Teign Estuary
Mussel Stock Assessment 2022

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March 2023

Devon & Severn IFCA
Inshore Fisheries and Conservation Authority

Contents

Version control history			
Author	**Date**	**Comment**	**Version**
SCu	20/09/2022	Draft report	0.1
	27/09/2022	Review by J Stewart	0.2
	07/03/2023	SCu amendments following JS review	0.3
	08/03/2023	Report finalised by JS	1.0

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 (JNCC, 2011). 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 (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 (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 (JNCC, 2011).

1.2 Objectives

The objective of this project is to carry out and report on biennial 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. 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 mussels, which can be compared to previous years. 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 Study Site: 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.

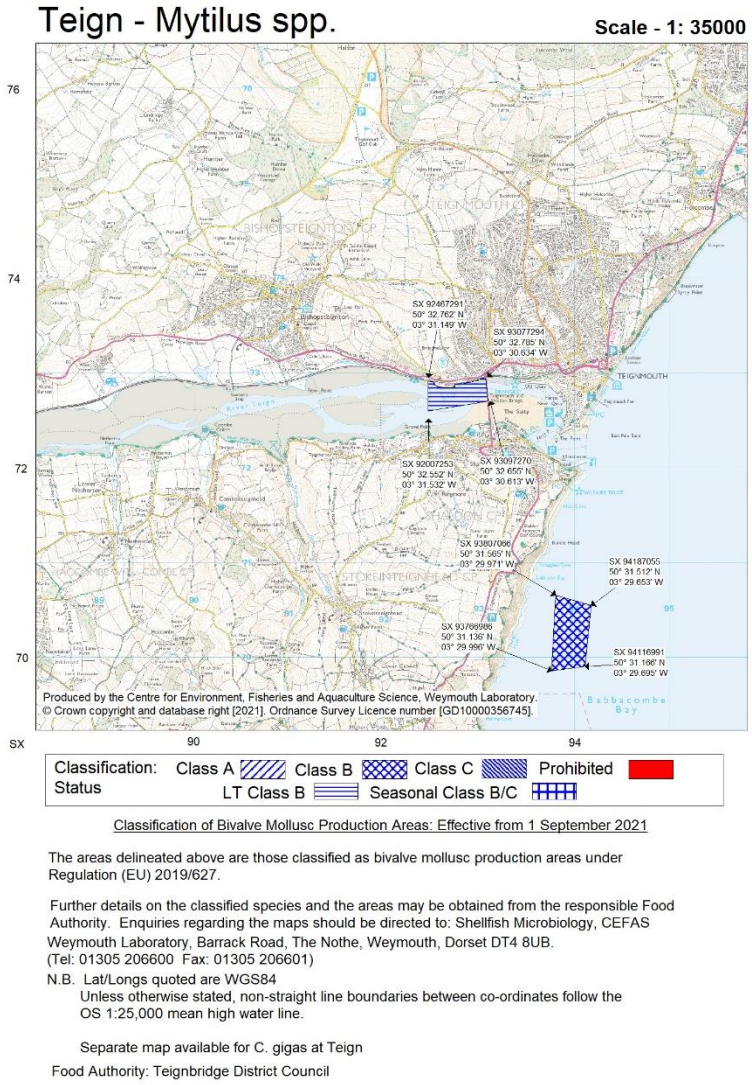

Figure 1 Classified Mussel Harvesting Areas on the Teign Estuary as they were classified during the surveys reported here (Cefas, 2021). Up to date classification zone maps are available on the Cefas website.

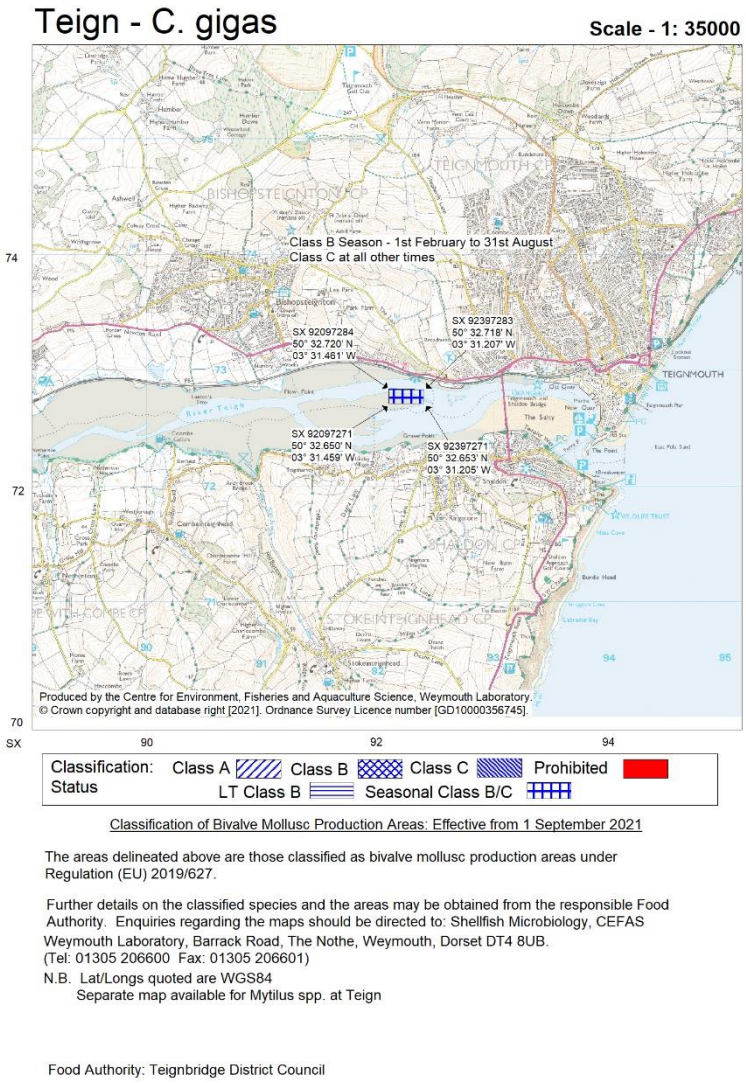

Figure 2 Classified Pacific Oyster Harvesting Areas on the Teign Estuary as they were classified during the surveys reported here (Cefas, 2021). Up to date classification zone maps are available on the Cefas website.

2.2 Survey methodology

This document reports on surveys conducted at Polly Steps and the Salty in 2012 and 2018-2022. A new site adjacent to the Salty was also surveyed in 2022. In this and future reports, this area will be referred to as 'Salty East', until such time as the Salty and Salty East areas merge together. Both The Salty and Salty East were surveyed on 14th July 2022 during a spring low 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. Polly Steps was visited on 15th August 2022 but due to the observed absence of live mussel, no transects were walked and no samples were taken. Instead, two officers conducted a visual sweep search of the Polly Steps 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.

A follow up visual sweep was conducted of The Salty and Salty East on 16th August 2022 to determine if there had been any change in the bed area over a short period of time following the July survey (Figure 4).

In Figure 4, the visual sweep areas shown under the Teignmouth and Shaldon Bridge, the Salty and Salty East all represent the edge of the bed walked by officers, within which mussel was present. The visual sweep area at Polly Steps indicates the area searched but in which no live mussel was found.

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 area was recorded on the first visit to each bed by walking the extent of the live mussel habitat and marking coordinates with a handheld GPS. The Salty and Polly Steps were first visited in 2012. Salty East was first visited on the survey date in July 2022. The perimeters were subsequently mapped in QGIS v3.2 (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.

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.

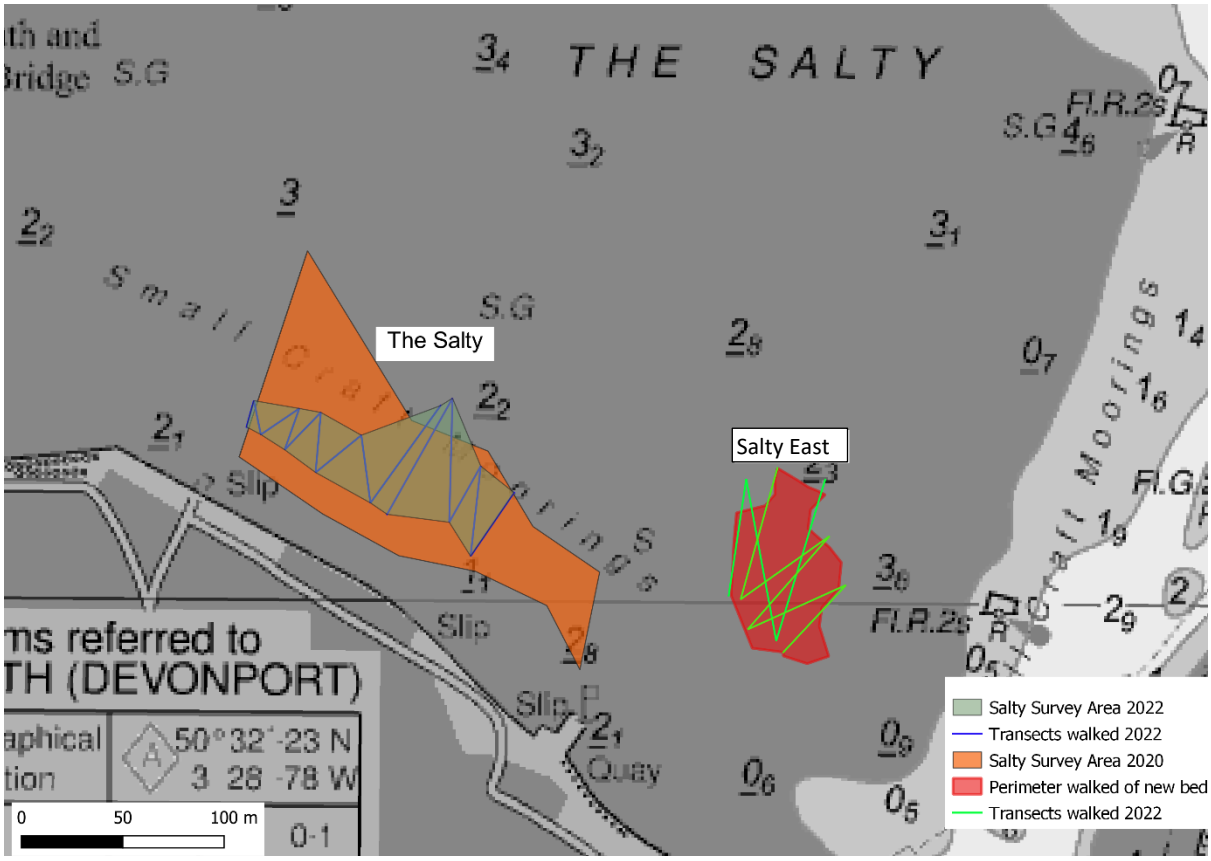

Figure 3 Area of mussel bed at the Salty in 2020 (orange) and 2022 (green). Transect lines walked in 2022 are shown in blue. Bed area mapped by generating a minimum convex polygon around the transect lines. The new area of mussel bed (Salty East) is shown in red.

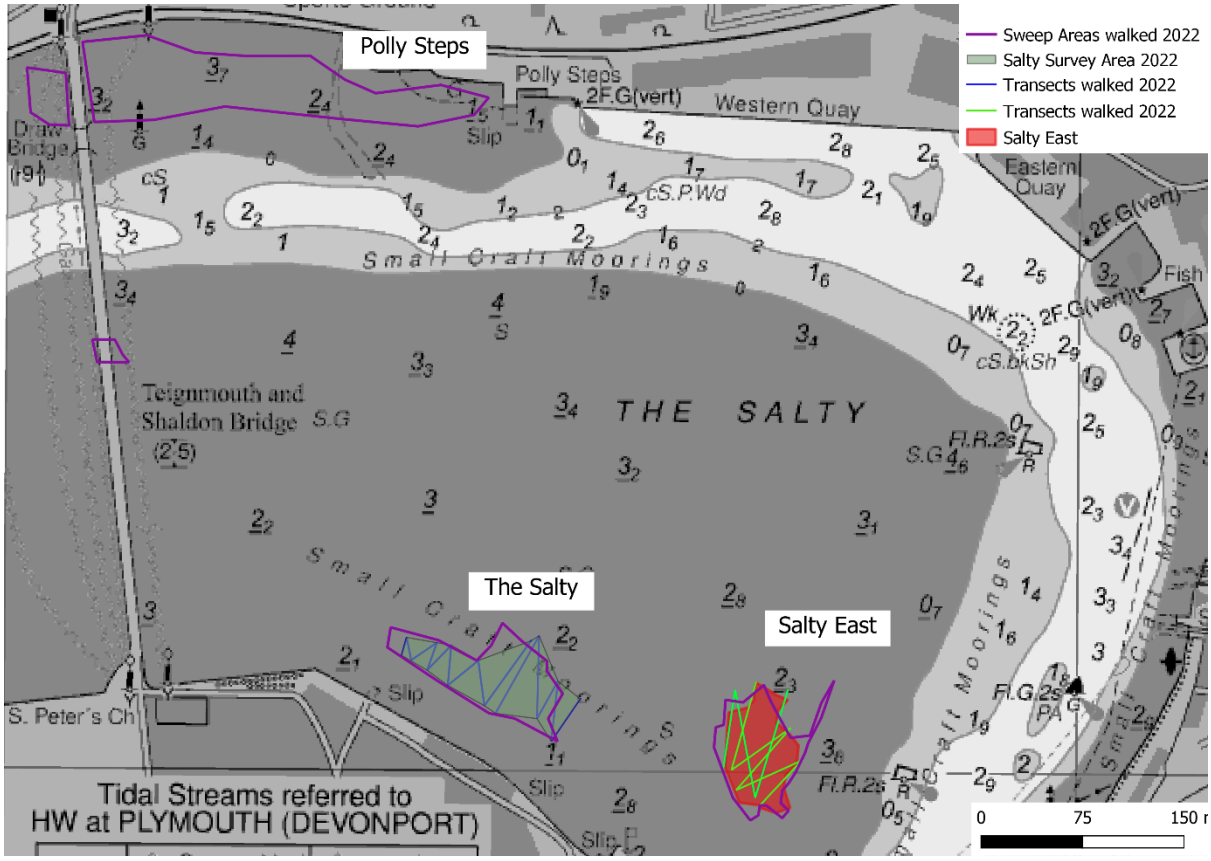

Figure 4 Area of mussel bed at the Salty in 2022 (green). Transect lines walked are shown in blue. Bed area mapped by generating a minimum convex polygon around the transect lines. The new area of mussel bed (Salty East) is shown in red. Perimeters of the areas where visual sweeps were conducted are shown in the purple outline. For the visual sweep areas under the Teignmouth and Shaldon Bridge, the Salty and Salty East, these areas represent the edge of the bed walked by officers, within which mussel was present. The visual sweep area at Polly Steps indicates the area searched but in which no live mussel was found.

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 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 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

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

Equation 3: Calculation of mussel tonnage

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

3. Results

The results presented here focus on the areas in which mussels were found and which were surveyed using the transect methodology outlined in section 2.2. No mussel was found at Polly Steps during a dedicated visual sweep by two Officers (Figure 4) so this area was not formally surveyed. A small area of mussel was found under the Teignmouth and Shaldon Bridge (Figure 4) and the perimeter of this patch was walked. However, the patch was too small for a formal transect. Areas referred to here as the Salty and Salty East were surveyed with transects.

3.1. The Salty

A total of 16 samples were collected from 14 transects on the Salty. The area surveyed declined by 42% in 2022 compared to 2020 (Figure 8). The northern and south-eastern area that was surveyed in 2020 was not included in the 2022 survey (Figure 3) either due to mussel being absent (northern area) or the bed being inaccessible due to tide and channel position (south-eastern area). Despite this difference in surveyed area, the total tonnage of stock has remained the same (Figure 5) and increases in density and coverage of mussel across the bed/survey area were observed (Figure 6). Of the total 36 tonnes of stock observed in 2022, 83% of this was of marketable size (>41mm) and 2.8% was spat (<30mm) (Figure 7).

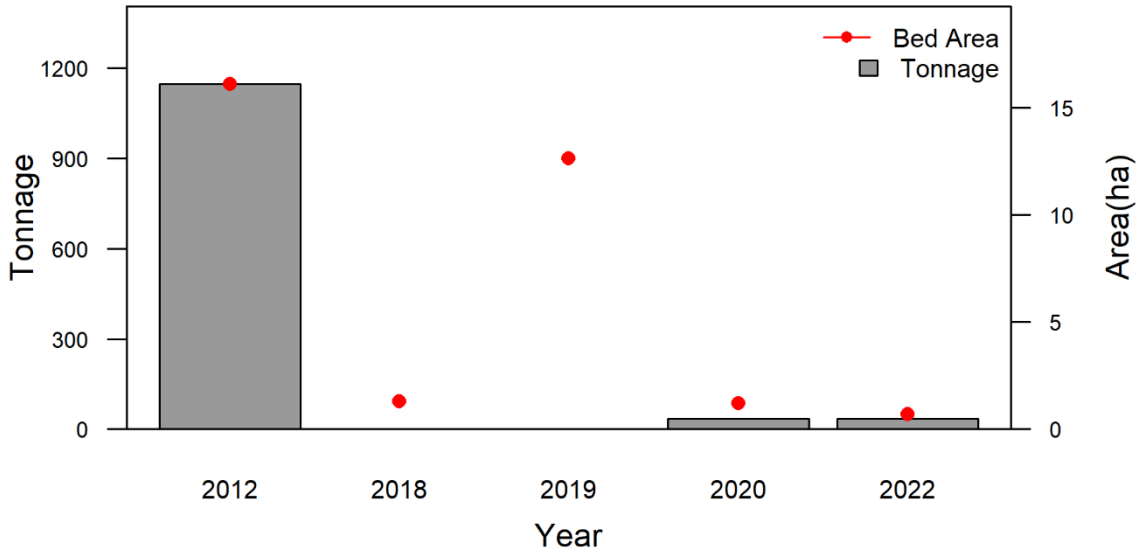

Figure 5 Total area surveyed plotted over tonnage of total stock within the Salty mussel bed in 2012 and 2018–2022. The "Bed Area" represents the surveyed area and may not be representative of the area over which mussel was distributed. For example, in 2019 a large area of the Salty was surveyed but there were no high density patches of mussel and so no samples were taken from which to estimate tonnage.

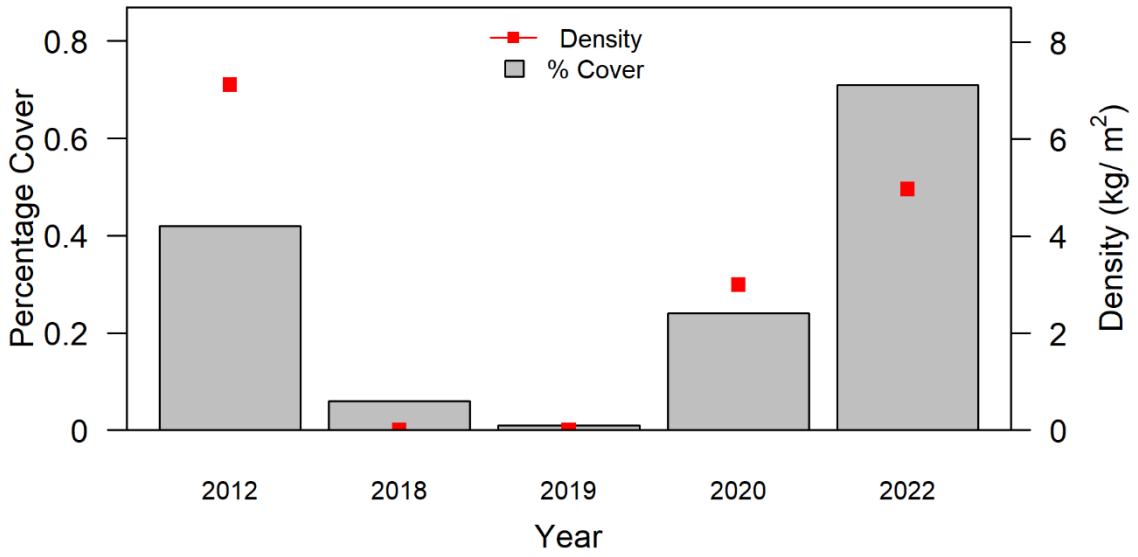

Figure 6 Percentage cover and density of mussel across the Salty in 2012 and 2018-2022.

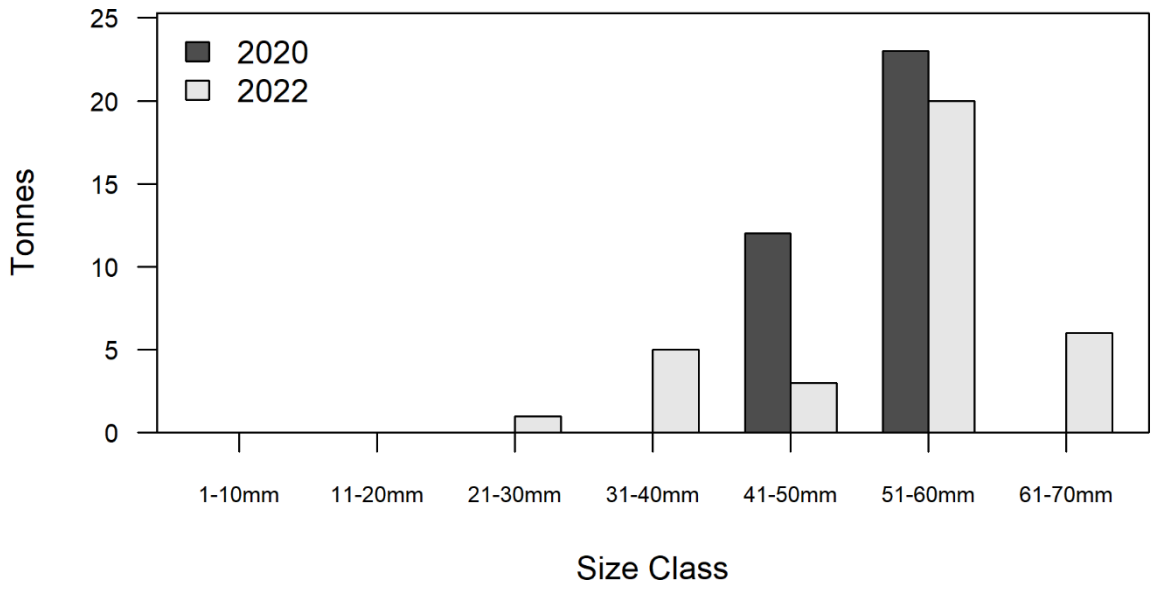

Figure 7 Tonnage of each 10mm size class for the Salty 2020 and 2022 stock.

3.2. Salty East

A local stakeholder advised D&S IFCA of an area adjacent to the Salty where live mussel had been observed. This area was subsequently surveyed on 14th July 2022, and 22 samples were collected from 8 transects. The surveyed bed covered 0.4 hectares and contained a calculated 11 tonnes of mussel. Salty East had a density of 3.24 kg m^{-2} of mussel with 82% coverage. Of the 11 tonnes of stock observed in 2022, 27% of this was of marketable size (>41mm) and 27% was spat (<30mm).

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, and due to intentional removal of raised areas of mussel around boat moorings on the Salty. Mussel beds in 2012 covered 42% of The Salty, totalling 1148 tonnes (Gray, 2012). Both The Salty and Polly Steps are no longer areas on which large expanses of dense live mussel are found; live mussel is present on the Salty but the area surveyed has varied significantly between years and the presence of live mussel was effectively negligible at Polly Steps.

In 2012 and 2019, the majority of the accessible area on the Salty (whether mussel was obviously present or not) was surveyed, whereas in 2018, 2020 and 2022 smaller areas (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 but were useful in demonstrating the widespread absence of mussel across the Salty in years in which the survey area was large. The estimated density and percentage cover of mussels in 2018, 2020 and 2022 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.

Between 2020 and 2022 there was a decline in stock sized 41-60mm and an increase in that sized 61-70mm. This increase in larger mussel size could suggest that mature mussel has grown into larger size classes over the last two years, or some mussel may have been missed during the survey conducted in 2020.

Mussel spat (<30 mm) has been absent across the estuary during the previous two surveys (Figure 7), however 6.5% of the stock observed in 2022 was spat (<30 mm), the majority of this being on Salty East. Salty East contained an estimated 11 tonnes of mussel, which was spread across the 11-60mm size classes .This would indicate that some of the bed was previously included in the area surveyed in 2019. Although the 2019 report indicated there was negligible evidence of live mussel within the survey area, there was a small patch adjacent to Salty East that contained low density of live mussel. This small patch could have therefore grown in density and spatial distribution to become the patch that is referred to here as Salty East. In 2020 the survey area focused more on the area of the Salty Shaldon, as the 2019 report indicated that this area contained a high density of mussel whereas there was little or no mussel present elsewhere. As a result Salty East was not included in the area surveyed in 2020. Although Salty East is small it has potential to continue to grow in both density and spatial distribution to possibly merge with the Salty. In addition, it has the potential over time to aid recovery of previous mussel habitat by being a stable brood resource for the recruitment by mussel larvae (Andrews et al., 2011). On-going monitoring should provide data relating to the rate and scale of any recovery and future analysis should consider combining Salty East with the Salty, depending on contiguity of these areas over the coming years.

5. Recommendations

It is recommended that stock assessments continue to be undertaken on a 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.

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. Consideration should be given to visiting the mussel beds during 2023 to attempt to identify any significant changes. In addition, engagement with local stakeholders should be continued in order to obtain information on of the state and extent of the mussel beds.

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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