Exe Estuary
Mussel Stock Assessment 2022

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Contents

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1. Introduction

1.1 *Mytilus* spp

Populations of the common mussel, *Mytilus* spp. are keystone species of intertidal and subtidal hard bottom communities throughout the temperate to subarctic coasts of the Northern Hemisphere (Väinölä and Strelkov, 2011).

Mussel 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). They 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). *Mytilus* spp. are filter feeders, feeding primarily on micro-algae, suspended debris and zooplankton, and play a vital role in estuaries by removing bacteria and toxins.

Mytilus edulis, commonly known as the Blue Mussel are cold-water mussels which can occur in brackish water (Gardner, 1996). Its native region has been difficult to identify because of the presence of similar species and subspecies (*Mytilus galloprovincialis* and *Mytilus trossulus*). However, its native distribution is thought to span across the North Atlantic and North Pacific coast of North America, Europe and in other temperate and polar waters.

Mytilus edulis and *Mytilus galloprovincialis* often occur in the same location in the northern range of *Mytilus galloprovincialis.* They are often difficult to distinguish due to their variation in shell shape as a result of environmental conditions. In addition, they may hybridize.

The reproductive strategy of *Mytilus* spp. 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 *Mytilus* spp. 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 and report on biennial surveys of the 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. The surveys provide data for a stock assessment of the beds to estimate the density of mussels on the beds and the total stock of marketable-sized mussels, which can be compared to previous years. 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. The data can also help inform the food availability for the overwintering birds for which the Estuary is designated, should Natural England request the data for this purpose. D&S IFCA have not tried to identify *Mytilus edulis* from *Mytilus galloprovincialis* during this survey.

2. Methodology

2.1 Study Site: 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).

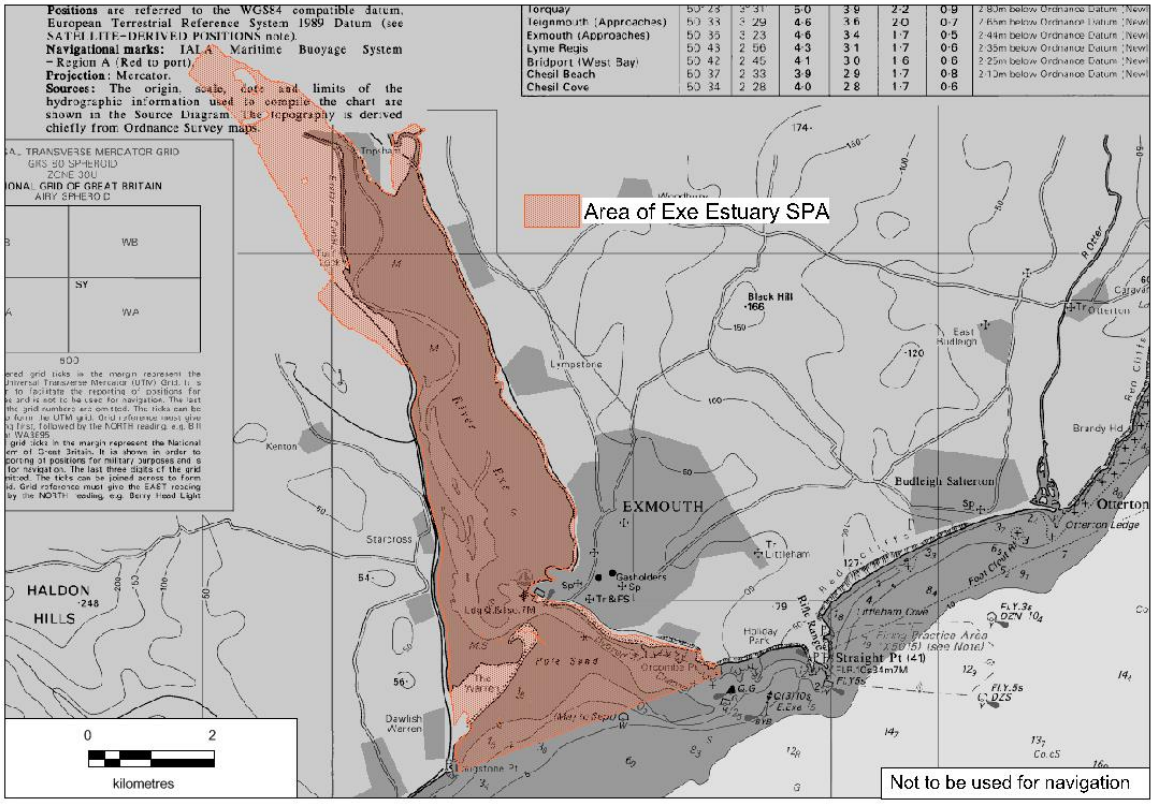
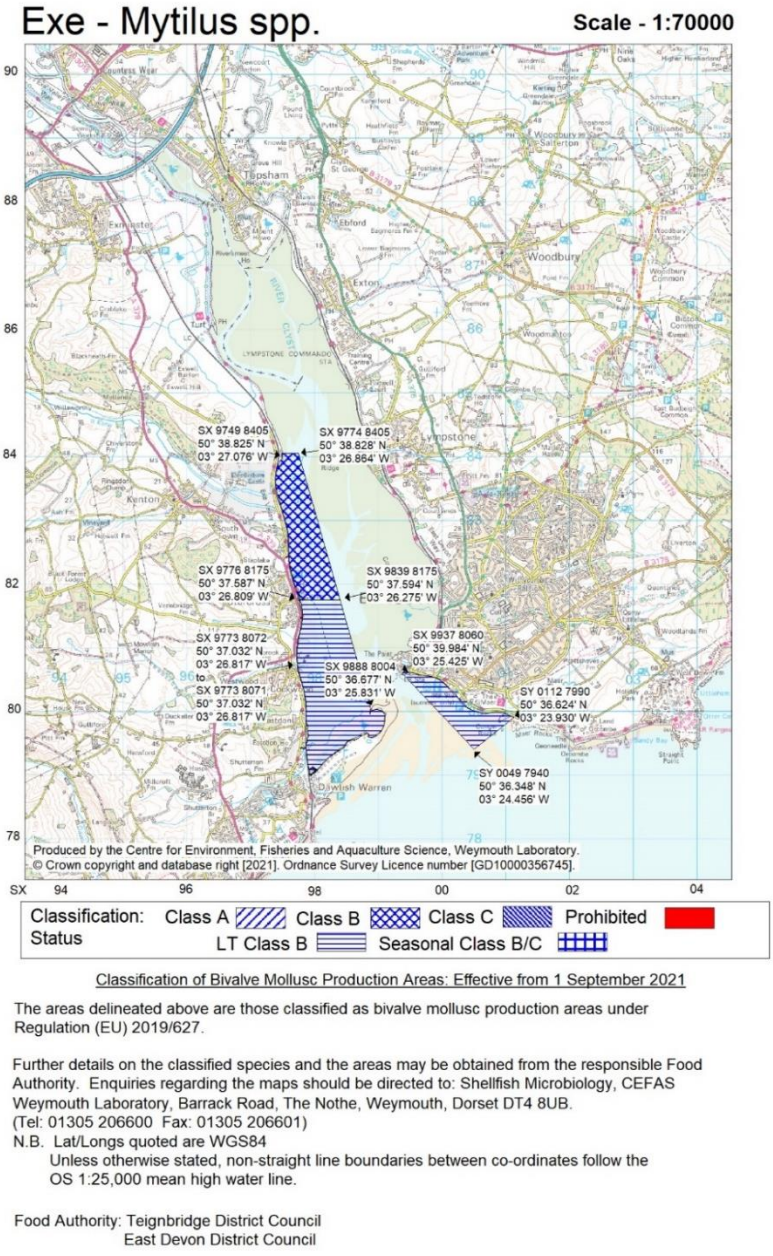


Figure 1 Area of the Exe Estuary SPA

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 2,000 tonnes of mussel seed per year, from sites at the mouth of and outside the estuary. The seed mussel is then normally 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. However, relaying of mussel has currently stopped due to reported changes in sediment load within the estuary. Exmouth Mussels Ltd hopes to start relaying mussel seed again in Autumn 2022-Winter 2023. The majority of their activity usually 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 at Lympstone, when access is possible. The beds at Starcross, which fall within the private fishery boundary, have to date been surveyed as a repetition of previous surveys. The initial surveys related to the relaying of mussels into the Starcross area when permission was granted in 2014 to remove seed mussel that settled on part of Bull Hill Bank. As mussels have not been harvested or re-laid to this area for several years, the surveying of this bed will not be continued after 2022.

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 2021

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

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Figure 2 Classified mussel harvesting areas on the Exe Estuary (Cefas, 2021)

2.2 Survey methodology

This document reports on surveys conducted between 2013–2022. Due to mussels being largely absent from the 2019 surveys and access issues, surveys were not undertaken at Lympstone in 2022. See the 2019 report (Thomas, 2019) for details of additional beds that were not surveyed during 2022. Surveys conducted on 18th and 19th April 2022 focused on the Bull Hill and Starcross areas (see Figure 3 and Figure 4). The survey site of Bull Hill is mid channel and, due to changes in the channel, required access by boat from Exmouth Docks in 2022. The Starcross areas were accessed on foot from the western bank of the Exe estuary. Bull Hill and Starcross were surveyed on a spring tide to ensure the full extent of the mussel bed was accessible; the survey area was determined based on previous survey locations and 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 at Bull Hill was first visited in 2013. The perimeter was subsequently mapped in QGIS v3 (Figure 3).

At the Bull Hill site (Figure 3), 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.

Due to the general absence of live mussel at Starcross, no transects were walked and no samples were taken. Instead, four officers conducted a visual sweep search of the Starcross area indicated in Figure 4 to locate mussel, before walking the perimeter of the searched area to define the GPS coordinates shown in Figure 4.

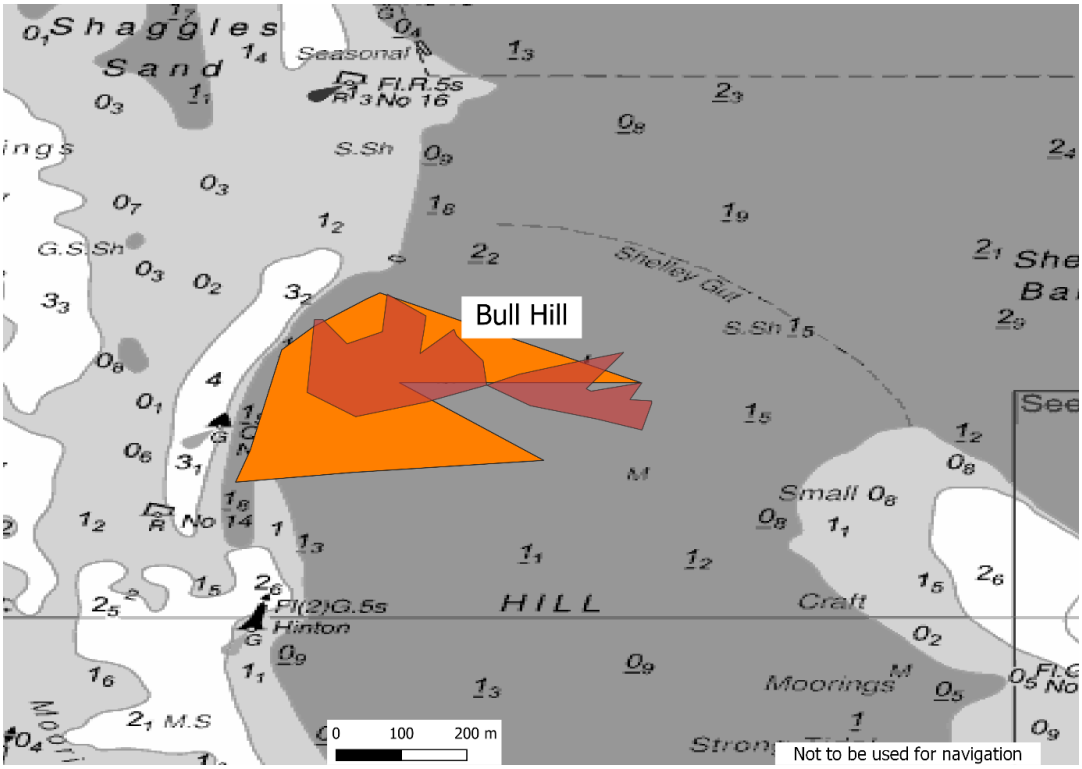

Figure 3 Area of mussel bed at Bull Hill surveyed in 2020 (orange) and 2022 (red). Mapped by generating a minimum convex polygon around the transect lines. The survey area in 2022 does not fully overlap the areas surveyed in 2020.

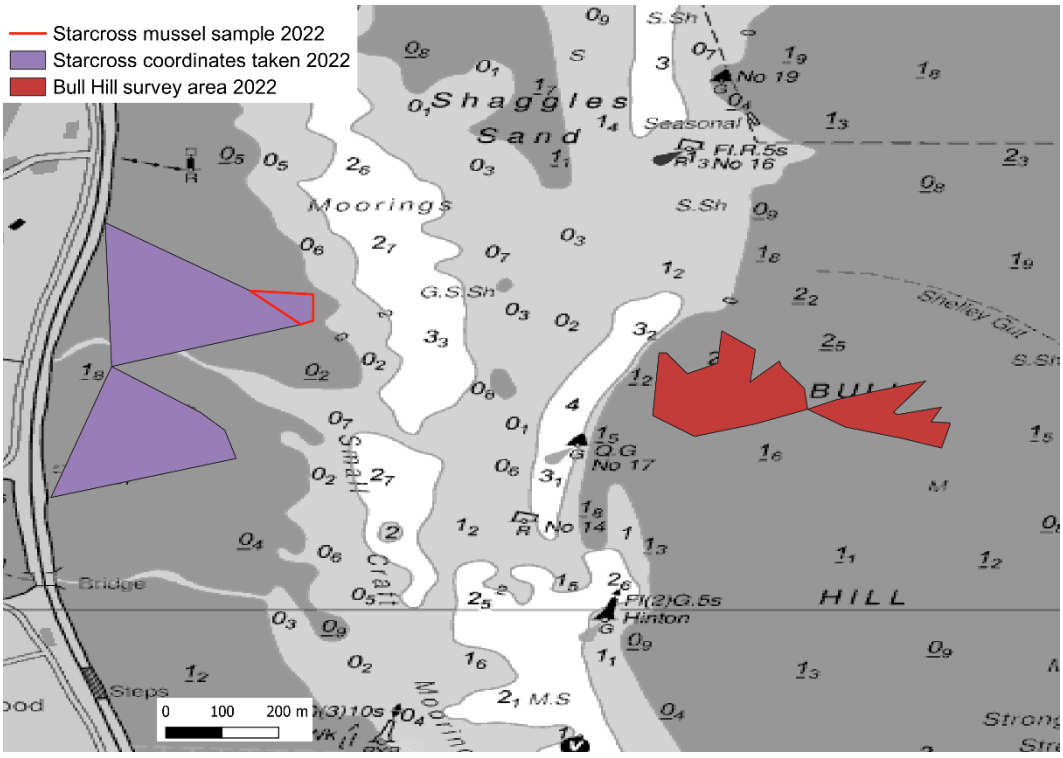

Figure 4 Area of mussel bed at Bull Hill surveyed in 2022 (red) mapped by generating a minimum convex polygon around the transect lines. Area where GPS coordinates were taken at Starcross (purple) in 2022 (red polygon indicates an area where some sparse mussel was observed between dense patches of Pacific oyster, *Magallana gigas*).

2.3 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 (Equation 3). Total tonnage across Bull Hill was calculated based on the weight of mussel in the samples taken and the metrics described above.

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

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

Equation 3: Calculation of mussel tonnage

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

3. Results

A total of 39 samples were collected from 25 transects on Bull Hill. Only sparse mussel has been detected here 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 2022 the surveyed mussel bed covered 4.4 hectares and contained a calculated 395 tonnes of mussel, compared to just 43 tonnes in 2020 (Figure 5). This section of Bull Hill bed now has the highest density and percentage cover of mussel since 2013 (Figure 6); density and percentage cover appear to be recovering to similar levels observed in 2013. However, it is important to note that (due to the smaller overall bed area) the overall tonnage is still less than a third of that observed in 2013, across an area less than half the size of that observed in 2013.

Of the total 395 tonnes stock observed in 2022, 63% of this was of marketable size (>41mm), and 4% was spat (<30mm) (Figure 7). Although the percentage of marketable size mussel is less than in 2020, the total tonnage of mussel in this size class has increased by 210 tonnes since 2020. In addition no spat was recorded in 2020 (Figure 7).

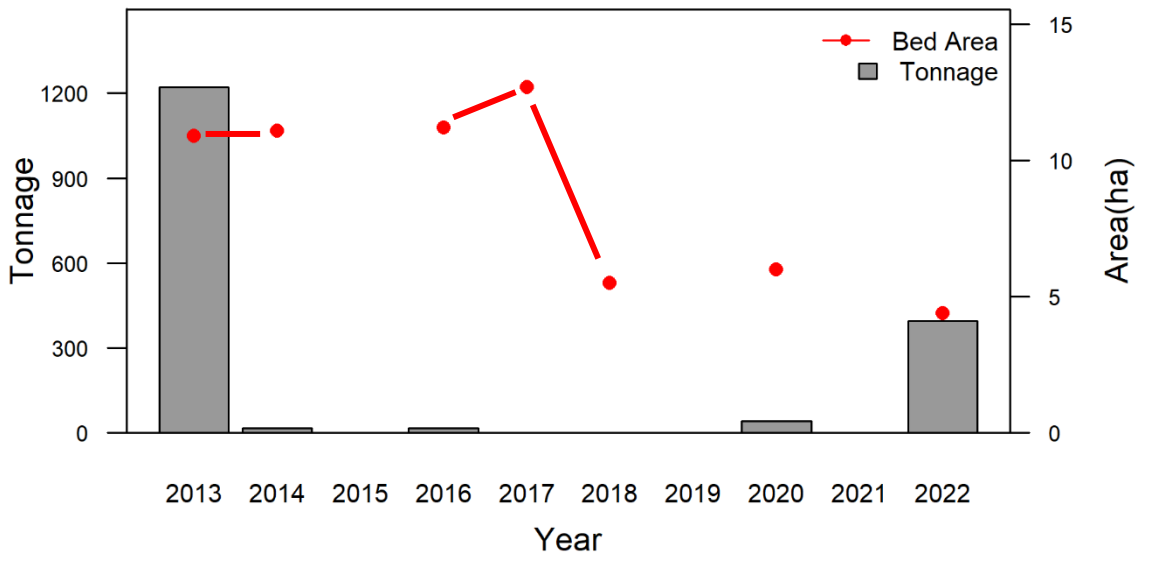

Figure 5 Total area surveyed plotted over tonnage of total stock within the Bull Hill mussel bed between 2013–2022.

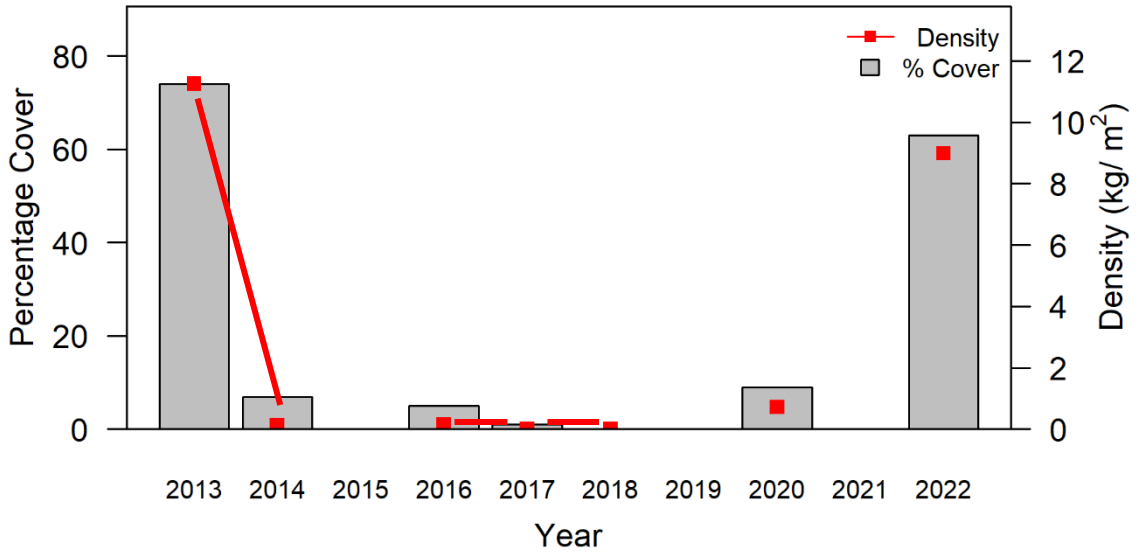

Figure 6 Percentage cover and density of mussels on the Bull Hill bed 2013–2022.

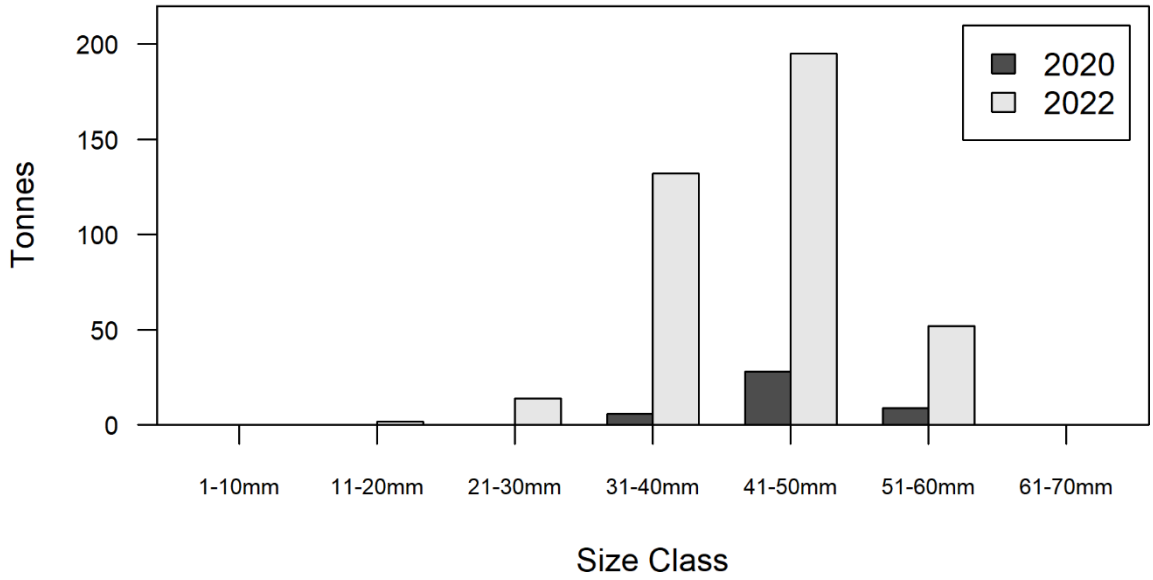

Figure 7 Tonnage of each 10mm size class for the Bull Hill stock from 2020-2022

Due to the general absence of live mussel at Starcross, no transect samples were taken. Some sparse mussel was observed within a dense Pacific oyster bed (Figure 4). A random selection of 29 mussels were measured within this area; of these, 4 were 41-50mm, 9 were 51-60mm and 16 were 61+mm.

4. Discussion

In 2014 large storms scoured away previously-stable mussel beds, which reshaped the local hydrology. This was later followed by several Harmful Algal Bloom (HAB) incidents which reduced mussel populations further. Since these events, mussel populations have been unable to recover to anywhere near the previous population estimates and have been absent in anything that could be described as a dense, homogeneous, and stable population within the estuary. Local stakeholders have also expressed concern that increased sedimentation in the estuary has smothered a proportion of the mussel and are of the opinion that this sedimentation has been caused or exacerbated by human activities (primarily the Dawlish Warren Management Scheme).

One of the sources of mussel recruitment in 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. Prior to 2017 Exmouth Mussels Ltd re-laid some seed mussel in the Starcross area although most was re-laid sub-tidally. In 2014 there was an unusual seed mussel settlement on Bull Hill Bank. D&S IFCA worked with Exmouth Mussels Ltd and Natural England and an agreed portion of this settlement was removed and some was re-laid on to the Starcross intertidal area to provide food for the birds. The remaining seed was re-laid sub-tidally. Since 2017 due to changes in the sediment load in the estuary very few mussels have remained on Starcross bed and no further relaying of seed mussel has taken place in this area. No recovery of the mussel beds have been observed in this area of the Exe Estuary.

In addition, large numbers of Pacific oyster, *Magallana gigas,* have established on the intertidal area of Starcross since 2018 and the survey site is now becoming a Pacific oyster bed. Pacific oysters have been farmed on the Exe Estuary and the settlement of wild pacific oysters, in recent years, in a similar niche within the same habitat is likely to cause concerns of population displacement. This applies to many of the estuaries in Northern Europe where mussels are now cohabiting with Pacific oysters. This concern is however largely unfounded. Biogenic Pacific oyster reefs and mussel beds, although ecologically and morphologically different are not exclusive habitats to their respective creators. Both habitats play host to a variety of differing species including mussels on oyster reefs and oysters on mussel beds. The growth of one species' population is not necessarily inhibited by the other, their nature as filter-feeding bivalves limits their interaction as direct competitors unless in a situation where stocking densities are unnaturally high (Shatkin et al. 1997, Ventilla 1982, Nehls et al., 2006). This may be the case when observed in the context of a dynamic open system estuary, such as the Exe, where nutrient availability is subject to a variety of differing pressures and toxic build up from faeces is incredibly unlikely. In this kind of system physical pressures like increased water flow will have a greater impact on mussel population size than nutrient deficiency from competition with Pacific oysters. It is most likely, based on the results seen in these monitoring reports, that the mussel populations previously found within the survey site of Starcross will see little to no recovery at all over the coming years. This is based on the near total absence of any established populations across the site, the current hydrological dynamics of the estuary and no relaying of mussel in the area.

A small mussel population has established on Bull Hill (Figure 5). This bed, although small, has potential to grow in both density and spatial distribution. All size classes of mussel found have shown an increase in tonnage on Bull Hill over the last two years (Figure 7). In addition, whilst conducting the survey, some large mussel was observed on Bull Hill. Given the size of the mussel observed it is unlikely that these have grown from those observed in the 2020 survey. This would suggest that some mussel may have been missed during the survey conducted in 2020 and the increase in tonnage has occurred over a period of more than two years. It should also be noted that 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).

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. The reported changes in sediment load, believed in part to be due to the flood defence work at Dawlish Warren 2016/7, and changes in the hydrography of the estuary has also caused Bull Hill Bank to alter causing some denudation of the bank. These factors may have influenced the extent and density of the mussel beds in these survey sites. The establishment of a small stable mussel population on Bull Hill is certainly a positive development and on-going monitoring, either on an annual or biennial basis should provide data relating to the rate and scale of recovery.

5. Recommendations

It is recommended that the stock assessment continue to be carried out on a 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. All future surveys will focus on the public beds on Bull Hill.

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