Southern IFCA Poole Harbour Bivalve Survey- 2023

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1. Introduction

This report provides details of the 2023 Poole Harbour Bivalve Survey, which is conducted annually for the purpose of monitoring commercially viable shellfish beds within Poole Harbour, UK. The survey began in 2015 and outputs are used as baseline against which to monitor trends in stock levels and potential changes in the population of commercial bivalve species, to support Southern IFCA's management decisions and aid in the evaluation of the sustainability of the Poole Harbour Dredge Fishery.

The survey evaluates length frequency data and Catch per Unit Effort (CPUE) data from 27 commercially fished shellfish beds within Poole Harbour (see Section 1.5) from 11 catch zones. The survey focuses on the primarily commercially harvested species, the common cockle (*Cerastoderma edule)* and Manila clam (*Ruditapes philippinarum)* (length frequency and CPUE), with length frequency information only collected for other bivalve species.

1.1 The fishery

Shellfish dredging in Poole Harbour originated using hand-ranking techniques to gather cockles. This was followed by the introduction of Manila clams in the 1980s, with the intention of establishing commercial aquaculture. The fishery transferred to the use of mechanical dredging as infrastructure advanced, which lead to the development of the pump-scoop dredge, which is currently seen in the modern-day fishery (*Figure 1)*. The Manila clam and common cockle are the primary species harvested however, American Hard-Shelled clams (*Mercenaria mercenaria*) and the native clam (*Ruditapes decussatus*) are also harvested in smaller quantities.

Figure 1. An example of the pump-scoop dredge which is used within the modern-day Poole Harbour Dredge Fishery to fish for clam and cockle species.

The Poole Harbour clam and cockle fishery was awarded dual certification under the Marine Stewardship Council's Sustainability Standard and the Seafish Responsible Fishing Scheme in 2018. The fishery runs from 25th May to 23rd December annually.

1.2 Pump-Scoop Dredge

The pump-scoop dredge was engineered to minimise ecological damage while maximising efficiency. Water jets are pressured towards the back of the dredge basket, directing sediment movement through the mechanical dredge basket. Dredge type and construction are restricted under the permit conditions of the Poole Harbour Dredge Permit Byelaw. The horsepower of the dredge may not exceed 15 and the basket size may not exceed 460mm in width by 460mm in depth by 300mm high (excluding poles or attachments). Dredge bars must have no less than 18mm between them and cross pieces used to strengthen the dredge basked must have a minimum spare of 40mm between them. Dredges must have a mandatory riddle (secondary sorting system) bar spacing of 18mm for sorting shellfish to ensure harvested stock is above the MCRS. Figure 2 shows an example pump-scoop-dredge.

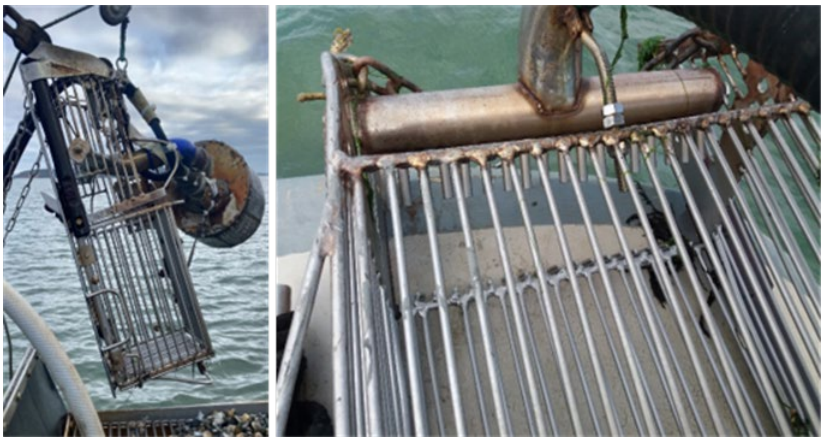

Figure 2. An example of the pump-scoop dredge used within the Poole Harbour Dredge fishery.

1.3 Manila clam *(Ruditapes philippinarum)*

The Manila clam (*Figure 3*) was introduced to Poole Harbour in 1988 for the purpose of aquaculture and became a self-sustaining population (Jensen *et al.,* 2004; Jensen *et al.,* 2005; Humphreys *et al.,* 2007). Manila clams inhabit muddy and fine sediments in the intertidal zone and shallows (Jensen *et al.,* 2005). They dwell in the top 40mm of the substratum, but can bury as deep as 100mm, and filter phytoplankton and sedimentary organic matter from the water (Lee, 1966; Dang *et al.,* 2009).

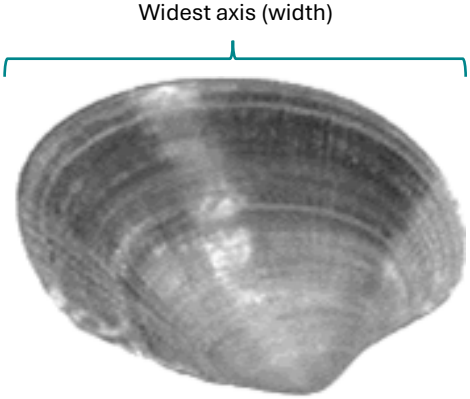

Figure 3. A diagram of the Manila clam. The widest point (width) was used to obtain length data within the Poole Bivalve Survey 2023.

Poole Harbour provides a relatively sheltered, nutrient rich, shallow water habitat with extensive intertidal mud flats, and temperatures up to 27°C in the summer. This provides optimum reproductive conditions for the species (Toba and Miyama, 1995; Jensen *et al.,* 2004; Jensen *et al.,* 2005; Chung *et al.,* 2005; Humphreys *et al.,* 2007).

In Poole Harbour the Manila clam spawning season occurs from July to September (Grisley, 2003; Jensen *et al.,* 2005; Tumnoi, 2012). Water temperature between 8°C and 27°C provides suitable conditions for larval development (Chung *et al.,* 2005; Drummond *et al.* 2006; Moura *et al.,* 2018). Below this threshold Manila clams are thought to be sexually inactive. In Poole Harbour Manila clam are capable of spawning more than once throughout the summer depending on environmental conditions with peak activity in September (Humphreys *et al.,* 2007; Jensen *et al.,* 2004;). In Poole Harbour juveniles grow up to 20 mm in their first 24 months (Jensen *et al.,* 2004). The rate of growth then reduces once individuals have reached sexual maturity.

1.4 Common cockle *(Cerastoderma edule)*

The common cockle (*Figure 4*) is commonly found to inhabit sandy bays and estuaries throughout the Southern IFCA District. Individuals burrow up to 50mm below the surface of sandy and fine gravel seabed from middle to lower intertidal zones. Cockles grow to up to 38mm for males, 20mm for females and are known for their distinct shell with 22-28 ribs. In the UK, spawning occurs between March and August (Seed and Brown, 1977; Newell & Bayne 1980), gametogenesis is initiated in the previous winter months (October to March).

Growth rate decreases with increasing tidal height, due to lack of immersion time and limited food availability and opportunity (Richardson *et al.,* 1980; Jensen, 1993; Montaudouin & Bachelet, 1996; Montaudouin, 1996). Similarly, in winter months, metabolic rate is slowed due to decreasing temperatures and cockles' inability to acclimatise. Cockles are filter feeders and individuals have the capability to filter half a litre of water per hour. The cockle fishery within Poole Harbour has commercial importance and populations densities of up to 10,000 per square metre have been recorded.

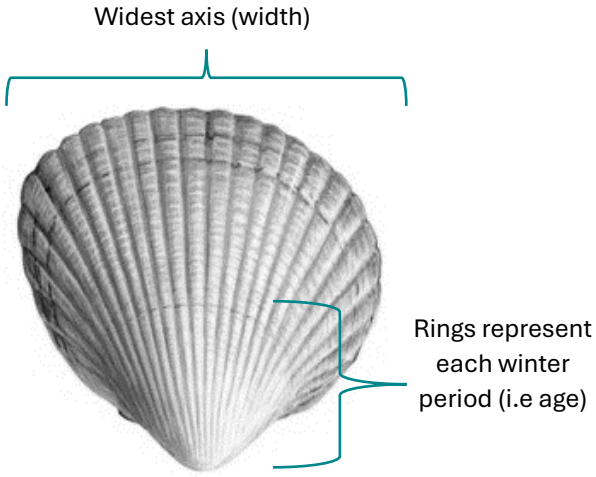

Figure 4. A diagram of the common cockle. Dark rings represent the number of wintering months which is used to decipher age. The widest axis (length) is highlighted, which was used to obtain length frequency data within the Poole Bivalve Survey 2023.

1.5 Southern IFCA Management

The fishery is managed under the Poole Harbour Dredge Permit Byelaw 2015[1] The byelaw manages the direct use of the pump-scoop dredge through a permit system, with up to 45 permits issued each year, where the permit is required to use the pump-scoop dredge equipment within Poole Harbour. The byelaw regulates a number of elements of the fishing operation including:

- Gear types, construction and restrictions
- Spatial and temporal restrictions
- Catch restrictions
- Reporting

As part of catch reporting requirements, fishers must submit a monthly catch return indicating, for each day fished, the hours fished, the quantities of species caught and the buyer(s). Fishers must also indicate which of 11 catch zones the catch has come from to allow for catch data to be related to the annual stock survey.

The fishery is located within the boundaries of the Poole Harbour Special Protection Area (SPA), Site of Special Scientific Interest (SSSI) and Ramsar Site, the Southern IFCA undertakes a Habitats Regulations Assessment to ensure that in permitting this fishery, Southern IFCA are operating in line with their legal duties under relevant legislations and there is no adverse effect on the SPA, SSSI or Ramsar Site from the fishery[2].

2 Methodology

The survey took place between 18th – 20th March 2023 and used local fishing vessel, FV Marnie George. A pump-scoop dredge was used in line with normal fishing practice and management measures (see Section 1.5).

The pump-scoop dredge is inherently size selective as fishers want to reduce the amount of post-capture measuring required to ensure compliance with MCRS. It is recognised therefore that the survey methodology will not fully sample the population below MCRS, although every effort is made to capture all shellfish from the dredge before it passes through the riddle. However, the sampling is carried out the same way each year therefore whilst the samples are not fully representative of the below MCRS part of the population there is the ability to make comparisons between years for under MCRS CPUE and length frequency due to the consistency in methodology. Please note, Site 2 was not sampled due to tidal constraints, therefore, for the 2023 survey, 26 shellfish beds were sampled.

The following methodology was followed:

1. Three dredge tows were conducted within a radius of 20m from a predetermined central point of each site. This central point is consistent across all survey years (*Table 1*).
2. After 2 minutes the dredge was brought inboard and bivalves were retained and labelled to the corresponding site and dredge tow (e.g. Site 1 Dredge 1).

[1] Poole-Harbourr-Dredge-Permit-Byelaw.pdf
[2] Poole Harbour HRA 2023-2024 season

3. Each species was identified, and the first 50 individuals were measured at their widest axis to the nearest millimetre (please refer to Figure 3 and Figure 4, which illustrates the measurement parameters).
4. Manila clams and common cockles were separated into above and below their relative Minimum Conservation Reference Size (MCRS) (35mm and 23.8mm respectively) and weighed.
5. Following measurement, all samples were returned to shellfish production areas within the same classification.

Table 1 identifies the sites surveyed within the Poole Harbour Dredge survey 2023 and their corresponding shellfish catch zones and reference points.

Site Number	Site Name	Zone	Latitude		Longitude	
1	Middle Ground	1	50	42.147	1	57.205
2	Whitley Lake	2	50	41.875	1	56.337
3	Aunt Betty	1	50	41.959	1	57.813
4	Blood Alley	3	50	40.900	1	58.023
5	Jerry's Point	3	50	40.498	1	57.717
6	Brands Bay South	4	50	40.040	1	58.569
7	Brands Bay West	4	50	40.362	1	58.837
8	Furzey Island	8	50	41.110	1	59.384
10	Newtons Bay	5	50	40.286	1	59.671
11	Ower Bay	6	50	40.617	2	00.282
11(2)	Wards	8	50	40.943	2	00.272
12	Round Island	8	50	41.027	2	01.053
13	Wych and Middlebere Lake	7	50	40.804	2	01.653
14	Long Island	8	50	41.457	2	00.803
15	Arne	9	50	41.914	2	01.425
15(2)	Inner Arne	9	50	42.006	2	01.621
16	Patchins Point	1	50	42.224	2	01.180
17	Giggers	11	50	41.575	2	03.996
18	Keysworth	11	50	42.175	2	03.894
18(2)	Inner Keysworth	11	50	42.215	2	04.181
19	Holton Mere	10	50	42.499	2	03.488
19(2)	Inner Holton Mere	10	50	42.629	2	03.965
20	Seagull	10	50	42.660	2	02.964
21	Rockley Spit	10	50	42.931	2	02.501
22	Hamworthy	1	50	42.494	2	00.437
23	Upton Lake	HB	50	43.546	2	00.267
24	Creekmore Lake	HB	50	43.610	1	59.738

3 Results

Results focus on the predominant commercial species within the harbour, Manila clam and common cockle. Other species found during the survey and harvested at a smaller scale include American Hard-Shelled clam *(Mercenaria mercenaria*), the Native *clam (Ruditapes decussatus*), the native oyster (Ostrea edulis), the Pacific oyster *(Magallana gigas*), the spiny cockle (*Acanthocardia aculeata)* and the blue mussel (*Mytilus edulis)*.

Length frequency data was analysed in reference to site, whereas Catch Per Unit Effort Data was applied to the 11 shellfish catch reporting zones under the Poole Harbour Dredge Permit Byelaw (Figure 5). Length frequency data and Catch Per Unit Effort Data (CPUE) were examined using Excel and R Studio. CPUE was determined using the weight data while factoring the size of the dredge and length of tows. Units of CPUE are kilograms per metre of dredge per hour (kg/m/hr).

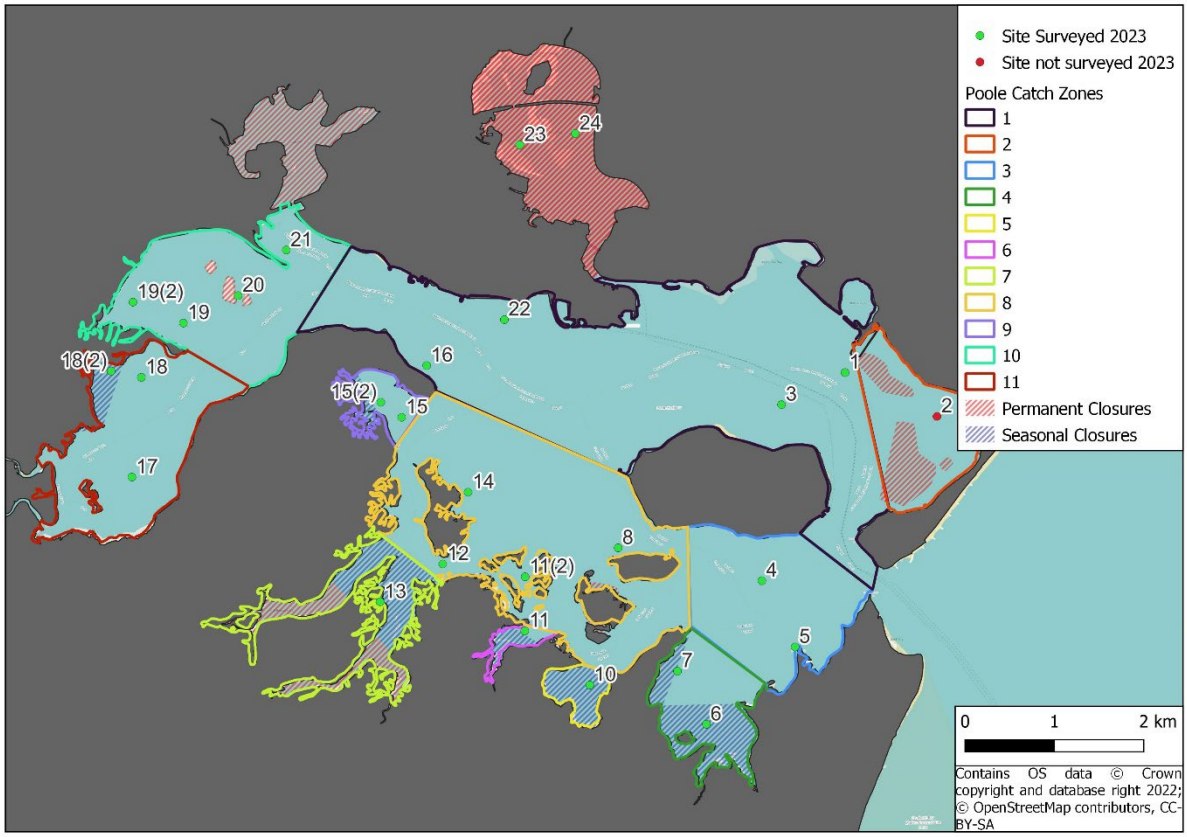

Figure 5. A visual representation of the sites within the Poole Harbour Bivalve Survey 2023. Sites are located with 11 shellfish catch zones. Sites are categorised as green (surveyed) or red (not surveyed). Seasonal and permanent closures included within the fishery byelaw have also been included.

3.1 Length Frequency Data

The average length (mm) of Manila clam and common cockle across three dredges per site are shown in (*Figure 6 A and B)*.

3.1.1 Manila Clam

- The average length of Manila clam varied from 49mm at Site 4 (n=7) to 33mm at Site 19(2) (n=150).
- All sites had an average width above the MCRS length, except Sites 19 and 19(2), both averaging just below the MCRS at 34.9mm and 33.1mm respectively.

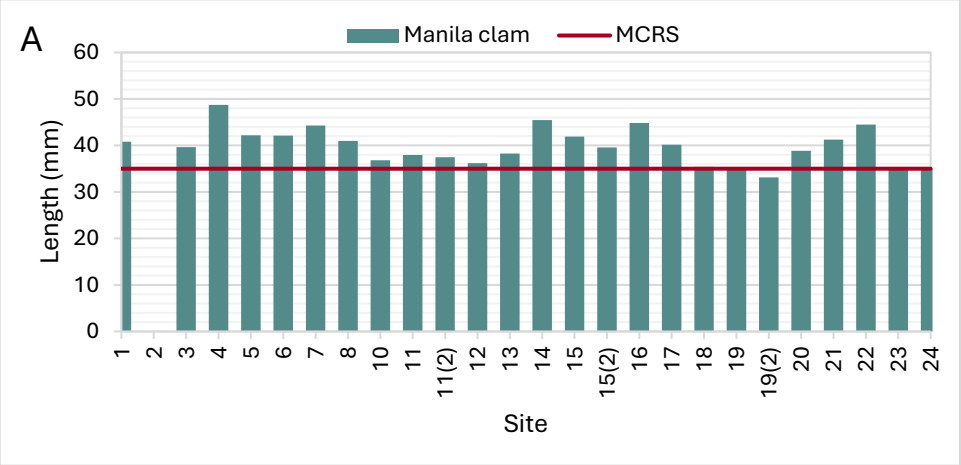

Fig 6A The average length of Manila clam (A) in each of the surveyed sites in the Poole Harbour Dredge Bivalve Survey 2023. The corresponding minimum conservation references size (MCRS) is represented as a red line to provide comparison (35mm).

3.1.2 Common cockle

- The average length of cockle varied from 38mm at Site 4 (n=96) to 22mm at Site 19(2) (n=94).
- All sites had an average width above the MCRS length, except site 19(2).

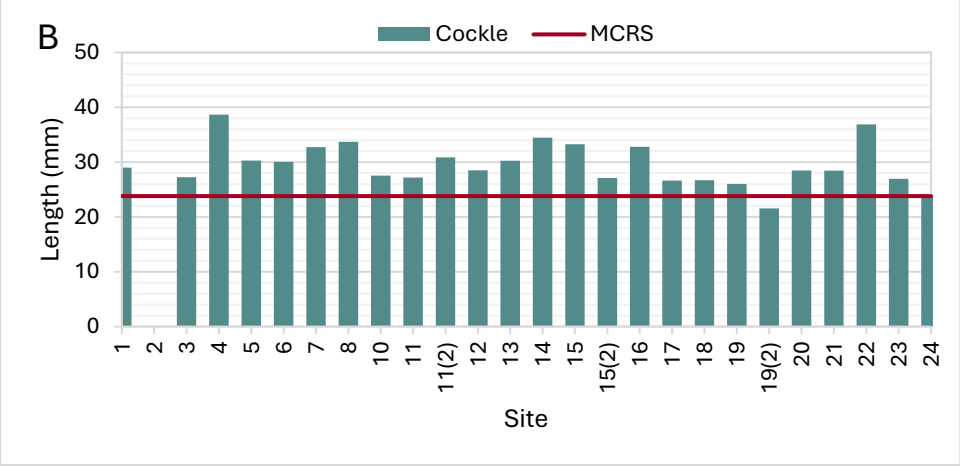

Figure 6B. The average length of common cockle in each of the surveyed sites in the Poole Harbour Dredge Bivalve Survey 2023. The corresponding minimum conservation references size (MCRS) is represented as a red line to provide comparison (23.8mm).

3.2 Catch Per Unit Effort (CPUE)

CPUE above and below the MCRS for Manila clam and common cockle are shown in Figure 7A and B respectively. Data has been analysed for 2023 and also in comparison to data from the previous two surveys, 2022 and 2021. Statistical analyses were performed using a non-parametric Kruskal-Wallis test with subsequent Dunn's test.

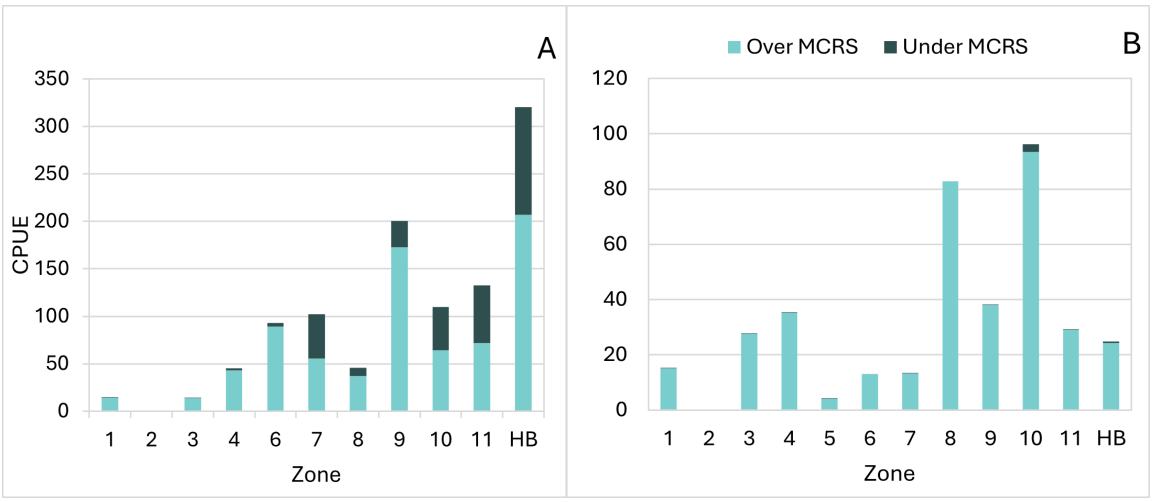

Fig 7 A and B. The Catch Per Unit Effort for Manila clam (A) and common cockle (B) per site surveyed within the Poole Harbour Survey 2023. Bars represented total CPUE which is also divided into above and below MCRS CPUE (light and dark blue representatively). Note that Site 2 was not surveyed.

3.2.1 Manila Clam

- For the 2023 survey, Holes Bay and zones 9 and 5 showed the highest average CPUE (above and below MCRS combined). The values were 207.02, 200.45 and 159.50 kg/m/hr, respectively.
- These sites also showed the highest above MCRS CPUE values at 207.02,172.79 and 107.42 km/m/hr respectively.
- All zones had a greater CPUE above MCRS than below MCRS. Holes Bay showed the greatest CPUE below MCRS at 113.27 kg/m/hr.
- Statistical comparison of the 2023 dataset showed a significant difference in the total CPUE between zones ($p<0.05$). Post-hoc testing revealed that total CPUE in zone 1 was significantly lower than zone 10, zone 11 and Holes Bay ($p<0.05$). There was also a significant difference between zone 3 and zone 10. There were no significant differences between the CPUE above or below MCRS between zones ($p>0.05$).
- Statistical comparisons between the last three survey years for each zone (2021-2023) showed no significant difference between the total CPUE of each zone compared between the 3 years ($p>0.05$) *(Figure 8)*.
- CPUE above and below MCRS also showed no significant difference between years ($p>0.05$). This suggests that over the last 3 surveys, the Manila clam CPUE has remained stable.

3.2.2 Common cockle

- For the 2023 survey, zones 10, 8 and 9 showed the highest average CPUE (above and below MCRS combined). The values were 95.05, 78.87 and 38.24 kg/m/hr respectively.
- These sites also showed the highest above MCRS CPUE values at 93.38, 82.73 and 37.98 kg/m/hr dredge per hour respectively. Zone 10 also showed the highest average under MCRS CPUE of 2.84 kg/m/hr dredge per hour.
- Statistical comparison between zones showed no significant differences in the total CPUE for the 2023 dataset. There was also no significant difference between zones in CPUE of under MCRS or above MCRS ($p>0.05$).
- Statistical comparisons between the last three survey years for each zone (2021-2023) showed significant results only for zones 8 and 10.
- Analysis of average total CPUE of common cockle in Zone 10 showed no significant differences between the 2022 and 2023 datasets ($p>0.05$), however, both had a significant increase in CPUE from the 2021 dataset ($p<0.05$).
- The average CPUE for above MCRS in zone 10 showed significant difference between years. Post-hoc testing showed the CPUE was significantly higher in 2022 and 2023 surveys compared to 2021 (both p values were under the 0.05 significance level). However, comparison between 2022 and 2023 showed no significant difference in CPUE of cockles above MCRS.
- Zone 10 showed significant a difference in average CPUE of cockles under MCRS, between years, however there was not enough variation between data for the years compared to variation within each year therefore the difference could not be detected in post-hoc testing.
- Average CPUE under MCRS in zone 8 showed significant difference between years ($p<0.05$), however post-hoc testing was unable to determine any differences as above.
- For these comparisons in Zone 10, visually the data shows a higher total CPUE and CPUE above MCRS in 2023 compared to 2022 and 2021 and the below MCRS is higher in 2022 and 2023 than in 2021.

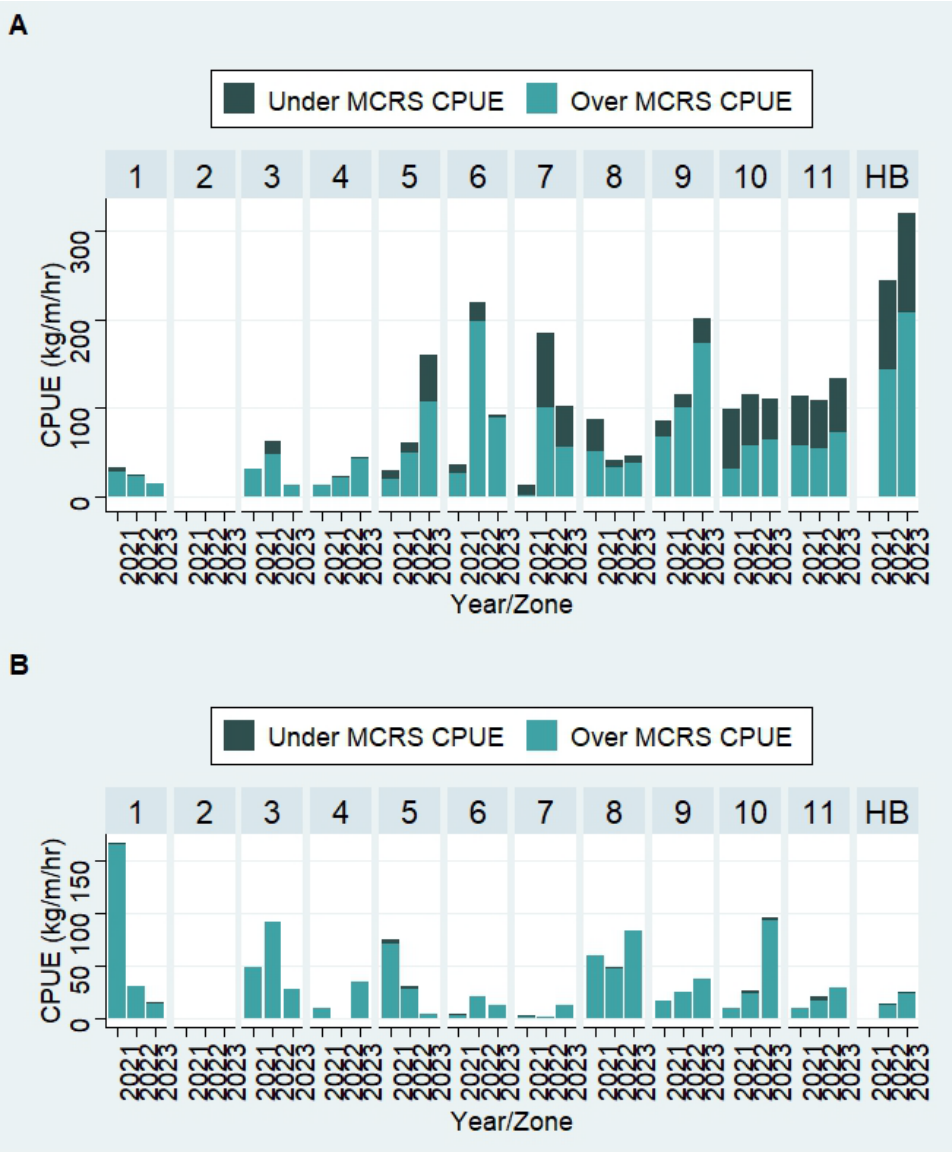

Figure 8. Catch per Unit Effort expressed as kg of shellfish per metre of dredge per hour for Manila clam (A) and common cockle (B). Dark blue bars represent CPUE under the MCRS for Manila clam and common cockle (35mm and 23.8mm respectively), and light blue bars represent the CPUE above the MCRS. Data has been grouped into the classified shellfish bed zones 1-11 and Holes Bay (HB) and shows the most recent three years of the survey (2021-2023).

4 Catch Data

Quantities of Manila clam and common cockle caught each month by the fishery for the 2020, 2021 and 2022 fishing seasons are shown in Figure 9 A and B, respectively. The fishing season runs from 25th May to 23rd December each year.

4.1 Manila clam

- The total landings over the season increased from 354.36 tonnes in 2020 to 492.02 tonnes in 2021, however this declined in 2022 to 337.32 tonnes. Statistical analysis showed no significant difference in the total landings of Manila clam between 2020-2022 ($p>0.05$).

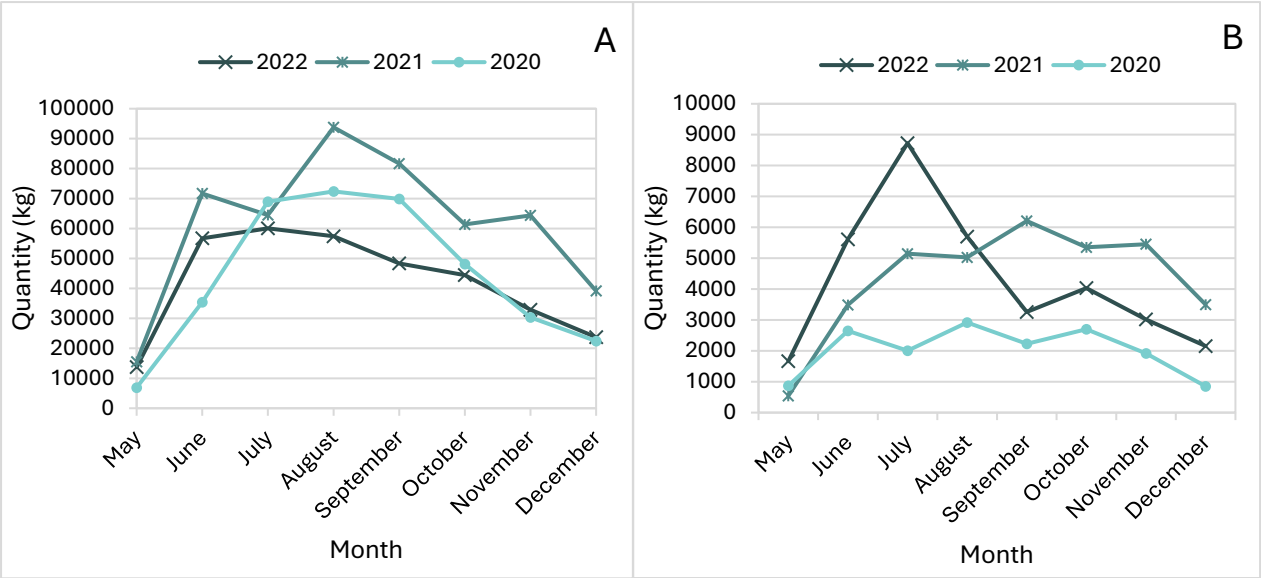

Figure 9 A and B. The monthly total catch (kg) of Manila clam submitted in catch returns from permits of the Poole Harbour Dredge Fishery for the 2022, 2021 and 2020 seasons.

- The peak landed catch for the 2022 season was at 6,055kg in July (Figure 9A). This follow trends from previous years which show peak landings during mid-summer months before steadily declining towards the end of the season in December.

4.2 Common cockle

- Statistical analysis showed a significant difference in landings between years ($p<0.05$) but post-hoc testing was not able to identify the changes.
- Analysis of raw landings data showed an increase in total catch from 16.12 tonne in 2020 to 34.16 tonne in 2022 (Figure 9B). There was a large increase in landings between 2020 and 2021 with catches stabilising during 2022 for the second half of the season but showing a large peak in landings for July of 2022, at 8,725kg.
- The monthly average quantity of cockles landed increased from 2016.13kg in 2020 to 4270.19kg in 2022. However, statistical analysis showed there was no significant difference in the monthly average landed between 2020-2022 ($p>0.05$).
- Trends follow previous years which show a peak in landings during mid-summer months before steady declining into the final seasons in December.

4.3 Comparison of catch data classified by zones

Since 2019, fishers have been required to report which fishing zones have been fished each day (figure 10 A and B). This provides zonal application to catch data.

4.3.1 Manila clam

- Zones 8, 10 and 11 have been consistently favourable for fishing between the last three years.

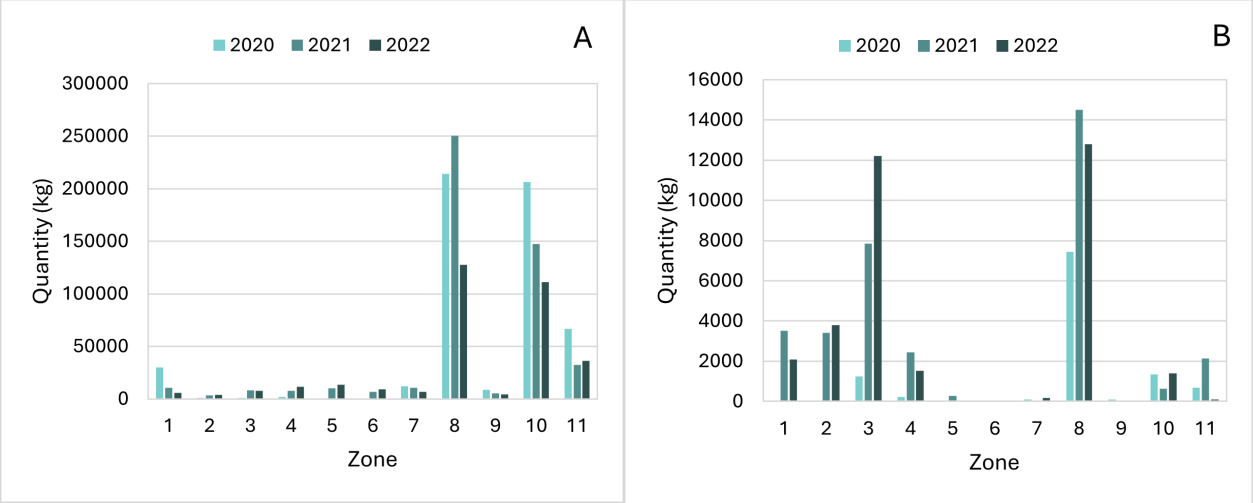

Figure 10 A and B. Landings of Manila clam (A) and common cockle (B) between 2020-2022. Information was gathered by submitted catch returned form the Poole Harbour Dredge Fishery. Zonal distribution of catch has been categorised.

- Quantities have slightly declined in zones 8 and 10 since 2021, but statistical analysis showed no significant difference between zonal catch data for Manila clams between 2020-2022 ($p>0.05$).

4.3.2 Common cockle

- Increasing catch data has been recorded in Blood Alley (zone 3) since 2020. zones 3 and 8 have been consistently favourable fishing grounds between 2020-2022.
- Statistical analysis showed no significant in zonal catch data for the common cockle between years ($p>0.05$).

5 Discussion

CPUE & Catch Data

- Quantifying CPUE from survey results and quantifying landings data provided by fishers allows the results to be analysed against level of fishing. This applied to the 11 catch zones, introduced since 2019, allows identification of any zonal changes which could be used to inform management.
- High output CPUE values compliment favourable fishing grounds for each species and similarly reflects the environmental stimuli driving habitation for both species. High CPUE of Manila clam are seen in muddy and fine-grounded sedimental areas of Arne, Inner Keysworth and Holton Mere, whereas high CPUE of cockles are found in sandy and coarse sediments displayed in sites such as Round Island, Seagull Island and Keysworth.
- Consistent landings data and no significant difference in CPUE suggest Manila clam stocks have been stable within the last 3 years.
- The statistical differences observed in total CPUE between zones with Zones 1 and 3 showing lower total CPUE than a selection of other zones is likely related to habitat type. Both Zones 1 & 3 are comprised of sandier, coarser sediments compared to the zones which showed a significantly higher total CPUE (10, 11 and Holes Bay) which are

comprised of muddier sediments, aligned with the preferred habitat type for Manila clam.

- Sites 23 and 24 in Holes Bay display high CPUE for Maila clams. The combination of a permanent fishing closure within Holes Bay since 2015, alongside preferred conditions for Manila clam growth, may result in a high reproduction rate with little to no removal.
- Zone 10 displayed an increase in CPUE of common cockle between 2021 and 2023 however stocks have stabilised since 2022.
- Although the quantity of landings of cockle has decreased slightly since 2020, statistical analysis showed no significant difference in landings catch data or CPUE data for the survey over the 3 years. This suggests that the fishing levels and stocks have remained stable.
- The quantities of cockle landed each season are consistently lower than Manila clam landings. This is due to market preferences and economic value of each species where Manila clam is the favoured species.

Length Frequency

- All sites showed the average width of Manila clam above the MCRS of 35mm, with exception to Sites 19 and 19(2) at Holton Mere. These two sites fall within catch Zone 10, which is one of the preferred fishing ground for clam dredging. Smaller sizes within Site 19 and Site 19(2) may be as a result of a slight increase in fishing pressure to Manila clams within zone 10 during the 2022 season. Similarly, the period between the fishing season and the survey taking place is likely to be subject to temperatures below that for optimal growth. Therefore, by the opening of the fishery on 25th May, sizes are expected to increase.
- Average length data also shows all sites, with the exception of site 19(2), above the MCRS for common cockle. There is less fishing effort in this area for cockle so it is likely that environmental variables may be causing the pattern seen here for the below MCRS average size.
- Similarly, the sampling method and the manner in which these species grow are likely to influence the differences in patterns in average size between the Manila clam and common cockle compared to their respective landing sizes seen this study. While the majority of the cockle population were above the MCRS for the species, the Manila clam sample populations was more varied in size.
- Previous zonal observations have showed that Manila clam grow differently depending on the region it inhabits within the Harbour; some individuals are seen to grow along the widest axis and remain thin, whereas other subpopulations grow in depth but remain narrow in length. Therefore, thicker Manila clams will be retained by the dredge regardless of if the length is above or below the MCRS. In contradiction, cockles are seen to grow more equally throughout their structure, meaning less undersized individuals are unintentionally caught in the dredge. This, alongside potential impacts from the differences in fishing pressures between species may therefore affect the species' relative size distributions. Therefore, a higher proportion of undersize Manila clams can be seen in the CPUE outputs.
- Sites in Holes Bay show a lower average size compared to other sites and a greater proportion of individuals under MCRS, despite the higher CPUE levels. This could

similarly be explained by variations in growth allometry seen in Manila clams across Poole Harbour resulting in a greater retention of Manila clam below MCRS. It could also be related to environmental variables, the testing for these is outside the scope of this study.

6 Conclusion

- The 2023 Poole Harbour Bivalve Survey has provided data which enables an assessment to be made of the stocks of the main commercially harvested species, Manila clam and common cockle, and for data to be compared to previous survey years.
- The results indicate that the harvestable populations of both species remain stable with CPUE showing either no significant differences between years or, for common cockle, an increase in CPUE in the last two survey years.
- Catch levels also remain consistent with no significant differences between years and no specific effects of catch levels can be discerned in the survey results.
- Length frequency also remains stable with the majority of sites showing an average size at or above the species MCRS. The exceptions to this are likely explained in the majority by environmental variables and growth allometry, although there may be an influence of fishing activity in the areas with the highest effort during the season.
- The populations of Manila clam and common cockle in Poole Harbour appear to be robust to the current level of fishing pressure with harvesting remaining sustainable in respect to stock levels.
- The survey will continue to be undertaken annually to extend the timeseries dataset which will facilitate being able to work towards identifying potential empirical reference points for stocks of Manila clam and common cockle, to further develop the work on this fishery in terms of monitoring stock levels and fishing effort to ensure sustainable practice.

7 References

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