Exe Estuary
Mussel Stock Assessment 2020

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1. Introduction

1.2 *Mytilus edulis*

Blue mussels, *Mytilus edulis*, are cold-water mussels which can occur in brackish water (Gardner, 1996). They are found on the north Atlantic and north Pacific coast of North America, Europe and in other temperate and polar waters. Blue mussels can occur intertidally and subtidally, and on a variety of substrates, from rocks to sediments, and in a range of conditions. “Blue mussel beds on sediment” are listed as a UK Biodiversity Action Plan (BAP) Priority Habitat (JNCC, 2011). This includes a range of sediments, such as sand, cobbles, pebbles, muddy sand and mud. *M. edulis* ability to occupy such a range of habitats results from its ability to withstand wide variation in salinity, desiccation, temperature and oxygen concentration (Bayne and Worrall, 1980; Seed and Suchanek, 1992; Andrews *et al.*, 2011).

M. edulis beds play an important role in the healthy functioning of marine ecosystems; having a role in coastal sediment dynamics, acting as a food source to wading birds, and providing an enhanced area of biodiversity in an otherwise sediment-dominated environment (JNCC, 2011). Mussel beds support their own diverse communities as the mussel matrix, composed of interconnected mussels and accumulated sediments and debris, provides numerous microhabitats and an organically enriched environment (Seed and Suchanek, 1992; Andrews *et al.*, 2011) Blue mussels are filter feeders, feeding primarily on micro-algae, suspended debris and zooplankton, and play a vital role in estuaries by removing bacteria and toxins.

The reproductive strategy of *M. edulis* is to deploy a large number of gametes, approximately three million eggs, into the surrounding water where fertilisation takes place (Andrews *et al.*, 2011). Following fertilisation, the zygotes, as planktonic larvae, undergo six stages of metamorphosis before settlement. Mussels can adapt their reproductive strategy depending on environmental conditions. For example, the release of gametes can be timed to complement favourable environmental conditions, and the planktonic phase can last between two and four weeks depending on temperature, food supply and availability of a suitable substrate to settle on (Andrews *et al.*, 2011). Depending on temperature and nutrient levels, spawning may occur just once or several times per year (Bayne and Worrall, 1980; Seed and Suchanek, 1992; Handå *et al.*, 2011).

Current threats to *M. edulis* beds include commercial fishing, water quality, coastal developments, anchoring, bait digging, and intensive recreational hand gathering (JNCC, 2011).

1.2 Objectives

The objective of this project is to carry out annual surveys of the public mussel beds on the Exe Estuary, to define where the mussel beds are and accurately map, using GIS, the overall extent of each of the mussel beds. D&S IFCA will undertake a stock assessment on each of the beds to estimate the density of mussels on the beds and the total stock of marketable mussels. Results of these surveys can be compared on an annual basis. This will help inform future management of the mussel beds on the Exe and the development of shellfisheries in this part of the D&S IFCA’s District.

2. Methodology

2.1 The Exe Estuary

The Exe Estuary is the one of the most highly designated nature conservation sites in Devon; it is a Ramsar Site, a Special Protection Area (SPA), and a Site of Special Scientific Interest (SSSI). It encompasses over 3,000 hectares of diverse aquatic and terrestrial habitats (EEMP, 2020). The Exe Estuary SPA includes both marine areas (i.e. land covered continuously or intermittently by tidal waters) and land which is not subject to tidal influence (Figure 1). Sub-features have been identified which describe the key habitats within the European Marine Site necessary to support the birds that qualify within the SPA. Bird usage of the site varies seasonally, with different areas being favoured over others at certain times of the year. The mussel beds are important in supporting the wintering wader and wildfowl assemblages to enable them to acquire sufficient energy reserves to ensure population survival (Natural England, 2020). Oystercatchers are the main bird species to use the mussel beds, along with redshank, curlew, turnstone and greenshank. Several thousand oystercatchers overwinter on the Exe Estuary and predominantly feed on the mussels, a few will also feed on cockles, winkles and ragworms (Goss-Custard and Verboven, 1993).

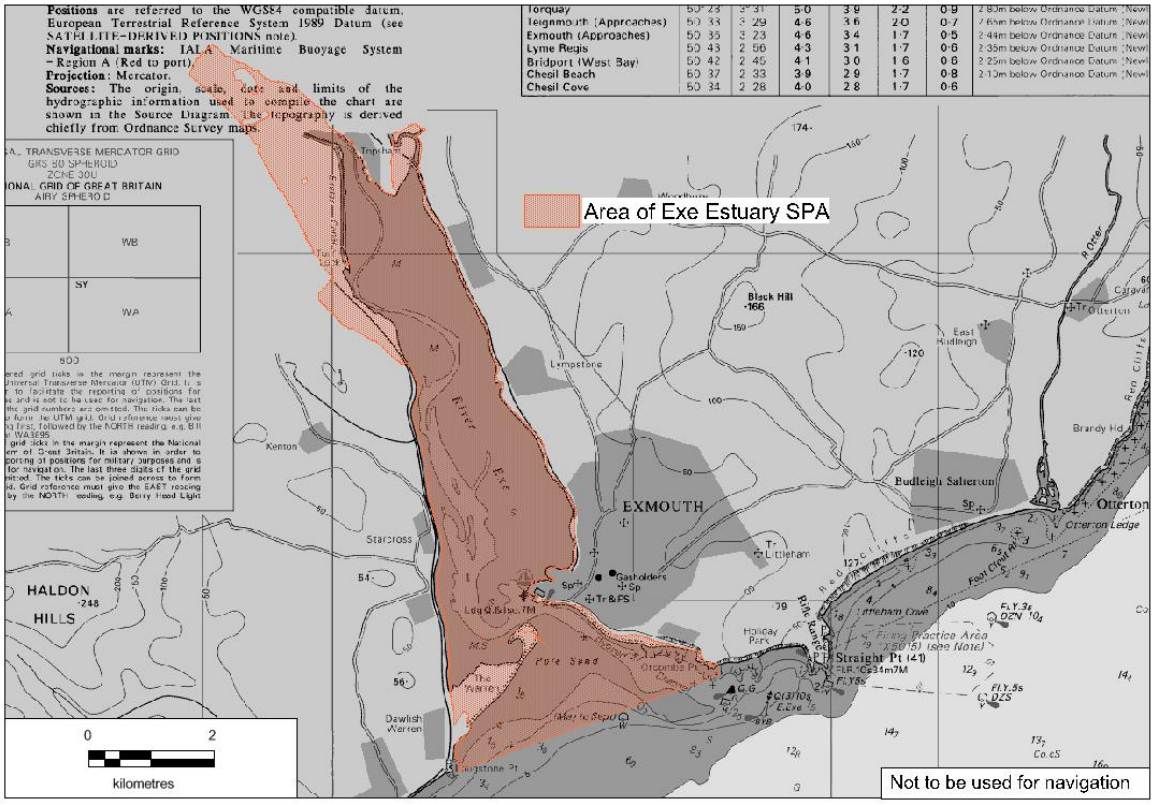
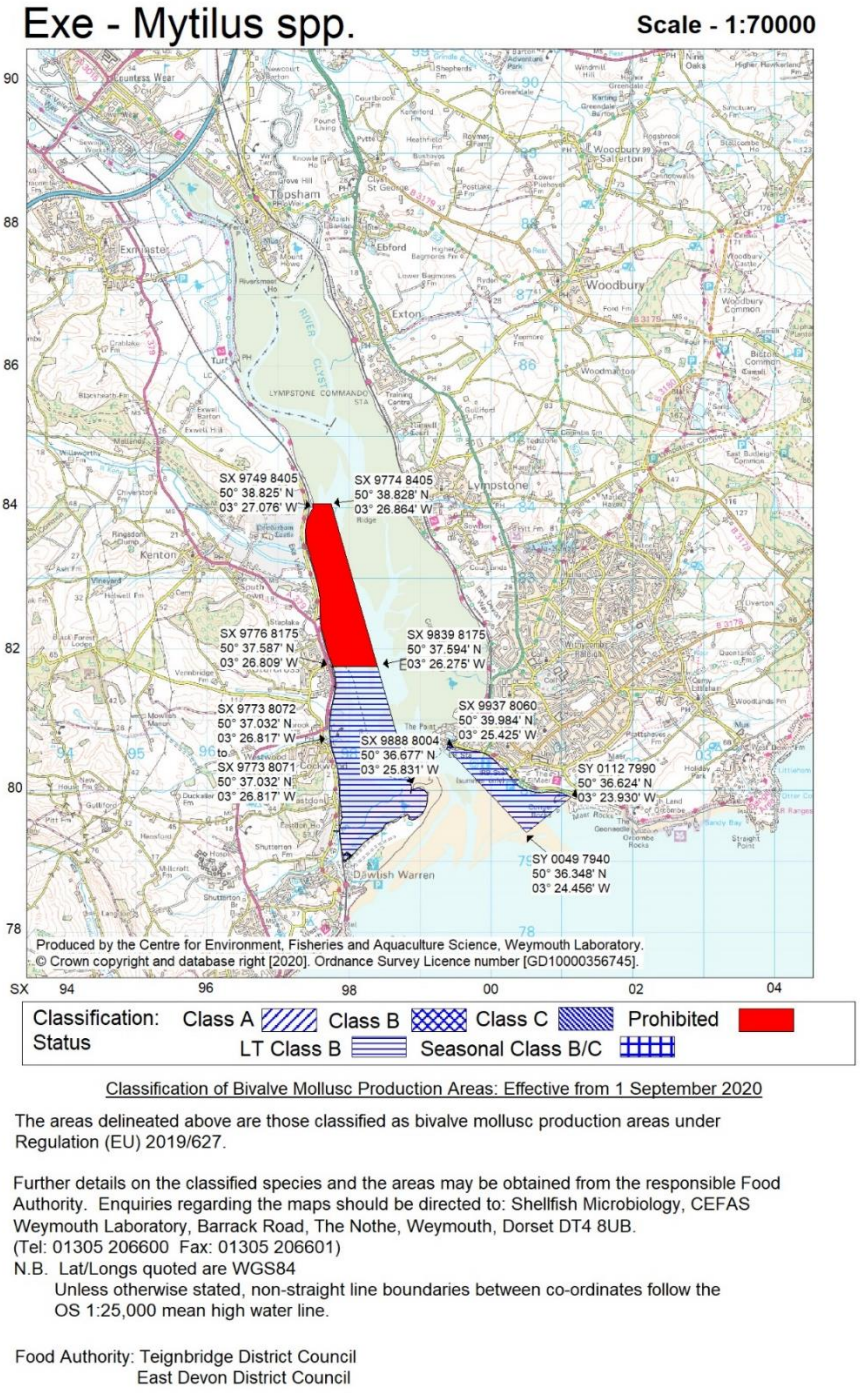


Figure 1 Area of the Exe Estuary SPA

The main commercial fishing activity occurring within the Exe Estuary SPA is the mussel fishery, worked by the Exmouth Mussels Limited. Exmouth Mussels Ltd. has in the past collected up to 2000 tonnes of mussel seed per year, from sites at the mouth of and outside the estuary. The seed mussel is then re-laid onto estuary fundus that Exmouth Mussels Ltd. leases, and therefore has rights to. Seed is re-laid at a ratio of 3:1, subtidal: intertidal. Once the seed has grown to marketable size, it is harvested using a “hydraulic jet elevator”, which uses water jets to dislodge the mussels from the bed onto a conveyor belt, which brings them up onto the fishing vessel for sorting. The main fishing activity occurs in the summer,

when most wintering bird populations are absent, however some activity takes place all year round. Commercial mussel harvesting can only take place on classified beds (Figure 2) and is predominantly occurring sub-tidally. Devon & Severn Inshore Fisheries and Conservation Authority's (D&S IFCA) stock assessments focus on the public fishery beds of Bull Hill and Starcross and the beds at Lympstone when access is possible. These areas have been popular for recreational shellfish collection.

D&S IFCA introduced a temporary closure, from 1st May 2019, on the public shellfish beds in the Exe Estuary due to the stocks in these areas being severely depleted.



Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2020

The areas delineated above are those classified as bivalve mollusc production areas under Regulation (EU) 2019/627.

Further details on the classified species and the areas may be obtained from the responsible Food Authority. Enquiries regarding the maps should be directed to: Shellfish Microbiology, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB.
(Tel: 01305 206600 Fax: 01305 206601)
N.B. Lat/Longs quoted are WGS84
Unless otherwise stated, non-straight line boundaries between co-ordinates follow the OS 1:25,000 mean high water line.

Food Authority: Teignbridge District Council
East Devon District Council

Figure 2 Classified mussel harvesting areas on the Exe Estuary (Cefas, 2020)

2.2 Survey methodology

Surveys were conducted between 2013–2020. As a result of COVID-19 restrictions the timeframe for completing surveys was greatly reduced compared to normal years, therefore only Bull Hill could be surveyed in 2020. See the 2019 report for details of additional beds that were not surveyed during 2020. The survey site (Bull Hill) is mid channel and due to changes in the channel required access by boat from Exmouth Docks in 2020. Bull Hill was surveyed on a spring tide to ensure the full extent of the mussel bed was accessible; the survey area was determined based on local stakeholder input as to the presence of mussel.

Due to the varying levels of patchiness and density the area surveyed cannot always be indicative of the size of a true mussel 'bed' and is a representation of the area in which live mussels were located. This means that the survey area will not always be purely on mussel bed, but also on areas where mussels occur in small, dispersed patches. The perimeter of this survey area was recorded on the first visit to the bed by walking the extent of the live mussel habitat and marking coordinates with a handheld GPS. The bed was first visited in 2013. The perimeter was subsequently mapped in QGIS v3 (Figure3).

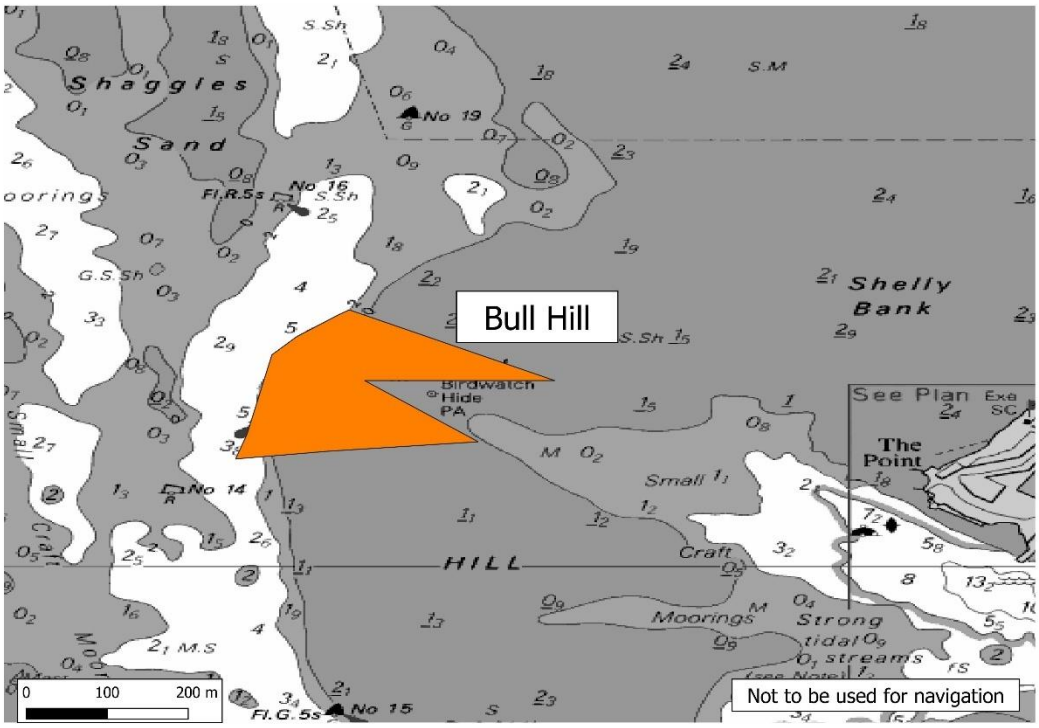


Figure 3 Area of mussel bed at Bull Hill surveyed in 2020 (orange). Mapped by generating a minimum convex polygon around the transect lines. The survey area in 2020 does not fully overlap the areas surveyed in previous years.

To determine coverage and patch density, transects were walked in a zig-zag pattern across the survey area, up to the extent of the mussel bed (e.g. to the low water mark or the point at which substrate changed or mussels disappeared). The start and end coordinates of each transect were recorded using a handheld GPS. A 4 ft bamboo cane with an 11cm ring attached to the end, arranged so that the ring sits flat on the ground when held out to one side, was used to determine the mussel coverage for each transect: Every three paces (one pace equals a single step) along each transect the cane was placed out to one side and the presence or absence of live mussels within the ring were recorded. On every fifth hit

(presence) the contents of the ring were taken as a sample, using an 11cm diameter corer. All mussel samples from the same transect were collected together in one bag and kept separate from those of other transects. This methodology is known as the Dutch Wand Method.

Once all transects are complete mussel samples are sieved and cleaned. For each transect the number of samples taken is recorded, all mussels are then measured and divided into the following size groups; 1-10mm, 11-20mm, 21-30mm, 31-40mm, 41-50mm, 51-60mm, 61-70mm, 70+mm.

2.2 Data analysis

The data collected from both the transects and samples were used to calculate the percentage cover (Equation 1), density (Equation 2) and area of the survey area (by generating a minimum convex polygon around the transect lines), which were then used to estimate the mussel tonnage on each site (

Equation ***3***). Total tonnage and survey area across all sites were calculated based on the weight of mussel in the samples taken and scaled up by the density and the area surveyed across all sites combined was calculated

Equation 1: Calculation of the percentage cover of mussel

$$\%\,\boldsymbol{cover} = \frac{no.hits}{no.hits + no.misses}$$

Equation 2: Calculation of the density of mussel cover

$$\boldsymbol{Density}\,(\boldsymbol{kg/m^2}) = \frac{total\ mussel\ weight\ sampled}{surface\ area\ sampled} \times \%\ cover$$

Equation 3: Calculation of mussel tonnage

$$\boldsymbol{Tonnage\ of\ mussel} = \frac{Density\ \times 10{,}000\ \times Area(ha)}{1000}$$

3. Results

Bull Hill was surveyed on 17/10/2020. Six samples were collected from 8 transects. Only sparse mussel has been detected on Bull Hill since 2014, with the exception of a small, dense area of spat found in 2019 covering an area of 0.25ha which was deemed too small to survey. In 2020 the area of mussel bed surveyed was different to that surveyed in previous years. In 2020 the surveyed mussel bed was covered 6 hectares and contained a calculated 43 tonnes mussel (Figure 4). This section of Bull Hill bed now has the highest density and percentage cover of mussel since pre-2014 (Figure 5), although it is still a fraction of what it was in 2013.

Of the total 43 tonnes stock, 86% of this was of marketable size (>41mm), with no spat (<30mm) being detected (Figure 6).

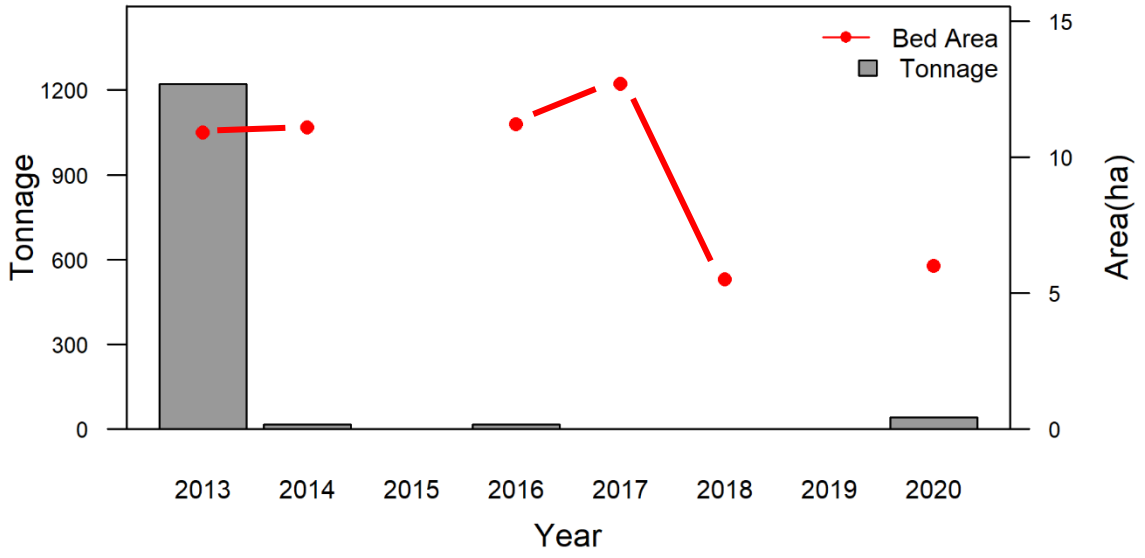


Figure 4 Total area surveyed plotted over tonnage of total stock within the Bull Hill mussel bed between 2013–2020.

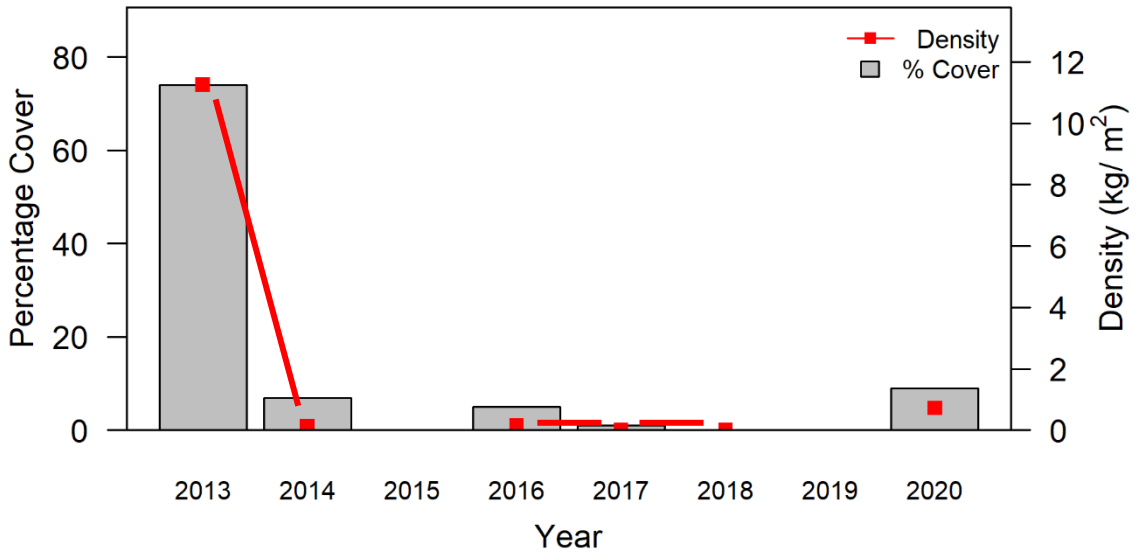


Figure 5 Percentage cover and density of mussels on the Bull Hill bed 2012–2020.

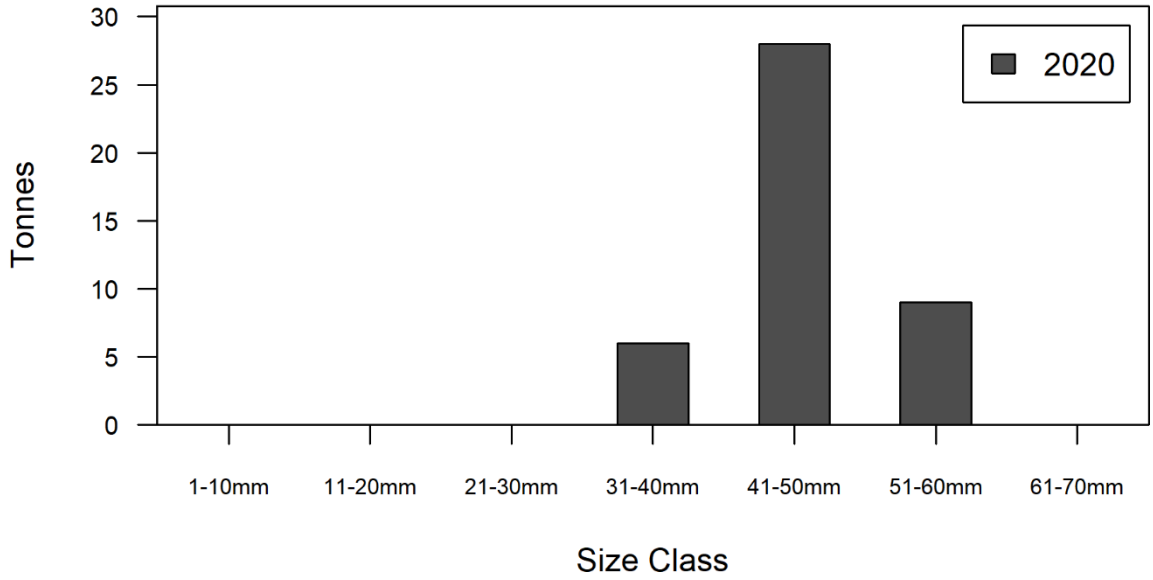


Figure 6 Tonnage of each 10mm size class for the Bull Hill 2020 stock.

4. Discussion

In 2014 large storms scoured away once previously stable beds, which reshaped the local hydrology. This was later followed by several Harmful Algal Bloom (HAB) incidents which reduced populations further. Since these events, mussel populations have been unable to recover to anywhere near the previous population estimates and are currently absent in anything that could be described as a dense, homogeneous, and stable population within the estuary.

A relatively small mussel population has established on Bull Hill (**Error! Reference source not found.** 5). This bed, although small, has potential to grow in both density and spatial distribution. All stock on Bull Hill was between 31-60mm (Figure 6), suggesting it is around 3-5 years old (Bayne and Worrall, 1980; Handå *et al.*, 2011). Recovery from a bed of the current size to Bull Hill's previous population levels, even without disturbance, could still take decades (Robins *et al.*, 2016). Exmouth Mussels Ltd have reported changes in the sediment load in the estuary believed in part to be due to the flood defence work at Dawlish Warren 2016/7, and changes in the hydrography of the estuary which has cause Bull Hill Bank to alter casing some denudation of the bank. These factors may have influenced the extent and density of the mussel beds. On-going monitoring, either on an annual or biennial basis should, however, provide data relating to the rate and scale of recovery.

The hydrology and fast-flowing nature of the Exe Estuary make it difficult for mussel spat to settle. McGrorty et al. (1990) found that on the Exe there was a strong positive correlation between densities of spat settlement and adult densities on the mussel beds, with spat rarely occurring at other sites on the estuary than in the byssal threads of adults. Spat seem only able to protect themselves by settling deep within the byssal threads of already established adults. One of the main sources of new recruitment in to the estuary is the relaying of mussel seed into the estuary, to be grown on for harvesting, by Exmouth Mussels Ltd. As part of their relaying activity, a portion of this seed is relayed intertidally to increase food availability for the over-wintering bird species, for which the estuary is designated as a SPA. This relaying occurs in the Starcross area. However, recent problems with sedimentation on the estuary have meant that Exmouth Mussels Ltd. have had to wind down their activity. It is

important to continue to carry out stock assessments to see if the sedimentation and/or the reduction in relaying will have an impact on the mussel populations across the estuary. The Starcross area, whilst lying within the privately leased area of the estuary, is also subject to hand gathering of mussels which is not covered by D&S IFCA's temporary closure of the public beds to mussel removal.

5. Recommendations

The establishment of a small stable mussel population on Bull Hill is certainly a positive development and will need continued monitoring. The beds at Starcross and Lympstone, that could not be surveyed in 2020, should be assessed during the next round of surveys to build a picture of changes in populations across the estuary as a whole.

It is recommended that the stock assessments continue to be carried out on an annual or biennial basis, to monitor any future changes and to detect any signs of recovery, especially whilst D&S IFCA's closure of harvesting from the public shellfish beds remains in place.

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