Teign Estuary
Mussel Stock Assessment 2020

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Contents

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KS	02/2021	Draft report	0.1
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1. Introduction

1.1 *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 (Maddock, 2008). This includes a range of sediments, such as sand, cobbles, pebbles, muddy sand and mud. The ability of *M. edulis* to occupy such a range of habitats results from its ability to withstand wide variation in salinity, desiccation, temperature and oxygen concentration (Bayne & Worrall 1980, Seed & 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 (Maddock, 2008). 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 (Andrews et al., 2011, Seed & Suchanek, 1992). 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 (eggs and sperm) into the surrounding water, where fertilisation takes place (Andrews et al., 2011). Following fertilisation, the 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 co-occur with favourable environmental conditions, and the planktonic larval 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 & Worrall 1980, Seed & Suchanek 1992, Handå et al., 2011).

Current threats to *M. edulis* beds include commercial fishing, poor water quality, coastal developments, anchoring, bait digging, and intensive recreational hand gathering (Maddock, 2008).

1.2 Objectives

The objective of this project is to carry out annual surveys of the public mussel beds on the Teign Estuary, to define where the mussel beds are and accurately map, using GIS, the overall extent of each of the mussel beds. Devon & Severn 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 Teign and the development of shellfisheries in this part of the Devon & Severn IFCA District.

2. Methodology

2.1 The Teign Estuary

The Teign Estuary is situated on the south coast of Devon, within the Devon and Severn Inshore Fisheries and Conservation Authority (D&S IFCA) District, and consists of an East-West aligned, broad tidal river channel. It has no current Marine Protected Area designation. Commercial harvesting of mussels (*Mytilus edulis*) and pacific oysters (*Magallana gigas* formally known as *Crassostrea gigas*) occurs in the Teign under the River Teign Mussel Fishery Order 1966 and the River Teign Mussel Fishery (Variation) (Oysters) Order 1995, (Teign Estuary Partnership, 2004). Figures 1 & 2 show the classified shellfish waters and production areas of the Teign Estuary, and the harvesting areas for *M. edulis* and *M. gigas*. From 1st May 2019, D&S IFCA introduced a temporary closure for the removal of mussels from the public shellfish beds in the Teign Estuary east of Shaldon Bridge due to the stocks being severely depleted.

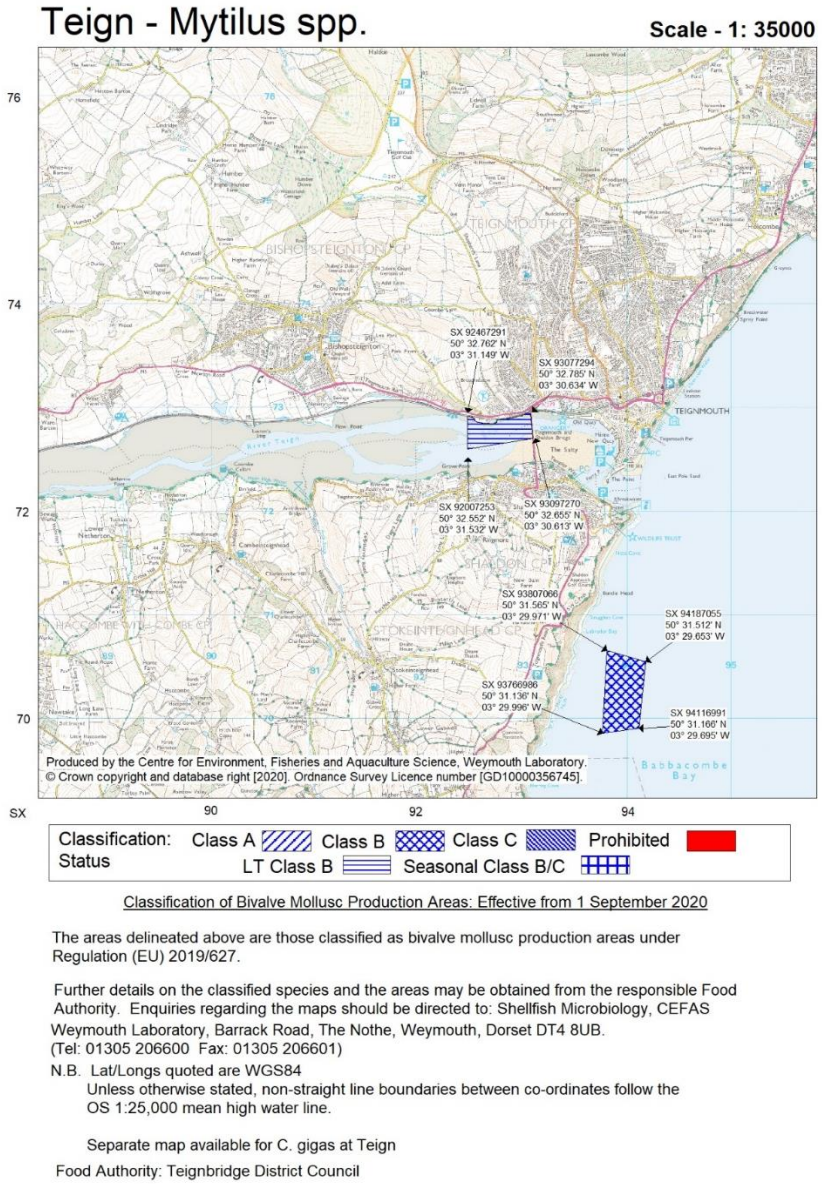

Figure 1 Classified Mussel Harvesting Areas on the Teign Estuary (Cefas, 2020)

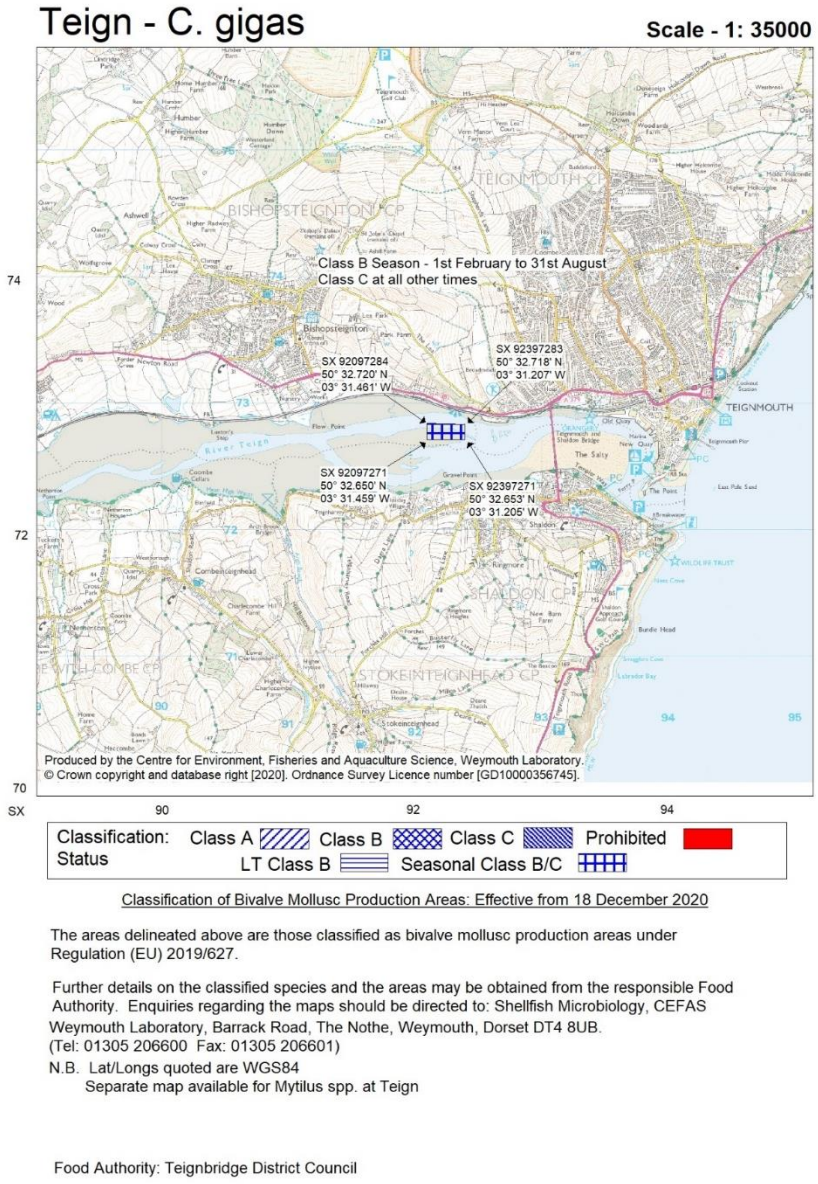

Figure 2 Classified Pacific Oyster Harvesting Areas on the Teign Estuary (Cefas, 2020)

2.2 Survey methodology

Surveys were conducted at Polly Steps and The Salty in 2012 and 2018–2020. All sites are surveyed on spring tides to ensure the full extent of the mussel beds are accessible.

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 rather 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 the survey areas within the Teign estuary were recorded on the first visit to each bed by walking the extent of the live mussel habitat and marking coordinates with a handheld GPS. Each bed was first visited in 2012. The perimeters were subsequently

mapped in QGIS v3.1(Figure 3). For subsequent visits, the perimeter is determined by using the start and end coordinates of the transects.

To determine coverage and patch density transects were walked in a zig-zag pattern across the survey area, up to the extent of live 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 (each pace consisting of 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.

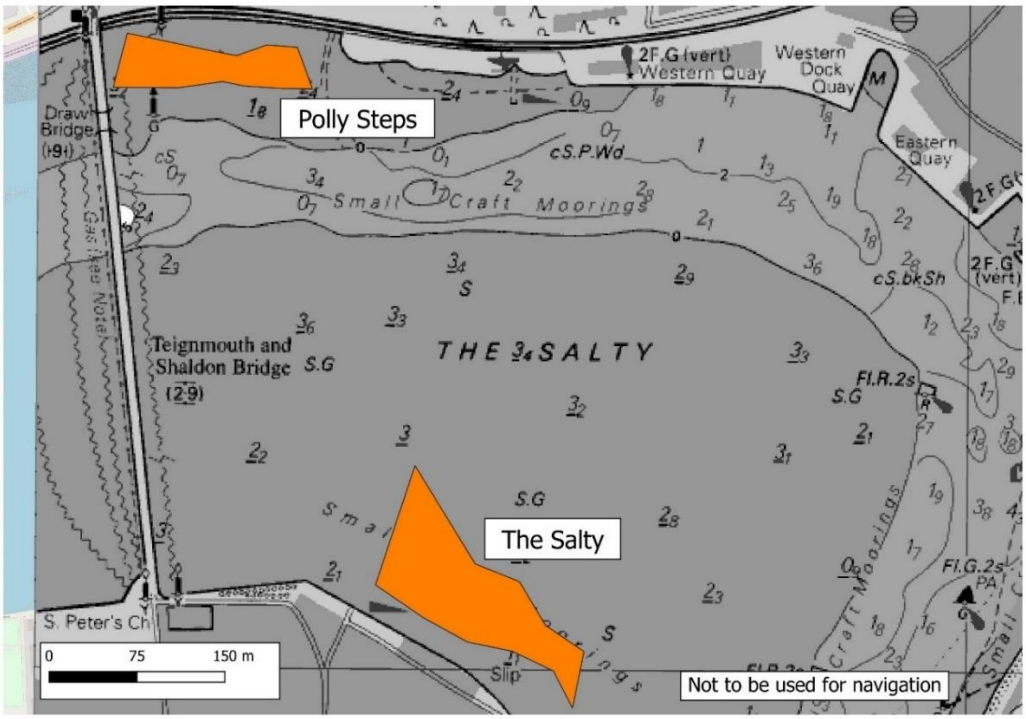

Figure 3 Area of each mussel bed surveyed (orange)

Once all transects were complete the mussel samples were sieved and cleaned. For each transect the number of samples taken was recorded, all mussels were 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. Size distribution data were obtained from the length measurements of mussels in the retained samples.

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

3.1 Combined survey sites

Both The Salty and Polly Steps were surveyed on 01/09/2020. A third bed (Shaldon) was surveyed in 2019, but in this analysis (and in previous years – 2018 and 2012) the Shaldon area was considered as part of the Salty bed. Since 2019 there has been a 16% increase in the total tonnage of mussel across all beds surveyed. Conversely, there was an 86% decrease in the area of the beds (Figure 5), however this could be due to the fact that in 2019 the whole area of The Salty was included in the survey area, not just the area containing mussel. The area of The Salty that was surveyed in 2020 was more similar to that surveyed in 2018. This discrepancy in bed area also impacts the estimates of percentage cover and mussel density across the sites (Figure 6), which show large increases from 2019. Similar to 2019, the whole area of the Salty was surveyed in 2012.

Mussel stock of marketable size (>41mm) increased from 96% in 2019 to 100% in 2020 (Figure 7), with no spat (<30mm) being detected in the period 2018-2020.

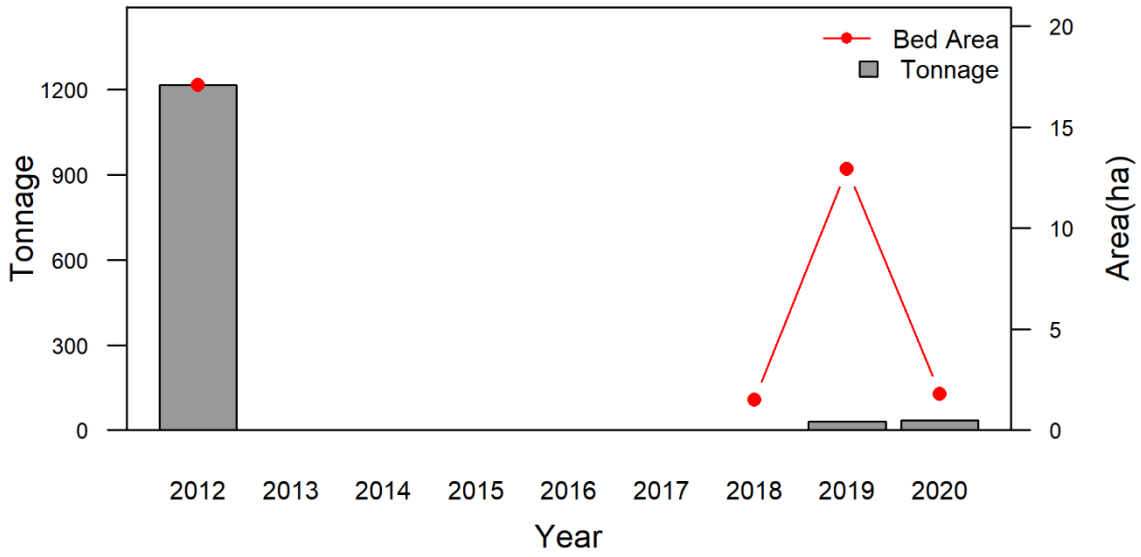

Figure 5 Total area surveyed plotted over tonnage of total stock within all survey areas in 2012 and 2018-2020.

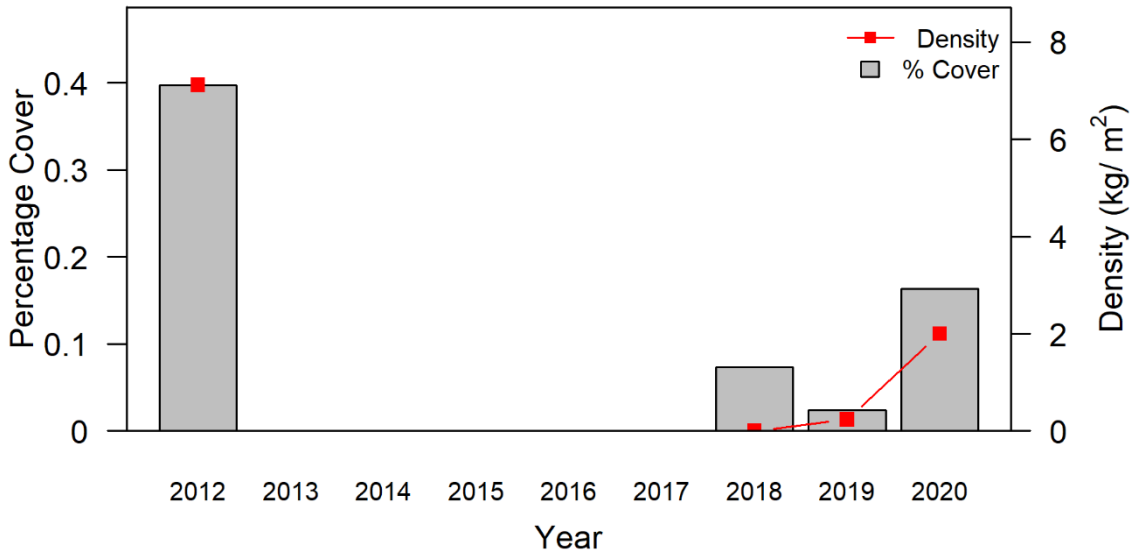

Figure 6 Percentage cover and density of mussel across all sites in 2012 and 2018-2020.

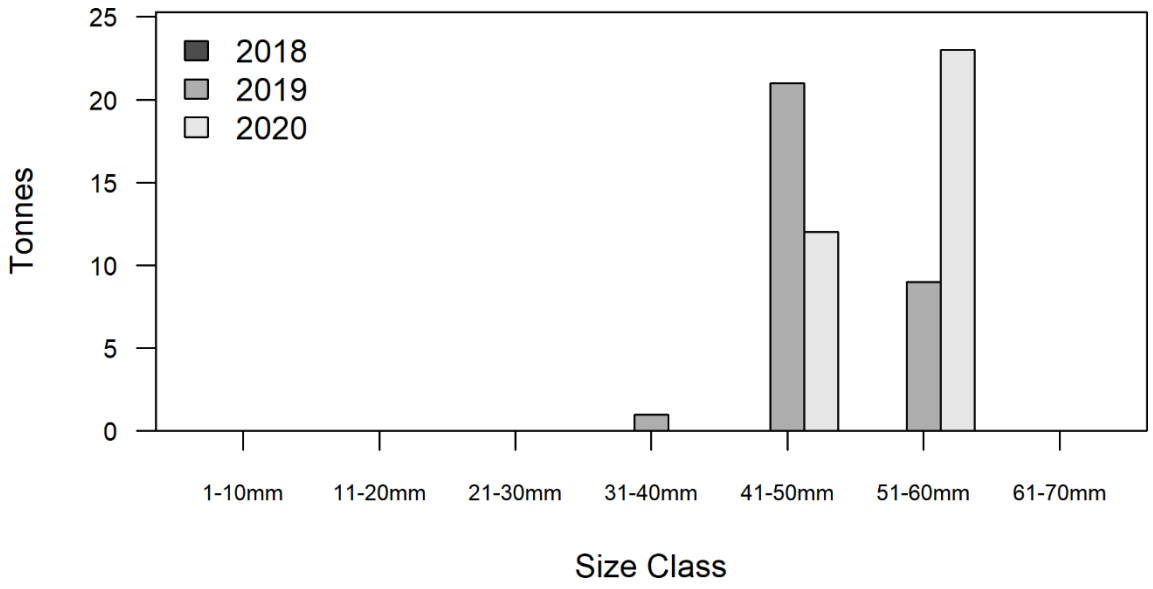

Figure 7 Total Combined 10mm size class for 2018-2020 stock.

3.2 The Salty

Across The Salty nine samples were collected from 11 transects. The area of the bed surveyed declined by 90% in 2020 when compared to 2019 (Figure 8), this was explained in section 3.1 above. Likewise, this is again reflected in increases in density and coverage of mussel across the bed/survey area (Figure 9). A positive sign for the bed is the increase in stock from zero in 2019 to 36 tonnes in 2020 (Figure 8). All of this stock is >41mm (Figure 10).

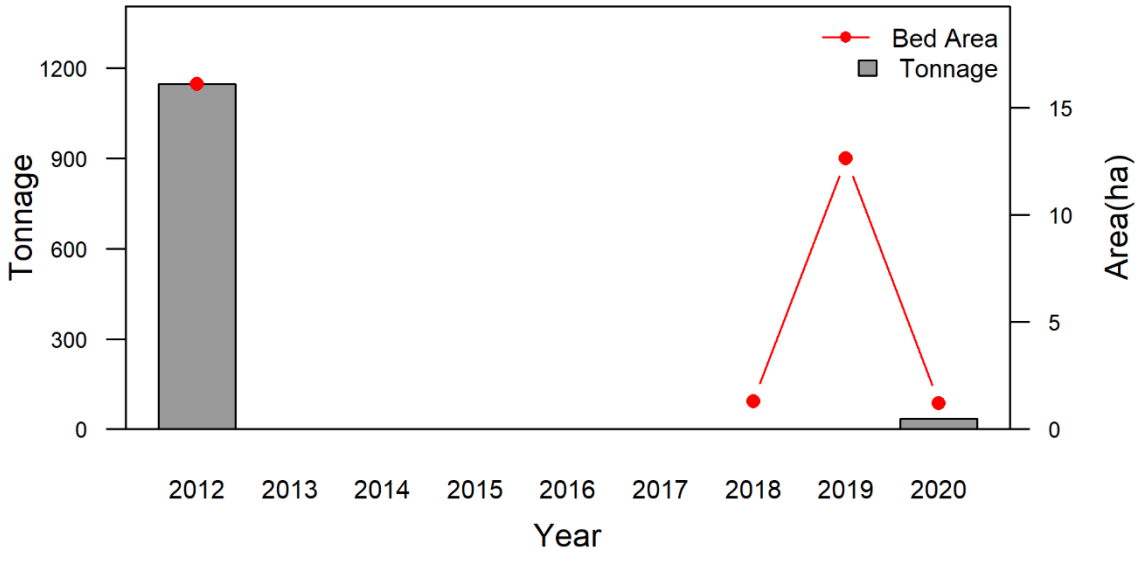

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Figure 8 Total area surveyed plotted over tonnage of total stock within The Salty mussel bed in 2012 and 2018–2020.

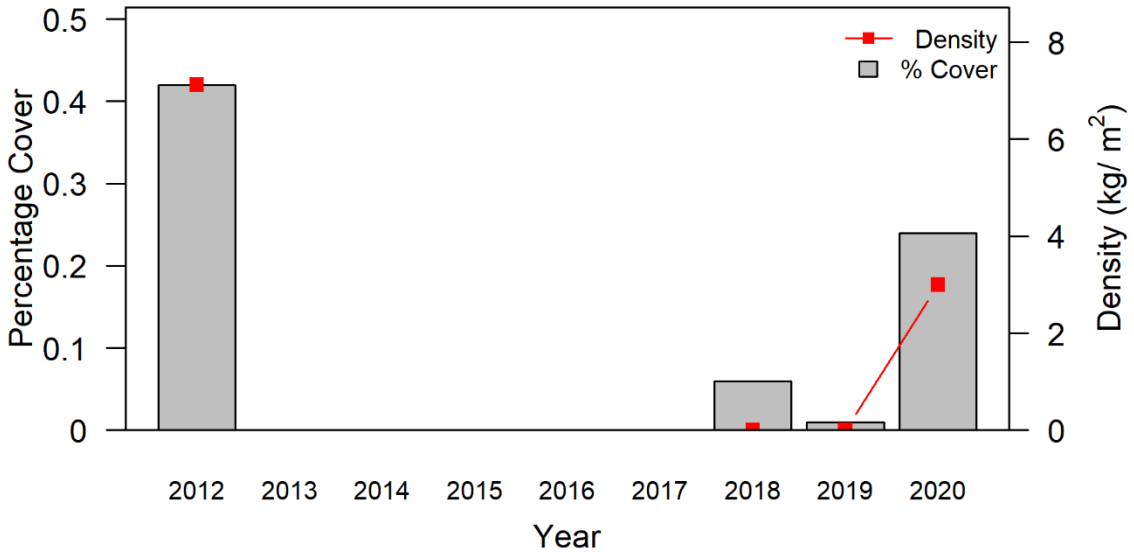

Figure 9 Percentage cover and density of mussel across The Salty in 2012 and 2018-2020.

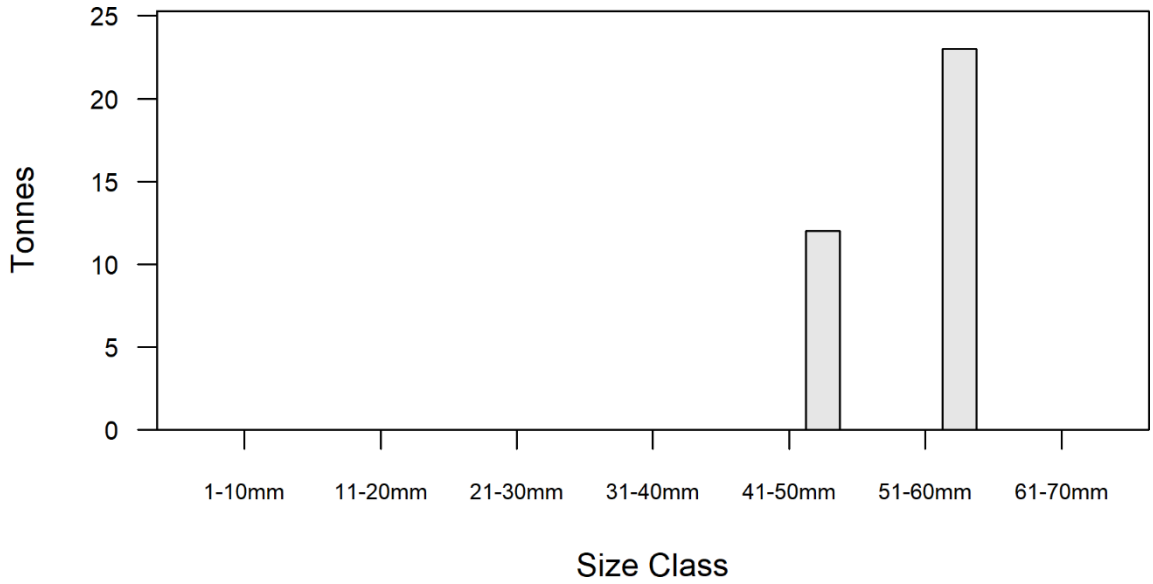

Figure 10 Tonnage of each 10mm size class for The Salty 2020 stock.

3.3 Polly Steps

No samples were collected from the 10 transects conducted on the Polly Steps bed in 2020, as only one “hit” was recorded on one transect. Therefore, there is no data available on the size class of mussel found on this bed. Despite a 200% increase in the surveyed area in 2020 compared to 2018, the tonnage remained negligible. Mussels are present in the survey area, but as not enough ‘hits’ were recorded on the transects due to the sparse nature of the mussels, therefore no samples were collected and estimates of tonnage were not able to be made. (Figure 11). Percentage cover and mussel density is still able to be calculated from the number of ‘hits’. In 2018, 13 “hits” were recorded across 10 transects, equating to a higher percentage coverage across the bed. There was a 93% decrease in percentage cover from 2018 to 2020 (Figure 12).

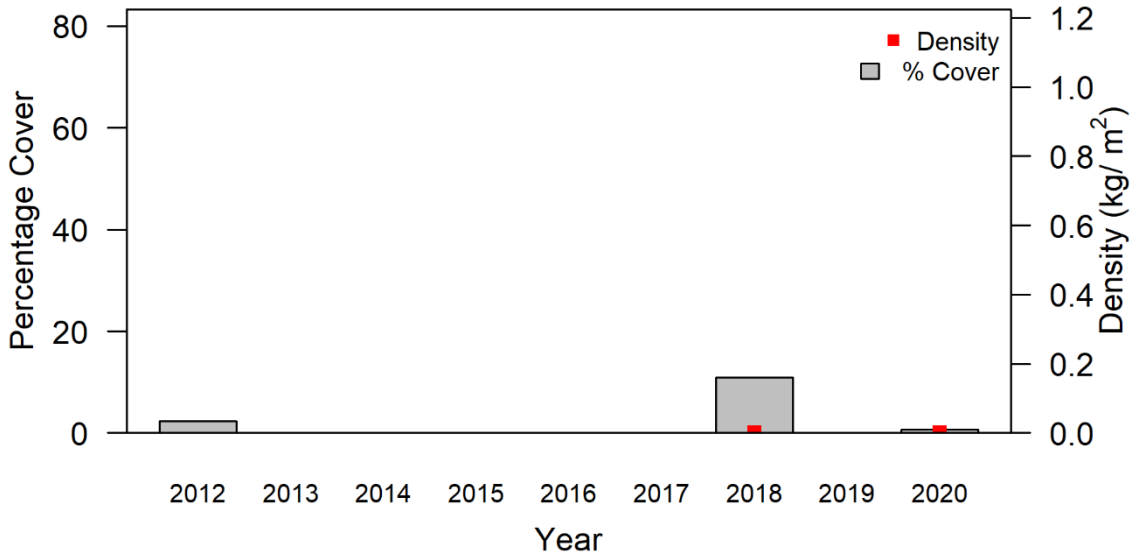

Figure 12 Percentage cover and density of mussel across Polly Steps in 2012, 2018 & 2020.

4. Discussion

Mussel populations within the Teign crashed between the 2012 and 2018 stock assessments, possibly due to the large storms in 2014 which may have scoured away once previously stable beds. Mussel beds in 2012 covered 42% of The Salty, totalling 1148 tonnes (Gray, 2012). Both The Salty and Polly Steps are no longer habitats on which large expanses of dense live mussel can be found, and live mussel is negligible in both areas except for very small areas where sparse patches of live mussel can be found.

The total area of mussel bed surveyed has varied significantly between years, especially on the Salty bed. In 2012 and 2019, the majority of the accessible area (whether mussel was obviously present or not) was surveyed, whereas in 2018 and 2020 smaller areas of the Salty (only where mussel presence was obvious) were surveyed. These differences in survey methods between years has resulted in a lack of inter-annual data comparability. The estimated density and percentage cover of mussels in 2018 and 2020 are likely over-estimates of overall density and percentage cover in the total area as the survey effort was focussed on areas with higher density or cover. Surveying larger areas using the same zig-zag transect method may have also caused some data comparability problems as in the larger survey areas the transect lengths would have been much longer and therefore the likelihood of acquiring the five ‘hits’ necessary to collect a sample will be greater. Although surveying smaller areas saves time, data comparability should be considered when interpreting the results and in planning future surveys.

No mussel spat (>30mm) has been detected on the estuary during the past three years (Figure 7). Between 2019 and 2020 there was a decline in stock sized 31-50mm and an increase in that sized 51-60mm. This suggests that there is unlikely to be much new recruitment or settlement of mussel spat on the Teign, and the increase in total stock tonnage is likely to be a result of mature mussel growing on into larger size classes.

In 2019 a mussel bed at Shaldon was surveyed separately from the Salty, despite being within the area of the Salty that was surveyed in 2012. The bed is almost permanently submerged apart from at extreme low water during the spring tide, which may explain why it was not re-surveyed until 2019. In 2019, this area was relatively dense and homogenous, containing an estimated 31 tonnes of mussel, so its presence on the estuary is a positive sign, as there is the potential over time for it to aid the recovery of previous mussel habitat by being a stable brood resource for the recruitment by mussel larvae (Andrews et al., 2011). In 2020, the Shaldon area was included in the Salty data, which meant the tonnage, percentage cover and density of mussels in The Salty survey area appeared to increase, despite a reduction in overall survey area. The area of mussel beds surveyed in future years should be carefully considered and future analysis should combine the Shaldon mussel bed with The Salty.

Depending on spawning times, the annual surveys may miss annual periods of heightened spat settlement (Bayne & Worrall, 1980). It should be noted the 2020 surveys were carried out later in the year than usual, due to COVID-19 lockdown restrictions, so spat recruitment levels could be linked to survey timings in relation to the seasonality of mussel spawning. Additionally, spat recruitment could be being underestimated due to the survey methodology, e.g. the smallest sizes could be being lost through the sieving process.

5. Recommendations

It is recommended that stock assessments continue to be undertaken on an annual or biennial basis, to monitor any future changes and to detect any signs of recovery and or seed settlement. This will help to inform any future management measures that D&S IFCA may consider for the collection of mussels. Polly Steps should be included in each survey for consistency.

The survey areas and methodology should be reviewed prior to future surveys and should consider how to improve interannual comparability of data sets, as well as how to ensure all sizes of mussels are being sampled.

The use of a fine mesh sieve is recommended for subsequent surveys to help establish whether spat recruitment <20mm is being underestimated due to survey technique. During the years where surveys are undertaken a second survey is also recommended to detect temporal changes to spat recruitment across the year, however it must be noted that due to resources and time constraints this is most likely not feasible.

The 2019 temporary closure of the Teign Estuary's public shellfish beds should remain in place for the foreseeable future until such time where there are established mussel beds considered both dense and large enough for sustainable exploitation.

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