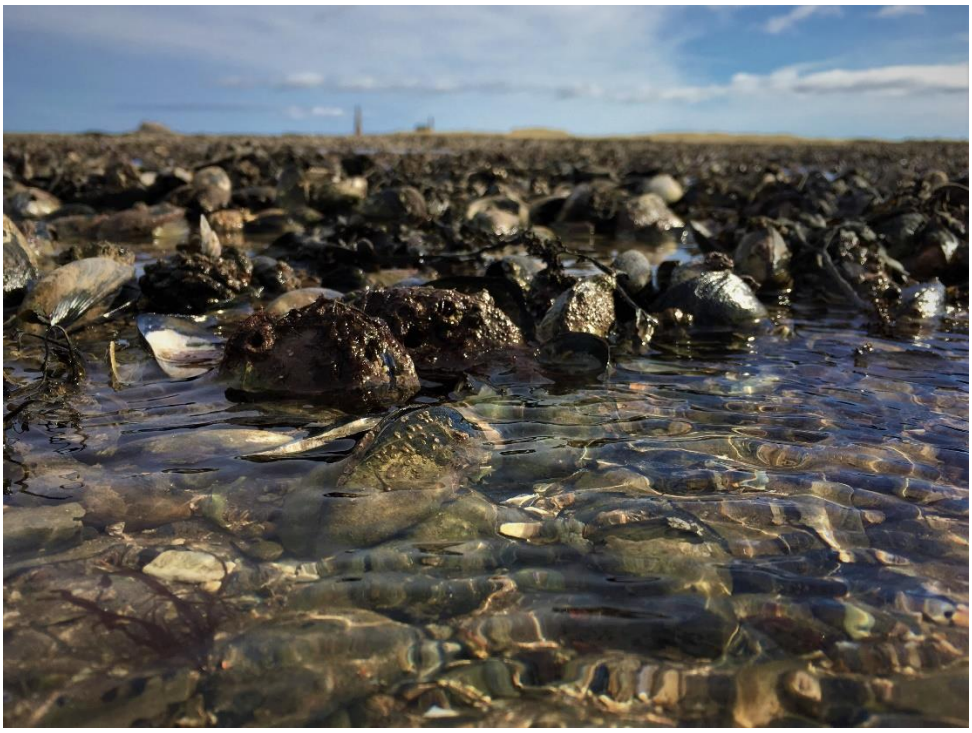
Holy Island Mussel Survey

2020



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Abstract

The purpose of this report is to assess and continue to monitor the state of the mussel bed at Holy Island Sands. The perimeter of the mussel bed was mapped, and percentage cover of mussels was estimated using the 'Walker and Nicholson' technique. Biomass, density and total number of mussels at the site were also calculated. Samples of mussels were collected, and total shell length and weight were measured. Surveys began in 2018 at the site and have been completed annually since then.

The mussel bed on Holy Island Sands in 2020 covered an area of 4.02ha with a percentage cover of 75%. The estimated values obtained for density, biomass and total number of mussels have decreased compared to the 2019 survey. Mean length of mussels sampled in 2020 increased from those sampled in 2019. The length distribution was typically unimodal and skewed towards a larger mussel size, with 85% of mussels were larger than the recommended minimum size of 45mm.

This report is intended to provide information relating to the health and distribution of the mussel bed on Holy Island Sands in order to inform future management of the site.

Introduction

The edible mussel (*Mytilus edulis*) is widely distributed, occurring in boreal and temperate waters, in both the southern and northern hemispheres (OSPAR, 2010). *M. edulis* is tolerant of a wide range of environmental conditions (Fisheries Agriculture Organisation (USA), no date) including fluctuations in salinity (Andrews *et al.,* 2011), and therefore occurs in both marine and brackish waters (Gardner, 1996). Mussels can form dense beds (Fenton, 1978) using byssus threads to attach to the substratum (Babarro *et al.,* 2008).

M. edulis beds are included in the OSPAR (Annex V) list of threatened and declining species and habitats and are listed as a UK biodiversity action Plan (BAP) Priority Habitat (Maddock, 2008). Threats to mussel beds include bait collection (Maddock, 2008), gathering for human consumption (Fenton, 1978), pollution (Hilgerloh, 1997), coastal development and anchoring (Maddock, 2008). It is currently unknown whether mussel beds are declining because of the aforementioned threats, due to bird predation or a combination of factors (Hilgerloh, 1997).

Northumberland Inshore Fisheries and Conservation Authority (NIFCA, formally Northumberland Sea Fisheries Committee) has conducted a stock assessment survey of the mussel beds at Fenham Flats, Lindisfarne on an annual basis since 2006. NIFCA has a long-term record of the population dynamics of the mussel bed at Fenham Flats and the results from recent years have shown a decrease in mussel density, total number of mussels and number of small mussels. The results also showed an increase in mean mussel size with the largest value recorded to date observed in 2015. Further study was deemed essential to determine if the trends discussed are as a result of recruitment failure or natural temporal variation. NIFCA therefore decided to expand the 2018 mussel surveys in include two additional sites (Holy Island Sands and St Cuthbert's) in order to compare the results from Fenham Flats with that of other mussel beds in the region. However, the beds were only partly surveyed in 2018. Only one of these sites (Holy Island Sands) was deemed comparable (similar underlying substrate and functionally displaying 'bed' characteristics i.e. aggregated mussels) to Fenham Flats mussel bed, therefore this site was also surveyed in 2019 and 2020.

Study Site

The mussel bed at Holy Island Sands is located on the mudflats to the west of Holy Island (Figure 1). This site is relatively small compared to Fenham Flats, covering an area of 4.02ha in 2020. This site appears to be an important feeding area for a number of nationally important bird species similar to Fenham Flats.

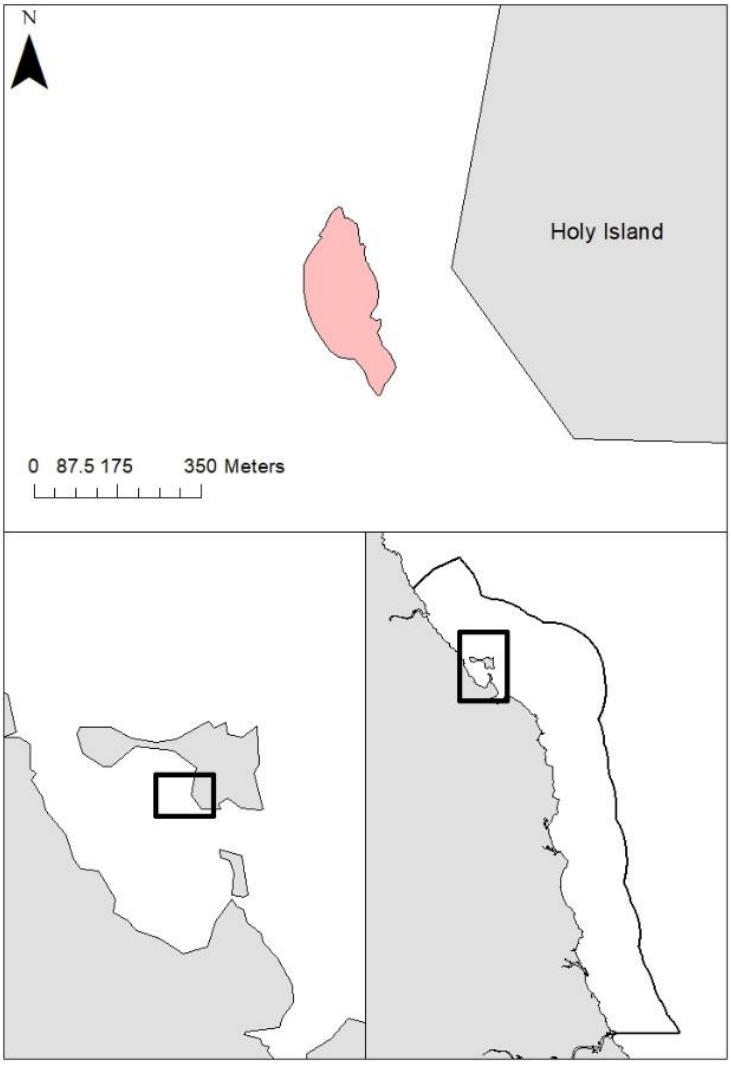


Figure 1: The estimated Holy Island Sands mussel bed area in 2020.

Methods

Two Inshore Fisheries & Conservation Officers (IFCOs), one of whom has previously walked the perimeter, walk the perimeter with a handheld GPS. Confidence in the accuracy of the area is low as the area of the mussel bed is difficult to define. There is no WFD definition of what constitutes a mussel bed so it can be subjective to define mussel bed area. The information was exported as a GPX file from the GPS using the Garmin GPS software Basecamp and then imported into ARC GIS to map and calculate the area of the mussel bed.

The percentage cover of mussels on the mussel beds were estimated using the 'Walker and Nicholson' survey technique (Walker and Nicholson, 1986) to allow comparison with other surveys in the area. Surveyors walked in a zigzag pattern across the mussel beds, in randomly determined directions, recording the proportion of footsteps landing on live mussels. The total number of steps was selected at random at the start of each transect and ranged from 55 to 300. Percentage cover was then calculated using the following equation:

Percentage Cover = (Number of footsteps landing on live mussels / Total number of footsteps) X 100

A mussel sample was taken at the start and end of each transect from within a 0.1m² sampling quadrat. The samples were sieved through a 6mm mesh and cleaned in intertidal pools to remove sediment. To reduce the impact of the study, the number of quadrat samples taken varied between sites due to the varying quantities and extent of mussels present. The number of mussels per 1m² was later calculated so that further calculations could be compared between sites.

Figure 2: Surveyors during the Holy Island Sands mussel bed survey.

The samples were processed removing dead shells and debris from the living mussels. Total shell lengths of all the mussels sampled were then measured (to the nearest millimetre) using a vernier caliper and divided into the following size groups: <45mm, 45-54mm and >54mm. The total weight (in grams) of mussels in each size category was also recorded for each sample. The density of mussels on the mussel bed was then calculated the following equation:

$$\text{Mussel Density} = \frac{\text{Number of mussels per m}^2 \text{ x Percentage Cover}}{100}$$

The total biomass of mussels on the mussel bed was then calculated using the following equation:

$$\text{Mussel Biomass (tonnes)} = \frac{\text{Mussel Mass per m}^2 \text{ x Area of Mussel Bed}}{1{,}000{,}000}$$

The estimated total no. of mussels at each site was also calculated using the following equation:

$$\text{Number of Mussels} = \frac{(\text{Area of Mussel Bed in m}^2 \text{ x Number of mussels per m}^2) \text{ x Percentage Cover}^*}{1{,}000{,}000}$$

*Percentage cover as a decimal (e.g. 53.86% would be 0.5386)

In 2019, it was decided to begin conducting analysis of the meat content of the mussels found within the Holy Island Sands mussel bed. This was done to determine if the meat content was declining and to begin recording this data as an additional monitoring tool of overall bed health. This was done by weighing a sample of mussels, removing the meat from this sample and recording a dry weight of the meat. The meat content was calculated using the following equation:

$$\text{Meat Content (\%)} = \frac{\text{Weight of Meat}}{\text{Weight in shell}} \text{ x } 100$$

Results

For the 2020 survey, a total of 10 samples (all mussel material – live, dead, empty shells – in a 0.1m² sampling quadrat) were taken across the Holy Island Sands mussel bed, with a total of 143 live mussels sampled. In 2018, the bed was only partially surveyed due to an incoming tide, therefore the data is likely not a true reflection of the bed at this time and has been removed from comparative analysis. A summary of the survey results can be seen in Table 1

Table 1: Summary of the results for the Holy Island mussel bed between 2018 and 2020.

	2018	2019	2020
Bed area (m^2)	31,100	40,400	40,202
Bed area (ha)	3.11	4.04	4.02
Percentage Cover	90%	66%	75%
Number of Samples	6	5	10
Average Size	35.15	48.08	48.29
Mass of Samples (g)	2,499	1,753	2,763
Mass per m^2 (g)	4,165	3,506	2,763
No. Mussels in Sample	184	95	143
No. Mussels per m^2	307	190	143
Density (No./m^2)	276.3	125.4	107.25
Biomass (Tonnes)	129.5	141.6	111.1
No. Mussels (Millions)	8.59	5.07	4.31
Whole Weight (g)	-	1,130	512
Meat Weight (g)	-	95	44
Meat Yield (%)	-	8.4	8.6

Bed area

Overall bed area in 2020 remained similar to the estimates in 2019, 4.02ha in 2020 and 4.04ha in the previous year (Table 1 and Figure 3). It should be noted that for the 2018 bed area was not included in the comparative analysis for the reasons stated earlier in this report.

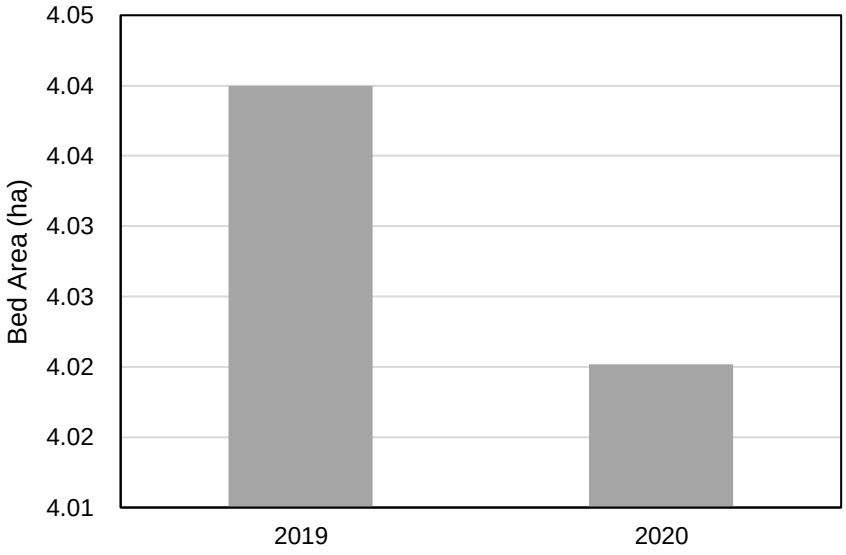


Figure 3: Bed area estimates for Holy Island Sands 2018-2020.

Percentage Cover

Percentage cover varied across the site in 2020, ranging from 58-96% across the varying walked transects, with an estimated percentage cover across the site of 75%, increasing from 66% in 2019 (Figure 4).

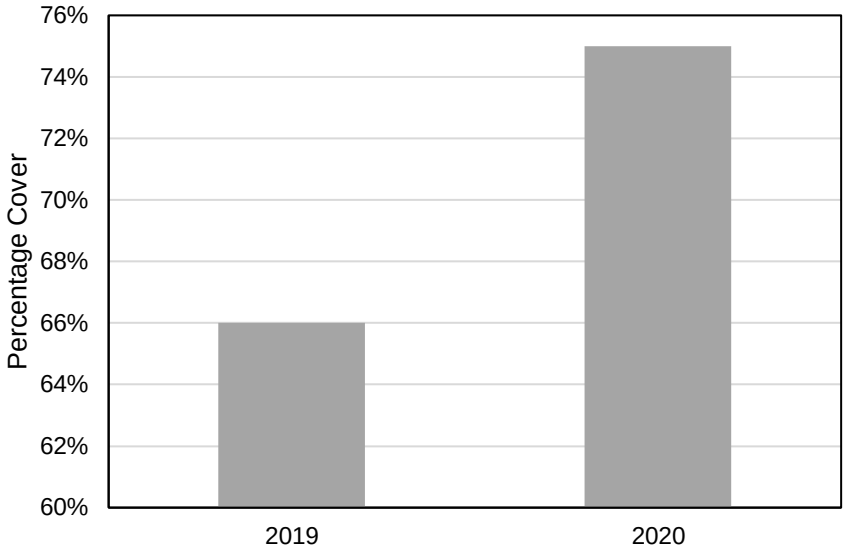


Figure 4: Percentage cover estimates for Holy Island Sands 2019-2020.

Mussel Density

Mussel density at this site has fallen since 2019, from 125 mussels/m^2, to 107 mussels/m^2 in 2020 (Figure 5). Despite these density estimates being far lower than those calculated in 2018, this data is viewed as very unreliable due to the nature of the survey in 2018, with the full bed extent unable to be calculated as a consequence of the incoming tide.

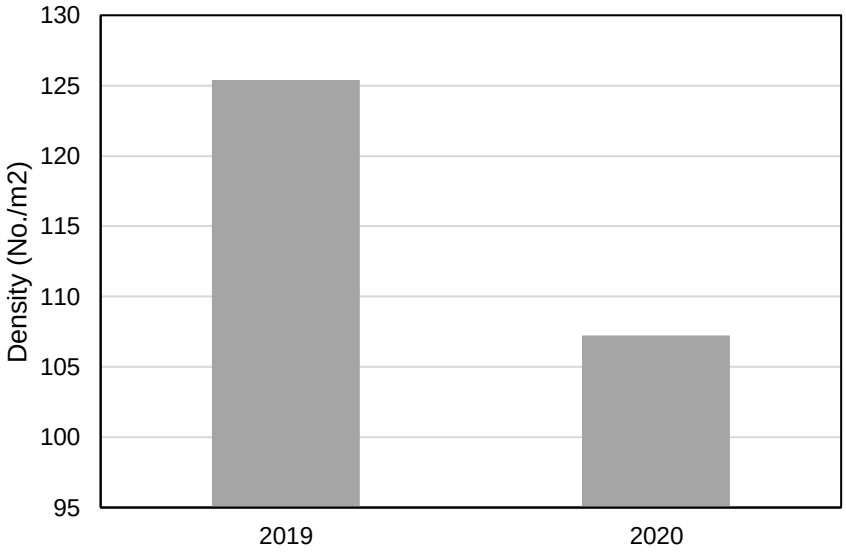


Figure 5: Mussel density estimates for Holy Island Sands 2018-2020.

Length Frequency

A total of 143 mussels were sampled during the 2020 survey. The length frequency over the period of surveying since 2018 has seen a gradual and steady shift to a larger mussel length, with 2020 having a very high number of mussels between 46-52mm (Figure 6) when compared to previous years. Average mussel size has followed the same increasing trend since 2018, increasing from 35.15mm in 2018 to 48.29mm in 2020 (Figure 7). Mean mussel size has remained steady since 2019, only increasing by 0.2mm in this time. In 2020, 85% of the mussels sampled had a shell length of over 45mm, compared to 80% and 51% in 2019 and 2018, respectively. When the sampled mussels for 2018-2020 were separated into size classes of <25mm, 26-49mm and >50mm, there is a clear trend of a declining proportion of mussels <25mm since 2018. In 2020, 5% of mussels sampled <25mm, although this is similar to what had been seen in the 2019 survey, with 6% of the population in this size class (Figure 8).

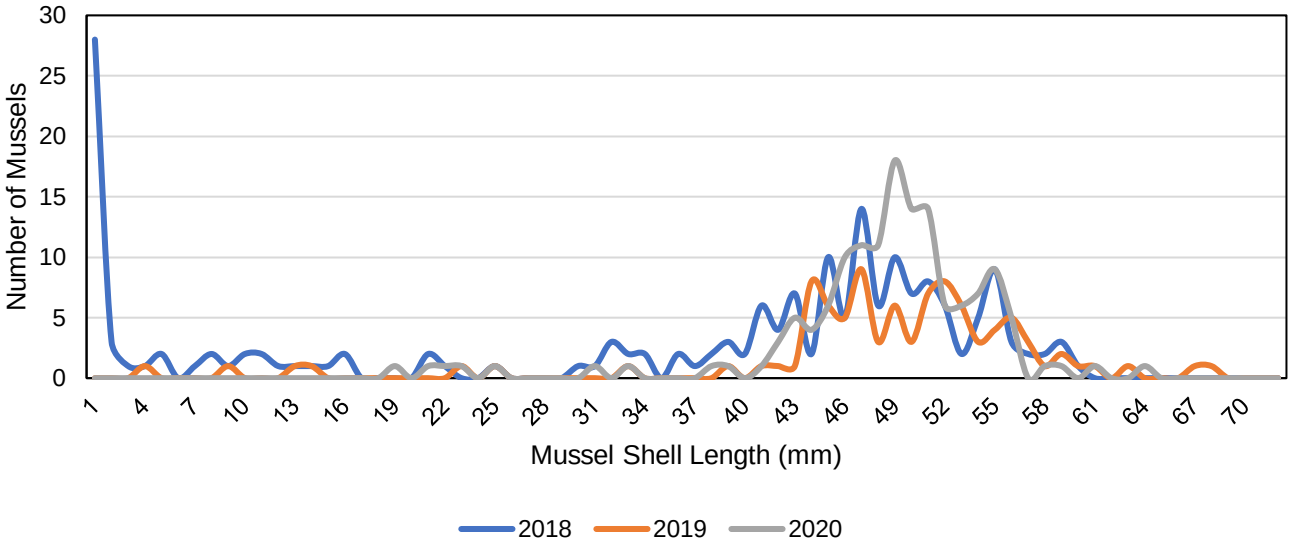
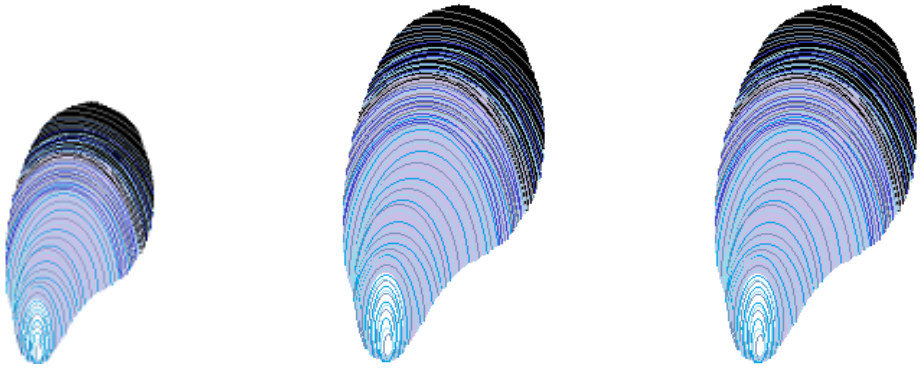


Figure 6: Mussel length frequency from samples collected during surveys of Holy Island Sands 2018-2020.



2018 35.15mm | **2019** 48.09mm | **2020** 48.29mm

Figure 7: Mean mussel size found during the Holy Island Sands mussel bed surveys 2018-2020.

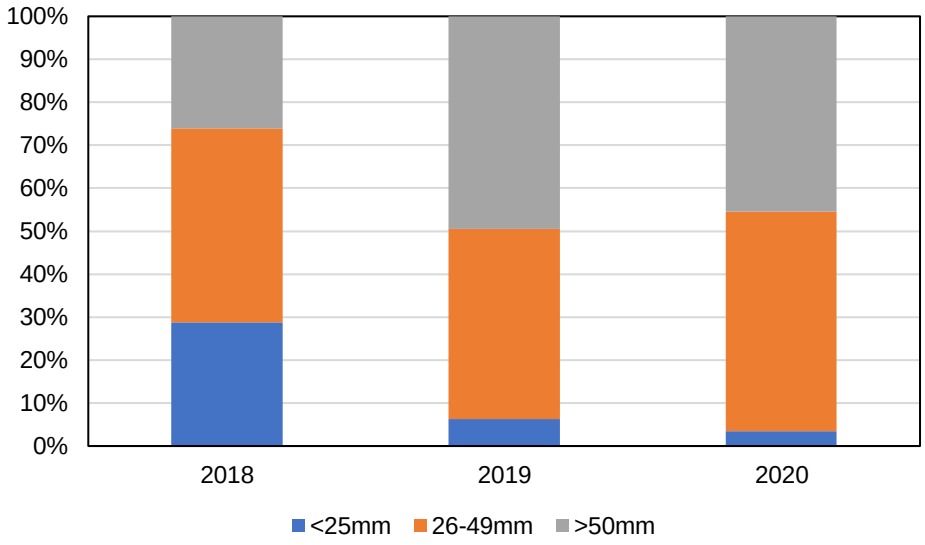


Figure 8: Proportional percentages of sampled mussels between 2018 and 2020 for the <25mm, 26-49mm and >50mm size classes.

Mussel Stock

As expected from the mussel density estimates and the observed declining trends, the total number of mussels at the site has followed a similar pattern of decline since 2019, falling from an estimated 5.07 million to 4.31 million in 2020 (Figure 9). Overall mussel biomass at the site fell to 111.1 tonnes in 2020, from 141.6 tonnes in 2019.

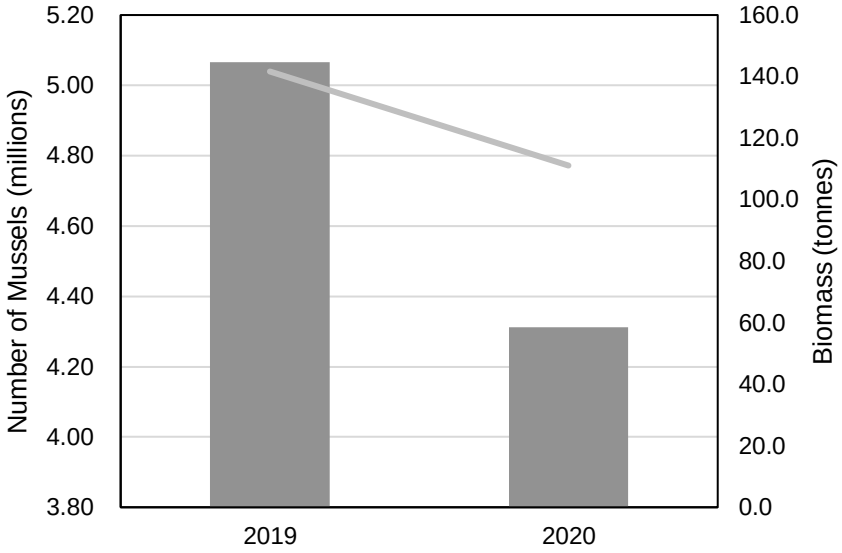


Figure 9: Mussel quantity and biomass estimates for Holy Island Sands 2018-2020.

Meat Content

After analysis of the meat content in 2020, there was a small increase in meat content in 2020 compared to 2019 (Table 2). The meat content of samples in 2020 was 0.2% higher than the previous year.

Table 2: Meat content analysis of samples taken in 2019 and 2020.

	2019	2020
Shell Weight (g)	1,130	512
Meat Weight (g)	95	44
Meat Content (%)	8.4	8.6

Discussion

The 2020 survey at Holy Island Sands is only the third year the survey has been carried out at this location and, as such, it is difficult to attribute any variations between years to any specific activity or influence. The aim is to complete future surveys annually to allow for any trends in the health of these beds to be recorded.

Bed Area

The data indicates the bed has remained stable since 2019. It is not possible to compare bed area results from 2019 and 2020 to the 2018 results as the survey was carried out on an incoming tide thus the bed area is likely to be underrepresented. It is assumed that the 2018 survey would have produced similar estimates of bed area to 2019 and 2020 results. No trends can be derived at this time, given the short duration of the surveys at this site.

Percentage Cover

Percentage cover was highly variable throughout the site, which is to be expected on a mussel bed, although there was less variation observed during the 2019 survey. This may be indicative of sparse patches within the mussel bed in 2020 that were not present in 2019, although percentage cover across the whole bed increased overall.

Mussel Density

Mussel density has declined at the site since 2019. It is not possible to compare the 2019 and 2020 estimates with those from 2018 given the issues previously mentioned regarding the 2018 survey. Future surveys will highlight whether this was the case or if the bed is truly in decline. A NIFCA commissioned report (Dent, 2019) highlighted that a neighbouring mussel bed at Fenham Flats (also surveyed by NIFCA) exhibited large fluctuations in mussel density between survey years, this may be occurring at Holy Island Sands.

Length Frequency

Mean shell length has fluctuated over the duration of the surveys however the overall trend shows an increase over time, with the 2020 value the highest recorded to date. The high proportions of larger mussels suggest an ageing population. Hilgerloh (1997) suggests that dominance by larger sized mussels occurs due to large mussels growing out of the size range exploited by predators. For example, oystercatchers target mussels between 30mm and 45mm in length (Meire and Ervynck, 1986), therefore individuals above 45mm will exhibit lower mortality due to reduced predation. The number of smaller individuals may be lower than expected as 1) smaller mussels may escape through the 5mm mesh of the sieve (however this does not explain the lack of mussels between 5mm and 44mm) and 2) recruitment may be limited at the site. Fewer 'medium' sized mussel in the 20-40mm size class range have also been described for mussel beds in the The Wash. Here, it is theorised that there is a mismatch in timings between a mussel first spawn and nutrient availability. Mussel have been reported to time spawning activity with higher levels of nutrient availability (Myrand et al., 2000). Smaller mussel must put a larger proportion of energetic reserves into reproduction than larger mussel. If the nutrients are not available to replenish depleted reserves this could cause die-off of smaller adult size classes. Larger mussels do not expend the same proportion of energy and so may be able to survive with fewer nutrients post spawning. Despite the percentage of mussels <25mm in the samples declining since 2018, it remained relatively stable between 2019 and 2020. This may indicate a slowing trend of decline, or that the population will continue to exhibit this sort of size distribution in future. Further study will be used to determine whether this is the case for the Hold Island Sands mussel bed.

Mussel Stock

On the face of it, the data does indicate a decline in mussel abundance and overall biomass, however future monitoring will be carried out to determine if this is an ongoing trend. NIFCA is aware of some limited exploitation of the mussel bed by hand gathering activities collecting mussel for angling bait, however the collection of mussel for bait is not permitted under Lindisfarne Natural Nature Reserve byelaws.

Meat Content

The meat content analysis highlighted a slight increase between 2019 and 2020. This could indicate a decline in the health of the mussel population. Meat content is subject to seasonal variation (Okumus and Stirling, 1998), however as the surveys were conducted at similar times, it is unlikely this explains the change. Research has shown that meat content in mussels is indicative of food availability, with a higher meat content being observed when food is plentiful (Orban et al., 2002). Therefore, this change could highlight a lack of food availability. Ongoing surveys shall monitor this trend, as only having data for 2019 and 2020 does not allow for an accurate picture to be built up.

Further Study

1. NIFCA plan to continue annual surveys of the mussel beds at Holy Island Sands Fenham Flats to understand the trends and health of the sites.
2. NIFCA would like to investigate the use of unmanned aerial vehicles (UAVs or drones) to conduct mussel surveys at both Lindisfarne and Blyth Estuary to improve both accuracy and safety for IFCOs and volunteers.
3. A future study could also look at the feeding habits of birds at the site to determine 1) how important mussels are to their diet and 2) what size classes are consumed by which species.

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