, it was revealed that there was a significant increase in clams under minimum size ($P<0.05$) but not in clams over minimum size, highlighting that the significant increase in overall numbers is mainly due to an increase in undersized individuals (1).

Between Autumn 2018 and Spring 2019, CPUE results indicated that there was no significant difference between the two surveys. There was however an overall decrease in the Manila clam population over this period, both for individuals over and under minimum size. This reflects the period of time that the fishery is seasonally open for dredging, highlighting that the population decreased during a time of commercial fishing (2).

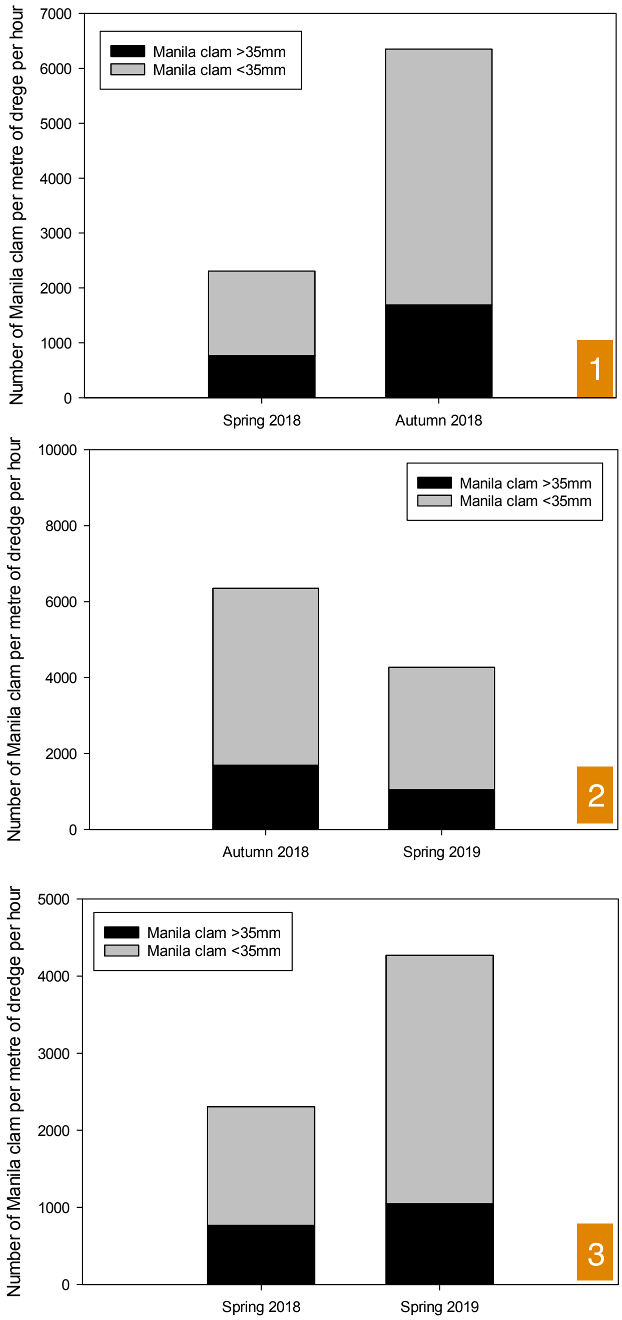

Figure 3.3 - Number of Manila clam per metre of dredge per hour for individuals above and below minimum size in Southampton Water. Comparisons are made between Spring to Autumn 2018 (1), Autumn 2018 to Spring 2019 (2), and Spring 2018 to Spring 2019 (3).

Comparison of CPUE data between Spring 2018 and Spring 2019 indicated that the Manila clam population in Southampton Water in Spring 2019 is significantly higher than in Spring 2018 ($P<0.05$), reflecting an increase in population over the course of 1 year. Upon further analysis of size, a significant increase in the section of the population below minimum size was observed ($P<0.05$), but not in clams above minimum size (3). This highlights that the overall population increase can be explained mostly by an increase in undersized clams.

Average sizes for cockles found in Southampton Water showed the majority of cockles to be above minimum size, with the exception of beds 2 and 3 displaying averages lower than minimum size (Figure 3.4) (1). Average size of American Hard-Shelled clams on the other hand were below minimum size across all beds, however only 29 individuals were caught across the entire Spring 2019 survey (Figure 3.4) (2).

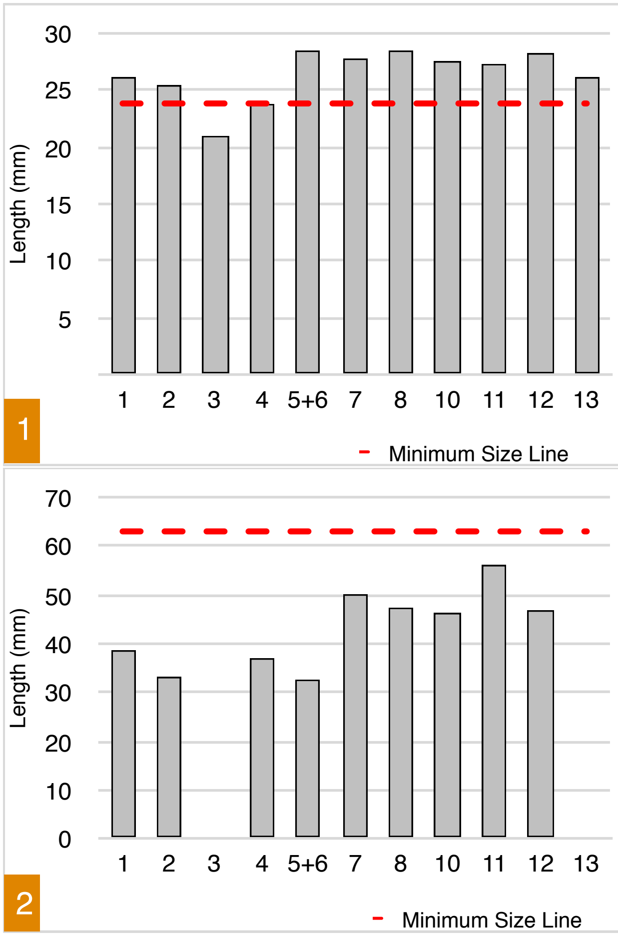

Figure 3.4 - Average length of cockle (1) and American Hard-Shelled clam (2) for each bed surveyed in Southampton Water. A minimum size line (red dash) is included for reference of average length against minimum size.

3.2.Portsmouth Harbour

Total catch of Manila clam remained fairly constant throughout the three surveys, rising a small amount from 417 in Spring 2018 to 611 in Spring 2019. Cockle catch was much higher however, with 2411 individuals caught in Spring 2018, and 3491 in Spring 2019.

Manila clam average sizes in Portsmouth Harbour were mostly found to be above minimum size, with only beds 5 and 6 displaying an average under minimum size (Figure 3.5). Bed 1 to 3 combined displayed an average size nearly 10mm over minimum size, however the sample size of this area was only 6.

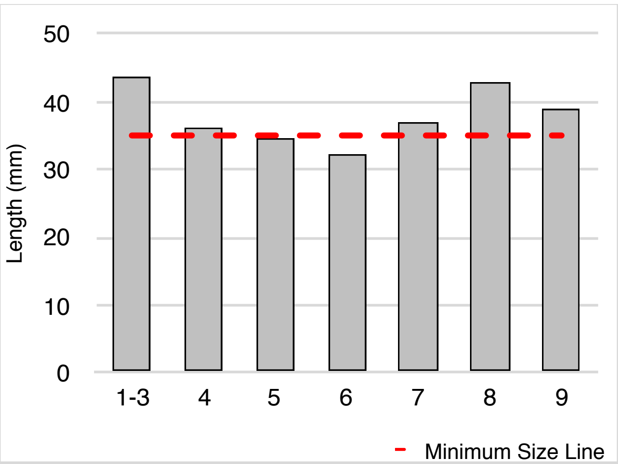

Figure 3.5 - Average length of Manila clam (mm) for each bed surveyed in Portsmouth Harbour. A minimum size line (red dash) is included for visualisation of average length in relation to minimum size.

Weight data for the Spring 2019 Portsmouth Harbour survey showed that beds 5 and 6 contained the greatest overall biomass of Manila clam, and bed 1-3 the smallest (Figure 3.6). Most beds were comprised of a greater biomass of clams over minimum size than under, indicating a mature population present. Only bed 6 contained a higher biomass of clams under minimum size.

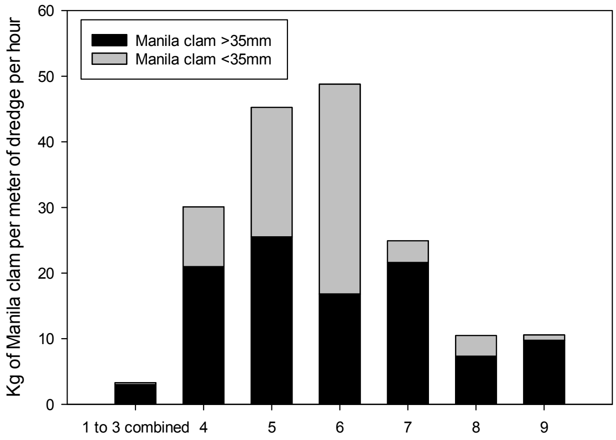

Figure 3.6 - Weight (kg) per metre of dredge per hour for Manila clam above and below minimum size in each bed surveyed in Portsmouth Harbour.

CPUE data based on Manila clam weight in Portsmouth Harbour indicated that there were no significant differences between any of the 3 surveys, neither for overall weight nor for weight of populations below or above minimum size (Figure 3.7). This reflects that the population has not changed significantly, regardless of the fishery being open or closed. This is not to say that no population changes were observed at all however.

Between Spring to Autumn 2018, a period when the fishery was closed, a decrease in Manila clam biomass can be seen, particularly for the section of the population above minimum size. This means that the clam population decreased, despite there being no pressure from commercial fishing.

Between Autumn 2018 to Spring 2019, a much less noticeable change in Manila clam population was observed, with biomass of clams over minimum size remaining virtually unchanged, whilst biomass of clams under minimum size experienced a small increase. This reflects the period of time that the fishery was open for dredging, highlighting that biomass increased despite commercial fishing being present in the area.

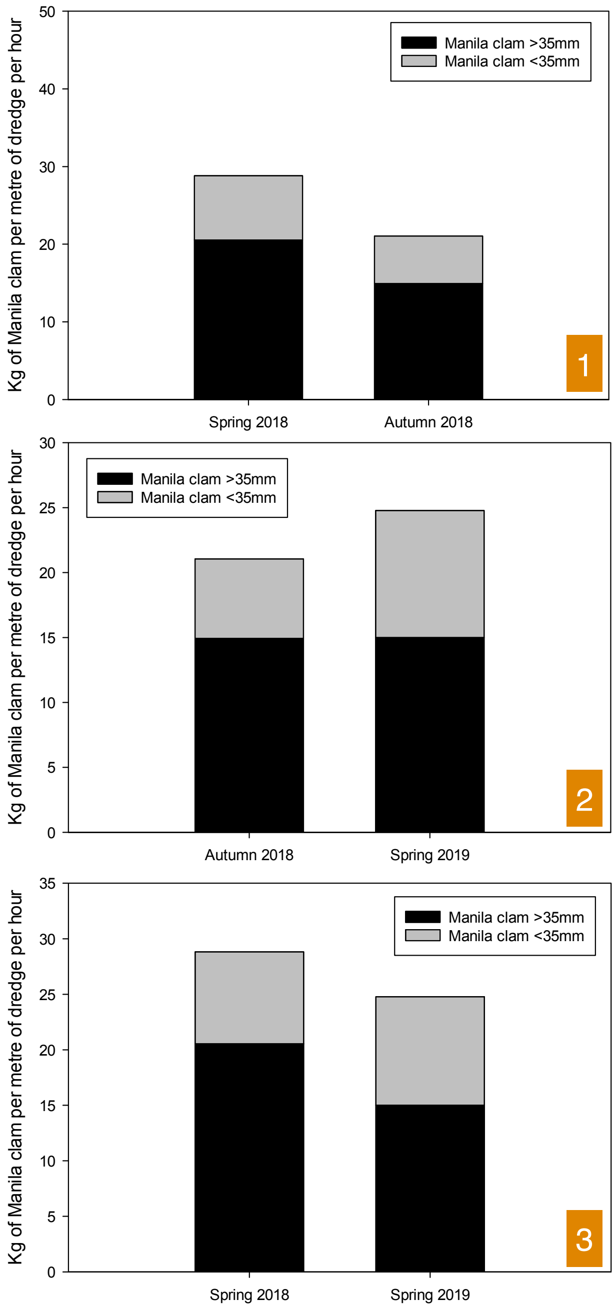

Figure 3.7 - Average weight of Manila clam per metre of dredge per hour for individuals above and below minimum size in Portsmouth Harbour. Comparisons are made between Spring to Autumn 2018 (1), Autumn 2018 to Spring 2019 (2), and Spring 2018 to Spring 2019 (3).

Manila clam biomass in Portsmouth Harbour between Spring 2018 to Spring 2019 displayed an overall decrease, both for populations above and below minimum size. This highlights an overall decrease in the biomass of clams across a one year period.

Average size of cockles surveyed in Portsmouth Harbour in Spring 2019 showed that all cockle beds were on average above the minimum size, indicating a mature population based on size (Figure 3.8) (1). Average size of American Hard-Shelled clams showed all beds to contain clams below the minimum size, however this was based off data from only 50 individuals across the entire survey. (Figure 3.8) (2).

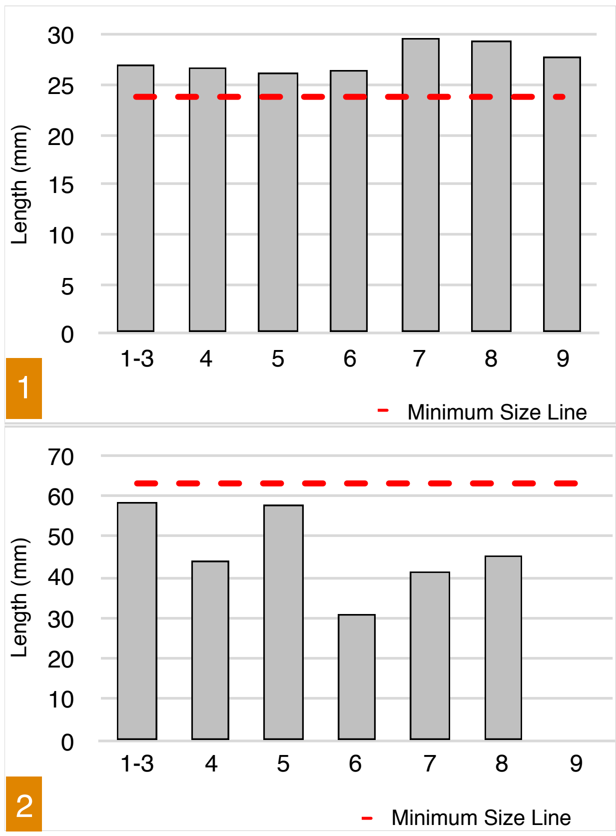

Figure 3.8 - Average length of cockle (1) and American Hard-Shelled clam (2) for each bed surveyed in Portsmouth Harbour in 2019. A minimum size line is included for reference of average length against minimum size.

3.3. Langstone Harbour

Langstone Harbour yielded a small catch of Manila clam, with only 233 caught in Spring 2018. This number decreased to 175 individuals caught in Spring 2019. Cockle numbers were higher with 676 individuals caught in Spring 2018, but their number also dropped, with 477 caught in Spring 2019.

Manila clam average sizes in Langstone Harbour were all above minimum size, with beds 3, 4, and 6 averaging above 40mm per clam (Figure 3.9). This indicates a mature population based on size. Some of these averages are based on small quantities of data however, with only 6 individuals caught and measured for beds 4 and 6.

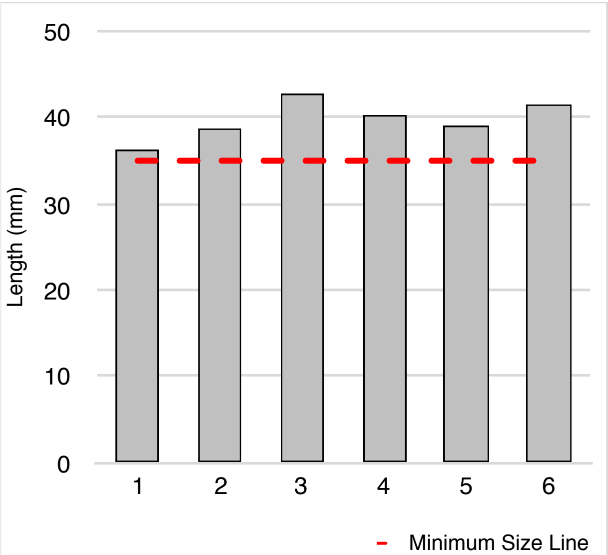

Figure 3.9 - Average length of Manila clam (mm) for each bed surveyed in Langstone Harbour. A minimum size line (red dash) is included for visualisation of average length in relation to minimum size.

Spring 2019 weight data for Langstone Harbour showed that beds 1 and 2 contained the highest overall Manila clam biomass, and beds 4 and 6 the lowest (Figure 3.10). All beds were comprised of a much higher biomass of clams above minimum size than below, indicating that this is predominantly a mature population.

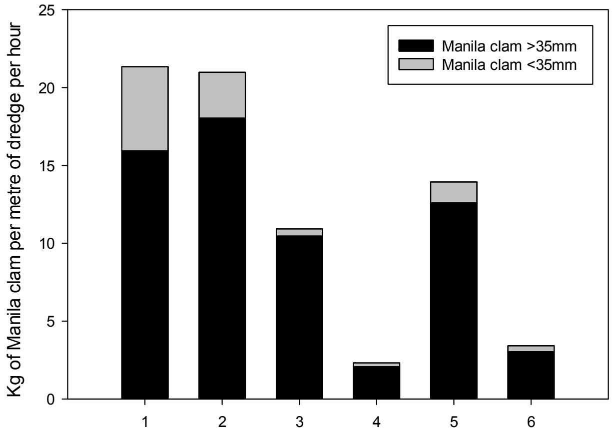

Figure 3.10 - Weight (kg) per metre of dredge per hour for Manila clam above and below minimum size in each bed of Langstone Harbour.

CPUE data based on Manila clam weight in Langstone Harbour displayed some some significant differences between open and closed seasons (Figure 3.11). Between Spring to Autumn 2018, an overall increase in Manila clam biomass was observed, but this increase was not significant, reflecting the period of time the fishery is seasonally closed for dredging (1). Upon further investigation however, a significant increase was observed for the section of the population under minimum size ($P<0.05$).

Between Autumn 2018 to Spring 2019, there were no significant differences observed for the overall Manila Clam population, and only a slight increase in overall population was observed at all. No significant differences were observed for the section of the population above or below minimum size either. This reflects the period when the fishery is open for dredging.

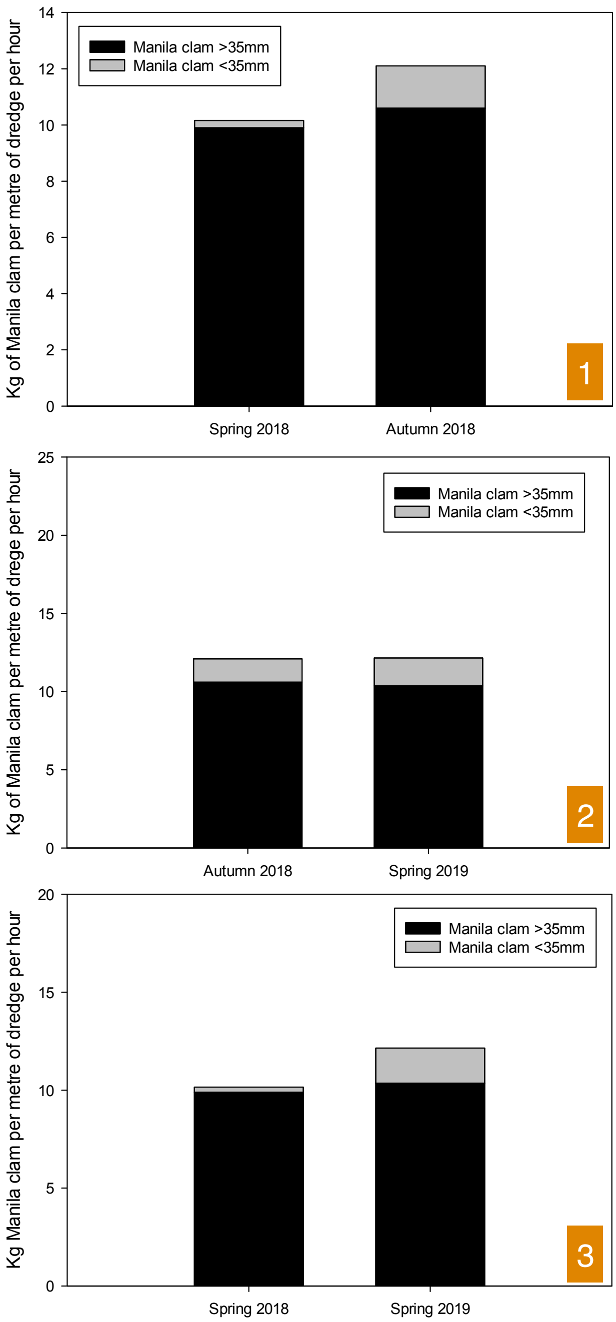

Figure 3.11 - Average weight of Manila clam per metre of dredge per hour for individuals above and below minimum size in Langstone Harbour. Comparisons are made between Spring to Autumn 2018 (1), Autumn 2018 to Spring 2019 (2), and Spring 2018 to Spring 2019 (3).

Between Spring 2018 to Spring 2019, an increase in overall Manila clam population is observed, however the increase is not statistically significant. This reflects that the fishery population has not changed much over a 1 year period. Upon further analysis, a significant increase in the section of the population under minimum size was observed (P<0.001), but not for those over minimum size.

The average size of cockles found in Spring 2019 in Langstone Harbour were above minimum size across all beds surveyed, indicating a mature population based on size (Figure 3.12) (1). Average size of American Hard-Shelled clams were under minimum size across all beds except from bed 6 (Figure 3.12) (2). This was however based on a small sample size of 34 individuals across the entire Spring 2019 survey.

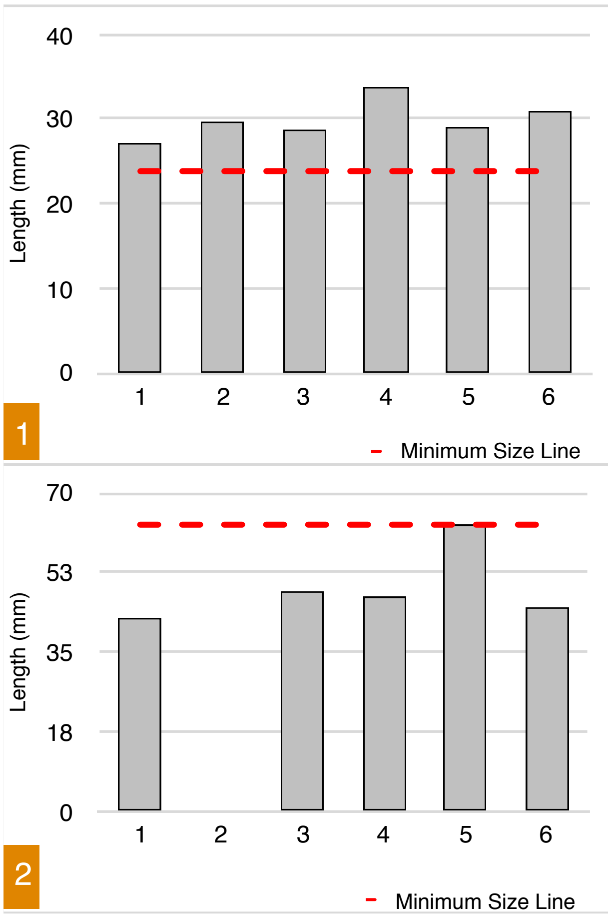

Figure 3.12 - Average length of cockle (1) and American Hard-Shelled clam (2) for each bed surveyed in Langstone Harbour. A minimum size line is included for reference of average length against minimum size.

4. Discussion

It is key to note that despite this assessment including data from three separate surveys over the course of 1 year, more data is still needed to establish trends of bivalve stock levels and health in the Solent. This is because there are many influencing factors that could have an impact over a larger temporal scale such as overfishing, natural variation, or other external factors. It therefore remains apparent that no conclusions can be drawn as of yet, and so emerging trends cannot be attributed to management alone.

It is also worth noting that the Solent bivalve fishery is set to become a permit fishery. This will mean that catch data will be collected as part of the permit conditions, enabling a much larger and more relevant dataset to be collected that reflects the portion of each population that is caught during each open season. This could give a better indication of the influence fishing practices are having on bivalve stocks, and if further management is required.

4.1. Southampton Water

Southampton Water hosts the largest commercial fishery of the three surveyed areas, and so effective management is important to maintain the bivalve populations present, as well as to maximise economic benefit for the fishery. The most heavily exploited beds in recent years have been beds 1 to 4 (Annex 2, Figures 6.1 and 6.2), however more recently bed 10 has also been targeted.

Average size data in Spring 2019 showed that Manila clam were predominantly undersized. Given that this survey was carried out at the end of the open season, combined with Southampton Water being a popular fishery, this trend can be expected. This is because many clams above minimum size would have been removed from the population through fishing throughout the open season, and so the remainder at the end of the season would likely be comprised predominantly of undersized individuals. As a time series of data is established, a more detailed analysis of the extent of the influence of fishing pressure on the proportion of undersized individuals will become possible.

Weight data reflect the same trend as average sizes, with a higher biomass of individuals under minimum size present in the population. This dominance of undersized clams could also be indicative of a longer term trend, whereby the introduction of a closed fishing season in 2018 could be influencing the undersized part of the population. In this case, the closed season has allowed for higher levels of reproduction and therefore spatfall of clams. This would in turn mean that by the end of the open season, a large number of juvenile clams are present in the population, lowering the average size and increasing the biomass of undersized clams. However, without more data collected in future surveys, it cannot be concluded as to whether removal of oversized individuals and the introduction of a closed season are the driving influences behind the dominance of undersized clams in Southampton Water.

There are also other reasons that the clam population could be comprised predominantly of undersized individuals. For example, a series of record breaking summer temperatures since 2016 may have facilitated high levels of spatfall for Manila clam. Considering that the Manila clam takes 1 to 3 years to reach maturity (Government of Canada, 2018), elevated spawning levels in the years prior to this survey due to higher temperatures could have facilitated a spike in the portion of the population under minimum size, resulting in the observations made in Spring 2019.

CPUE results based on clam count per metre of dredge per hour showed that the Manila clam population in Spring 2018 is significantly higher than Autumn 2018. This could indicate that the period of fishery closure has allowed for the repopulation of the stock after the open season. The increase is only significant in undersized clams, which could again reinforce the ideas that either the closed fishing season is facilitating an increase in juvenile clams, or that there has been an increased spatfall in the year or two before this period caused by external factors. The proceeding decrease in the overall population from Autumn 2018 to Spring 2019, though not significant, falls in line with the fact that the fishery was open during this period, resulting in a reduction in population. The lack of a significant population decrease could indicate that fishing is not having a significant impact on the population, therefore raising the idea that other significant changes in the population may be due to natural variation or other external factors, as opposed to fishing.

Over the course of one year from Spring 2018 to Spring 2019, the significant increase in the overall Manila clam population could suggest that the presence of a closed season is allowing for the Manila clam population to increase. If this is the case, then the introduction of the closed season is having the desired effect, and the clam population may continue to increase in future years until it reaches a plateau, whereby the environment has reached the maximum biomass it can sustain. Further surveying will reveal whether this is the case, as the increase in stock could also be due to natural variation. The larger increase in clams under minimum size over the course of one year once again highlights that juvenile numbers may be increasing due to management, natural variation, or other external factors. A proportional increase for both sections of the population under and over minimum size would be more desirable, as it reflects a healthier overall population growth.

4.2. Portsmouth Harbour

Portsmouth Harbour hosts a smaller bivalve fishery than Southampton Water, though it still supports an important Manila clam fishery. Of the beds surveyed within the area, beds 5 and 6 (Annex 2, Figure 6.4) are the most heavily exploited, as they contain a high quantity of clams.

Average size of Manila clam in Portsmouth Harbour indicated that the population was predominantly over minimum size at the end of the fishing season, reflecting a healthy and mature population. This is in contrast with Southampton Water, which could mean that Portsmouth Harbour, being a smaller fishery, is less affected by the open season, explaining why more individuals above minimum size remain at the end of the open season. Average weight data also displays a higher biomass of clams over minimum size, reinforcing the idea that the maturity of beds in Portsmouth Harbour could be due to lower fishing pressure, allowing more individuals to grow above minimum size.

CPUE data for Manila clams in Portsmouth Harbour yielded some unexpected population changes, though there were no significant differences between any of the surveys. From Spring to Autumn 2018, there was a decrease in overall biomass. Although this was not a statistically significant difference, the decrease is unexpected, as it means that during the closed season when there is no fishing pressure, the population still declined. This would suggest that the main influence on the clam population is not the fishery, or that the decrease in the population during this period is simply caused by natural variation. Further surveying going forward will help to gain a better understanding of the population fluctuations observed here.

Autumn 2018 to Spring 2019 showed a small increase in Manila clam biomass, meaning that despite the fishery being open, the population was not impacted and in fact increased, though not by a significant amount. This again suggests that the existing fishing pressure is not having a significant influence upon the population, and that the population is healthy. From Spring 2018 to Spring 2019, a decrease in overall population is observed, though it is not statistically significant. More data will be needed to highlight the longer term trends in clam population in Portsmouth Harbour, however the slight decrease in population despite the introduction of the closed season could mean that the population is healthy enough that management will not have as large an impact but will more help to maintain its current state. The decrease could also mean that there is a slow decline in the clam population occurring, but it is just as likely that this small decline can be explained by natural variation.

4.3. Langstone Harbour

Langstone Harbour is the smallest bivalve management area of the Solent, both by geographical area and bivalve population. As with all management areas within the Solent, the main bivalve species fished for is the Manila clam, and of the beds included in the survey, beds 1 and 2 (Annex 2, Figure 6.5) are the primary fishing areas within the area.

Spring 2019 average size data for Manila clam in Langstone Harbour showed all beds to have clams on average above minimum size. This is a similar trend to that observed in Portsmouth Harbour, and likewise the population looks to be mature and in good health. Average weight data showed that biomass of clams over minimum size was much higher than the biomass of clams under minimum size, which supports the observation that this is a healthy population. Langstone Harbour is a small fishery, so it is likely to be less affected by the open season, which could explain why so many individuals above minimum size remain at the end of the open season in Spring 2019.

Langstone Harbour CPUE comparison between surveys mirrors the general trends found for Southampton Water. Although there were no significant changes in overall Manila clam population, a significant increase in the undersized section of the population was seen between Spring to Autumn 2018. Like Southampton Water, this could be an indication that the closed season has allowed for an overall repopulation of the stock, though predominantly in the part of the population comprised of undersized individuals.

Between Autumn 2018 to Spring 2019, there was very little change in biomass, meaning that the population remained virtually unchanged during the open season. This indicates that fishing pressures are not having much of an influence upon the clam population in Langstone Harbour, and in fact the population is able to remain virtually the same despite the fishery being open.

From Spring 2018 to Spring 2019 an increase in overall biomass was observed, though this was not significant. Clams under minimum size displayed a significant increase across this period however, which, like Southampton Water, could suggest that an increase in undersized clams is occurring due to the introduction of the closed season in 2018. This could also be due to heightened spatfall in the couple of years prior to the survey through natural variation or other external factors. Further surveying is required to observe any longer term trends in the Manila clam population in Langstone Harbour.

4.4. Cockle

Across all three areas sampled, the average size data for the common cockle shows populations dominated by individuals at or above the minimum size. Although this needs to be considered alongside the fact that the dredge will not retain all individuals under the minimum size it is still worth noting that a similar pattern is seen across the majority of beds in all three areas. The common cockle is occasionally fished as the dominant species but is more often retained as a secondary species with the Manila clam being the target, therefore fishing activity is likely to target areas more favourable for the Manila clam than the common cockle. This may therefore result in a lower overall fishing pressure on the common cockle in the Solent, allowing a greater size range to be maintained as fewer larger individuals are being removed.

4.5. American Hard-Shelled Clam

It is difficult to determine a pattern of data for the American Hard-Shelled clam as the quantity of individuals obtained is low. Across all beds sampled in all three areas, the average size for this species is below the minimum size (63mm). This species is also occasionally targeted as

a main species by the fishing fleet, particularly when prices are higher, however it is still not targeted at the same effort level as the Manila clam, therefore impacts from the fishing fleet are likely to be lower. The small average size across all areas sampled however indicates that some factor may be having an impact on the population but there is not enough data to determine whether fishing activity is contributing to the pattern seen. In order to properly assess the population of American Hard-Shelled clam, either a more specialised catch method for American Hard-Shelled needs to be developed, or a higher frequency of surveys needs to be conducted to obtain more samples. As it stands, catches are too low to draw conclusions, apart from that of the few individuals caught, most are under minimum size.

5. References

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6. Annex

6.1. Annex 1

Table 1 - A summary of Spring 2019 catch data for Manila clam, cockle and American Hard-Shelled clam found in Southampton Water.

Summary of Measurement Data - Manila Clam

Bed ID	Manila Clam				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1	225	41.00	21	31.67	3.26
2	339	42	23	32.3356890459364	2.88
3	280	45	20	31.6857142857143	3.09
4	499	38	22	31.362676056338	2.98
5+6	112	46	16	32.9375	4.76
7	4	38	34	35.5	1.73
8	92	49	30	38.7826086956522	4.46
10	516	43	21	33.1712962962963	3.66
11	16	37	18	28.625	5.68
12	427	48	22	33.9358490566038	4.02
13	19	36	24	31.2105263157895	3.1
Total Measured	2510				

Summary of Measurement Data - Cockle

Bed ID	Cockle				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1	414	35.00	17	26.15	2.51
2	367	33	15	25.2905660377359	2.32
3	6	24	17	21	2.89827534923789
4	13	26.00	21	23.7692307692308	1.30
5+6	16	32	25	28.38	2.09
7	10	31	23	27.8	2.57
8	142	35	19	28.3521126760563	3.11
10	631	39	18	27.4049079754601	2.88
11	6	31	24	27.3333333333333	2.58
12	1343	35	20	28.07	2.58
13	92	36	14	25.9673913043478	3.06504965435469
Total Measured	2948				

Summary of Measurement Data - American Hard-Shelled clam

Bed ID	Mercenaria				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1	3	48.00	25	38.67	12.10
2	1	33	33	33	0.00
3	0	0	0	0	0
4	1	37	37	37	0
5+6	2	33	32	32.50	0.71
7	1	50	50	50	0.00
8	2	69	26	47.5	30.41
10	8	69	28	46.125	15.82
11	8	73	29	55.875	14.90
12	3	58.00	31	46.6666666666667	14.0118997046558
13	0	0	0	0	0
Total Measured	29				

Table 2 - A summary of Spring 2019 catch data for Manila clam, cockle and American Hard-Shelled clam found in Portsmouth Harbour.

Summary of Measurement Data - Manila Clam

Bed ID	Manila Clam				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1-3	6	54	33	43.50	7.15
4	90	56	23	35.9666666666667	5.72
5	167	56	22	34.5269461077844	4.96
6	234	58	18	32.3376068376068	5.38
7	64	48	23	36.859375	5.34
8	21	51	36	42.6666666666667	4.65
9	29	47	25	38.86	4.52
Total Measured	561				

Summary of Measurement Data - Cockle

Bed ID	Cockle				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1-3	64	37	19	26.97	3.75
4	342	37	21	26.6637554585153	2.96
5	225	37	20	26.2142857142857	2.98
6	2393	40	20	26.39	2.76
7	299	41	20	29.5714285714286	3.89
8	44	45	21	29.5454545454545	4.78
9	124	42	13	27.741935483871	6.05
Total Measured	3323				

Summary of Measurement Data - American Hard-Shelled clam

Bed ID	Mercenaria				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1-3	4	66	52	58.25	6.13
4	2	52	36	44	11.31
5	2	85	30	57.5	38.89
6	1	31	31	31	0.00
7	16	29	65	41.38	11.52
8	18	72	27	44.9444444444444	12.790033906142
9	7	117	52	84.2857142857143	30.9877087768376
Total Measured	25				

Table 3 - A summary of Spring 2019 catch data for Manila clam, cockle and American Hard-Shelled clam found in Langstone Harbour.

Summary of Measurement Data - Manila Clam					
Bed ID	Manila Clam				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1	65	49.00	25.00	36.20	5.06
2	50	49	29	38.82	5.60499048771244
3	19	60	29	42.6315789473684	7.71874001171312
4	6	47	32	40.1666666666667	6.27428614797466
5	29	62	31	39.1034482758621	6.22405946759489
6	6	63	30	41.6666666666667	12.4846572506684
Total Measured	140				

Summary of Measurement Data - Cockle					
Bed ID	Cockle				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1	342	36	20	27.04	2.78
2	93	35	22	29.5806451612903	3.39219878879775
3	76	43	20	28.7236842105263	4.95741514423401
4	15	40	27	33.7333333333333	3.75055551440939
5	129	39	21	28.9612403100775	3.4401196853616
6	21	39	21	31	3.89871773792359
Total Measured	526				

Summary of Measurement Data - American Hard-Shelled clam					
Bed ID	Mercenaria				
	Total Number	Largest (mm)	Smallest (mm)	Average (mm)	Standard Deviation
1	19	51.00	29.00	42.53	6.85
2	0	0	0	0	0.00
3	6	78	27	48.5	17.0499266860594
4	3	70	34	47	19.97
5	3	78	50	63	14.1067359796659
6	3	74	28	44.6666666666667	25.4820198048219
Total Measured	28				

6.2. Annex 2

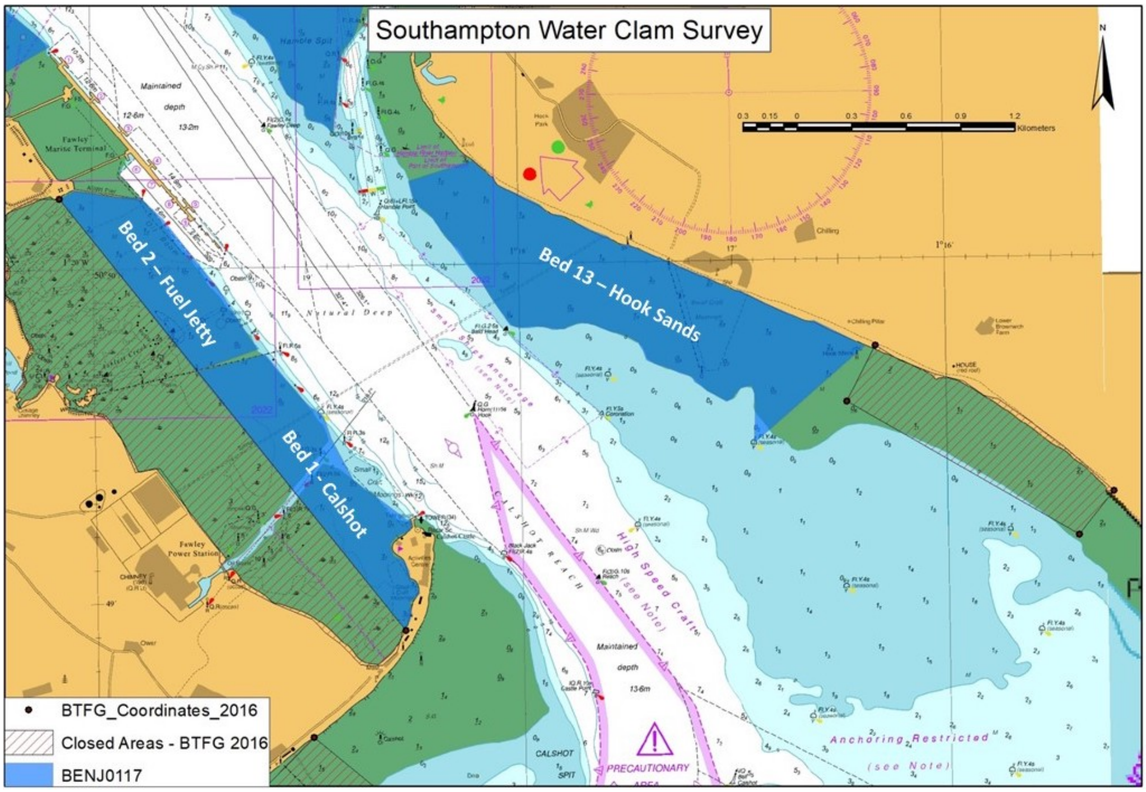

Figure 6.1 - A map detailing the location of surveyed beds 1, 2 and 13 of Southampton Water.

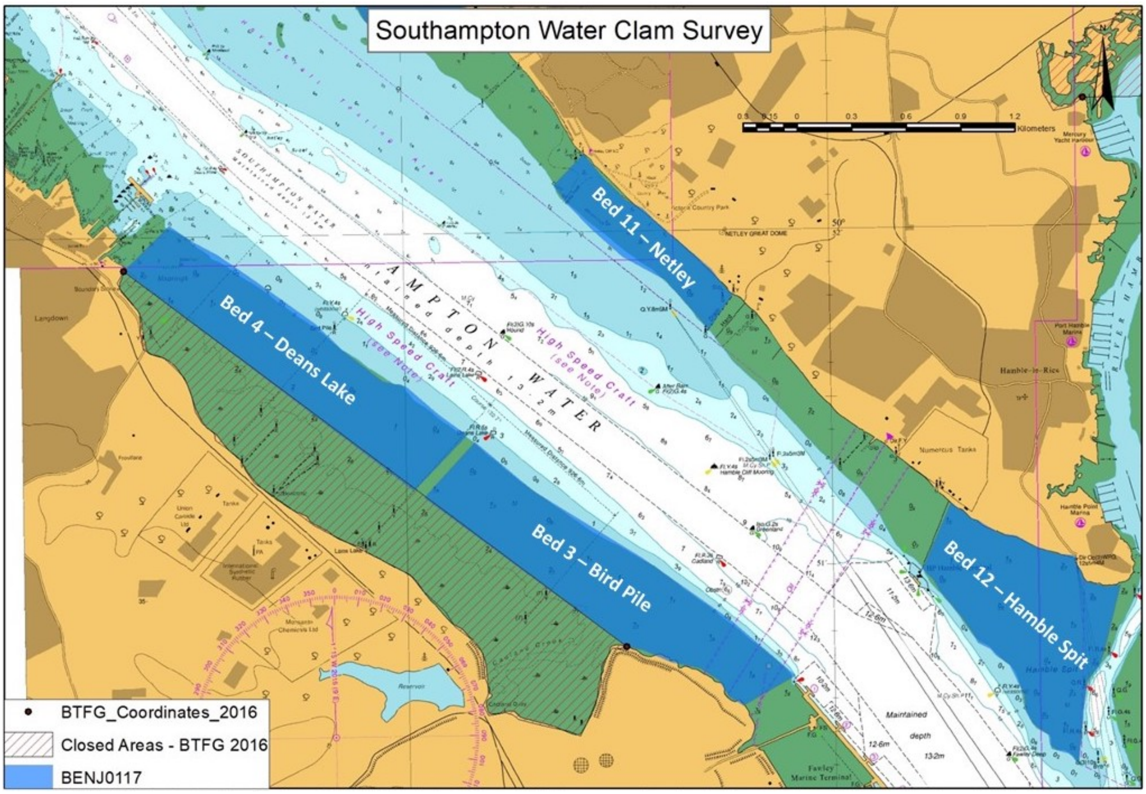

Figure 6.2 - A map detailing the location of surveyed beds 3, 4, 11 and 12 of Southampton Water.

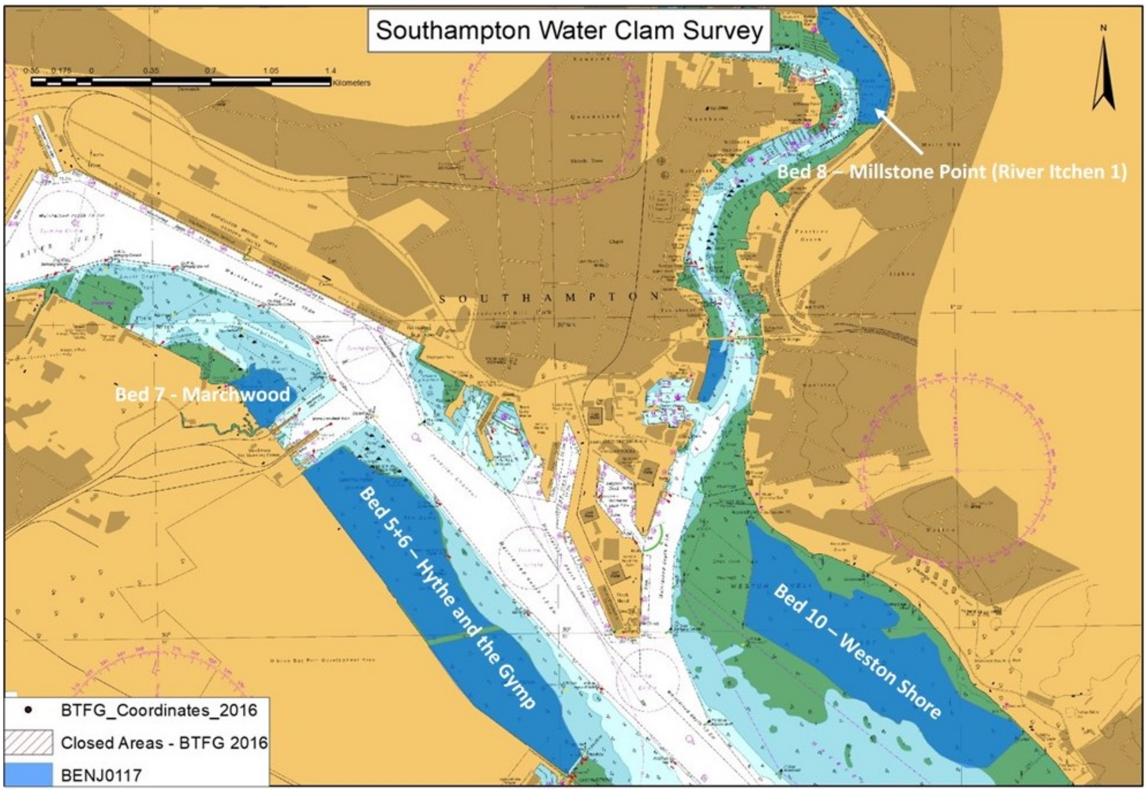

Figure 6.3 - A map detailing the location of surveyed beds 5+6, 7 and 10 of Southampton Water.

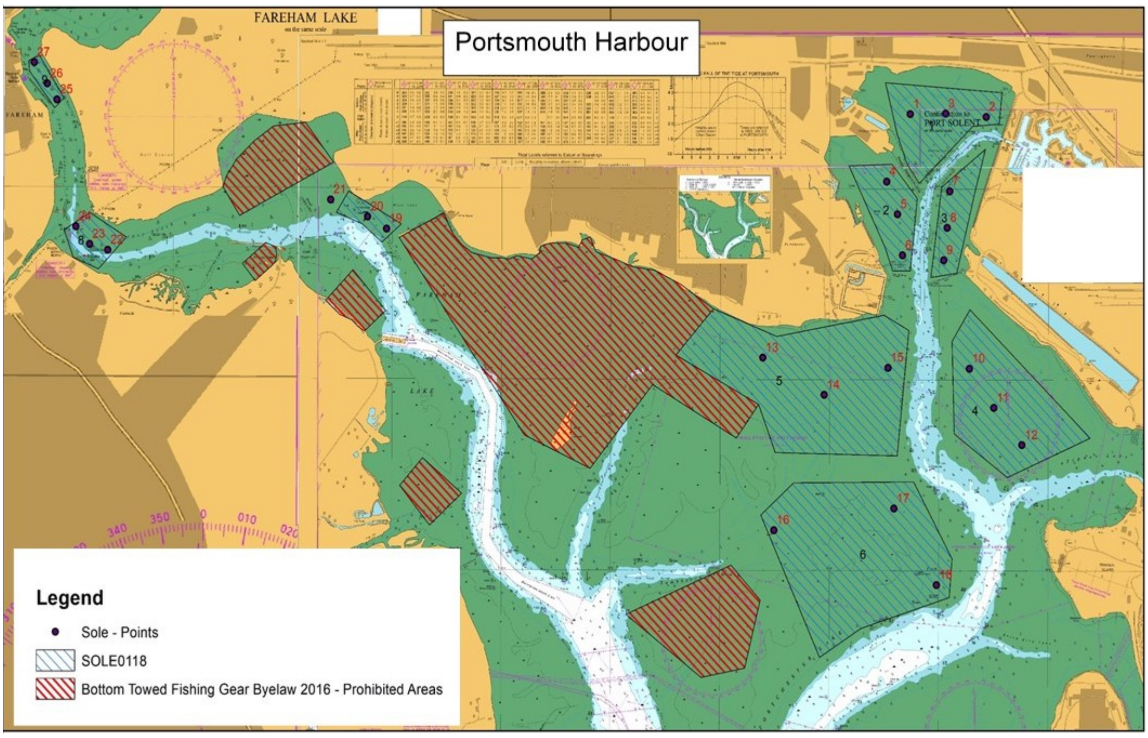

Figure 6.4 - A map detailing the location of the surveyed beds of Portsmouth Harbour.

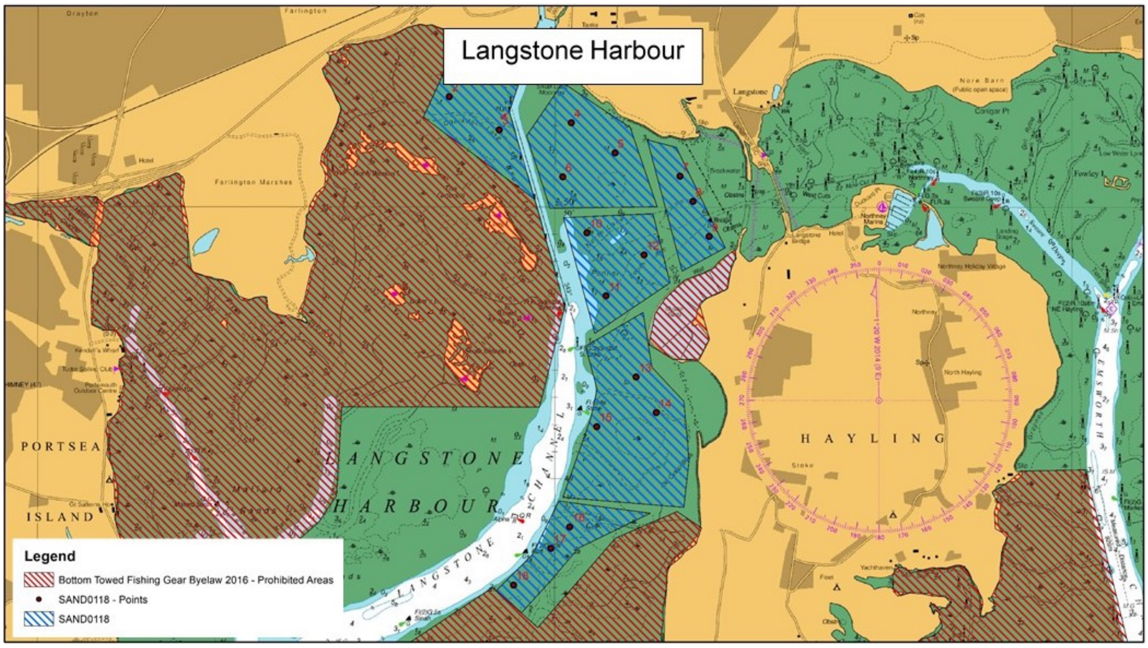

Figure 6.5 - A map detailing the location of the surveyed beds of Langstone Harbour.