Teign Estuary
Mussel Stock Assessment 2019

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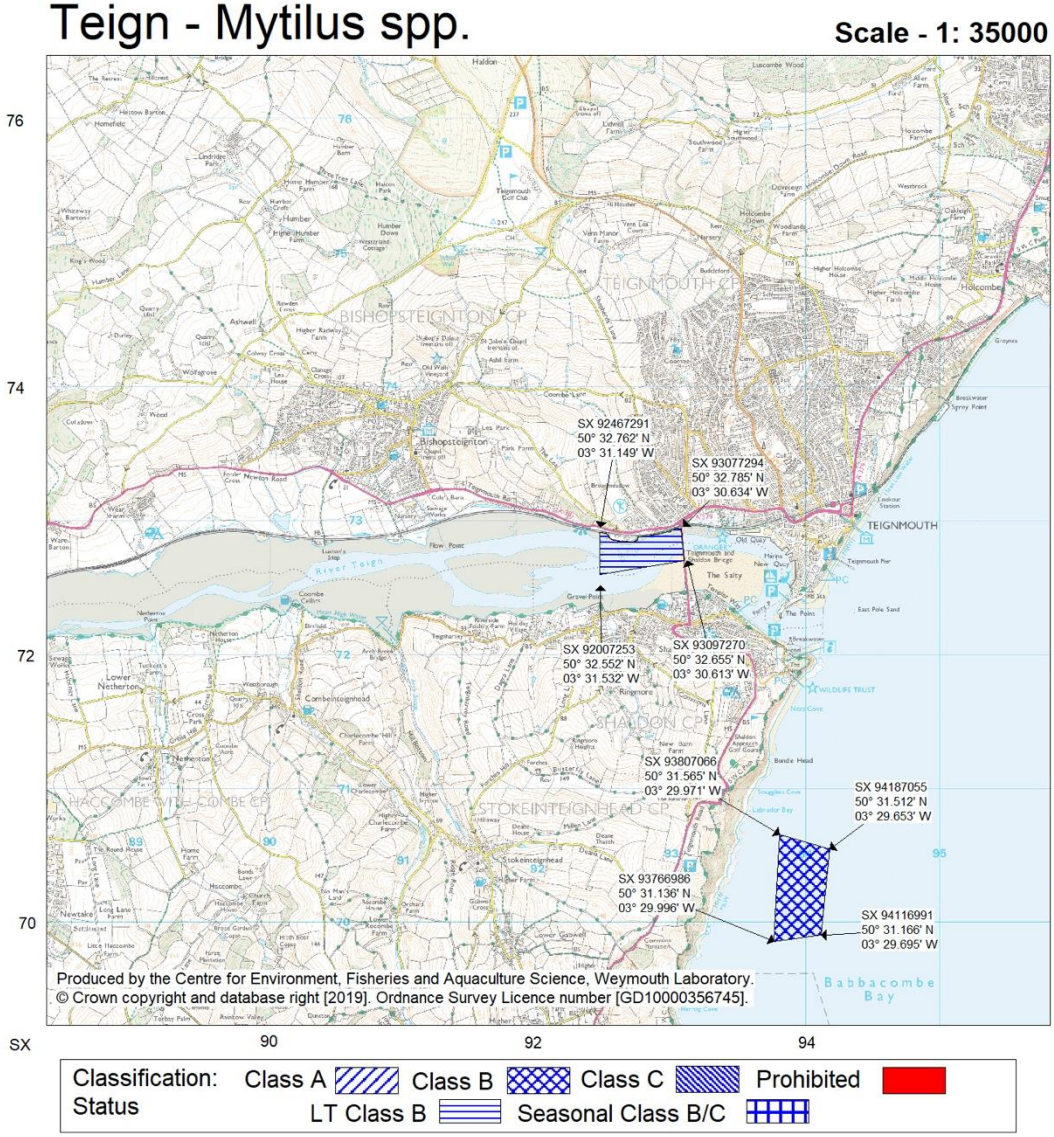
Contents

1. Introduction

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. There has been shellfish harvesting and aquaculture in Devon's estuaries for hundreds of years. The main harvest has been mussels and oysters. 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 - 3 show the classified shellfish waters and production areas of the Teign Estuary, and the harvesting areas for *M. edulis* and *M. gigas*. From the 1st May 2019, D&S IFCA introduced a temporary closure for the removal of mussels on the public shellfish beds in the Teign Estuary East of Shaldon Bridge due to the stocks being severely depleted.

The objective of this research is to carry out annual surveys of the public mussel beds located East of Shaldon bridge within the Teign Estuary, to define and accurately map, using GIS where live mussel is present. 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 between years. This will help inform future management of the public mussel beds on the Teign Estuary and the development of shellfisheries in this part of the D&S IFCA's District.



Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2019

The areas delineated above are those classified as bivalve mollusc production areas under EU Regulation 854/2004.

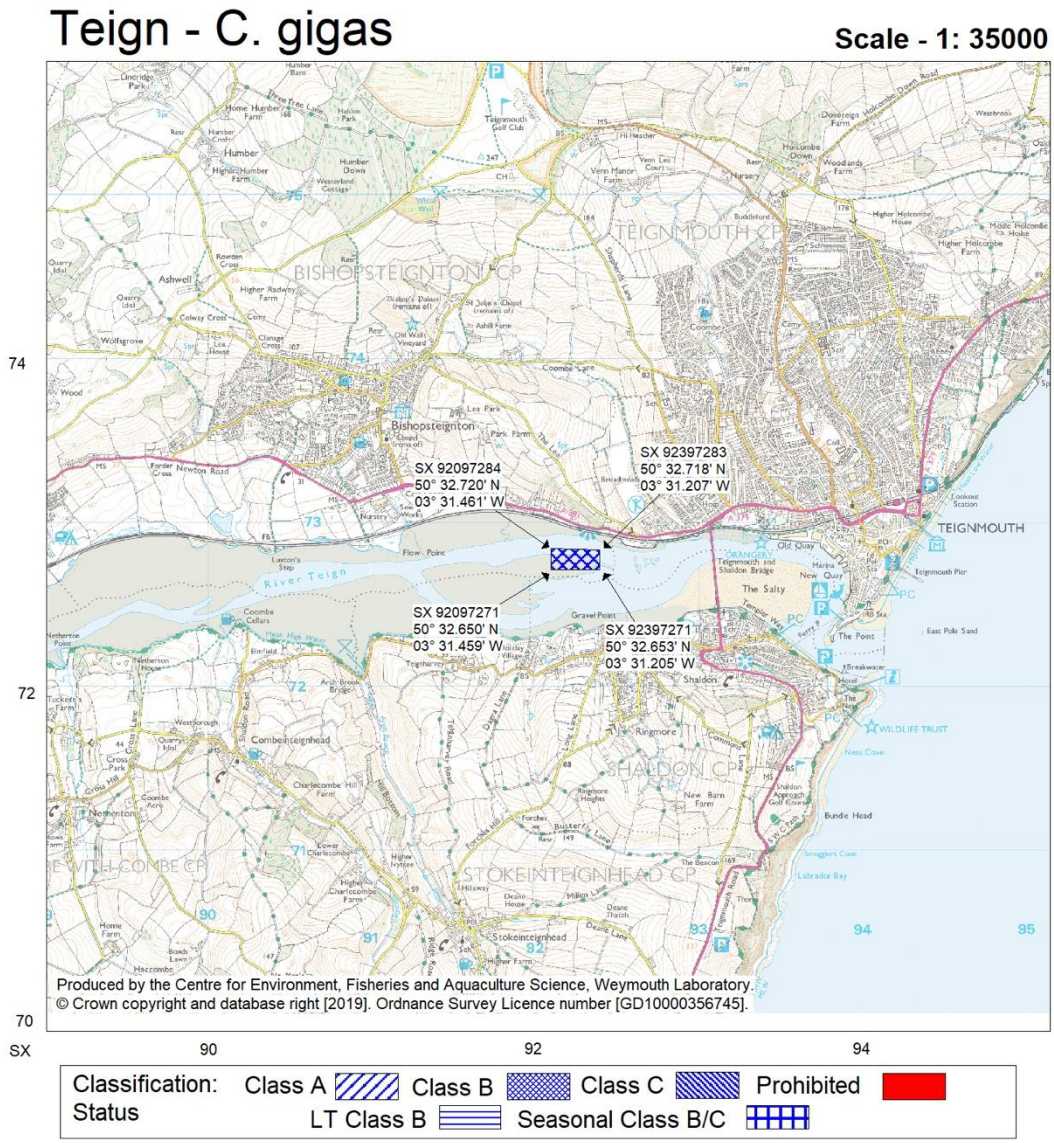
Further details on the classified species and the areas may be obtained from the responsible Food Authority. Enquiries regarding the maps should be directed to: Shellfish Microbiology, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB.
(Tel: 01305 206600 Fax: 01305 206601)

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.

Separate map available for C. gigas at Teign

Food Authority: Teignbridge District Council

Figure 1 Classified Mussel Harvesting Areas on the Teign Estuary (Cefas, 2019)



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Separate map available for Mytilus spp. at Teign

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Figure 2 Classified Pacific Oyster Harvesting Areas on the Teign Estuary (Cefas, 2019)

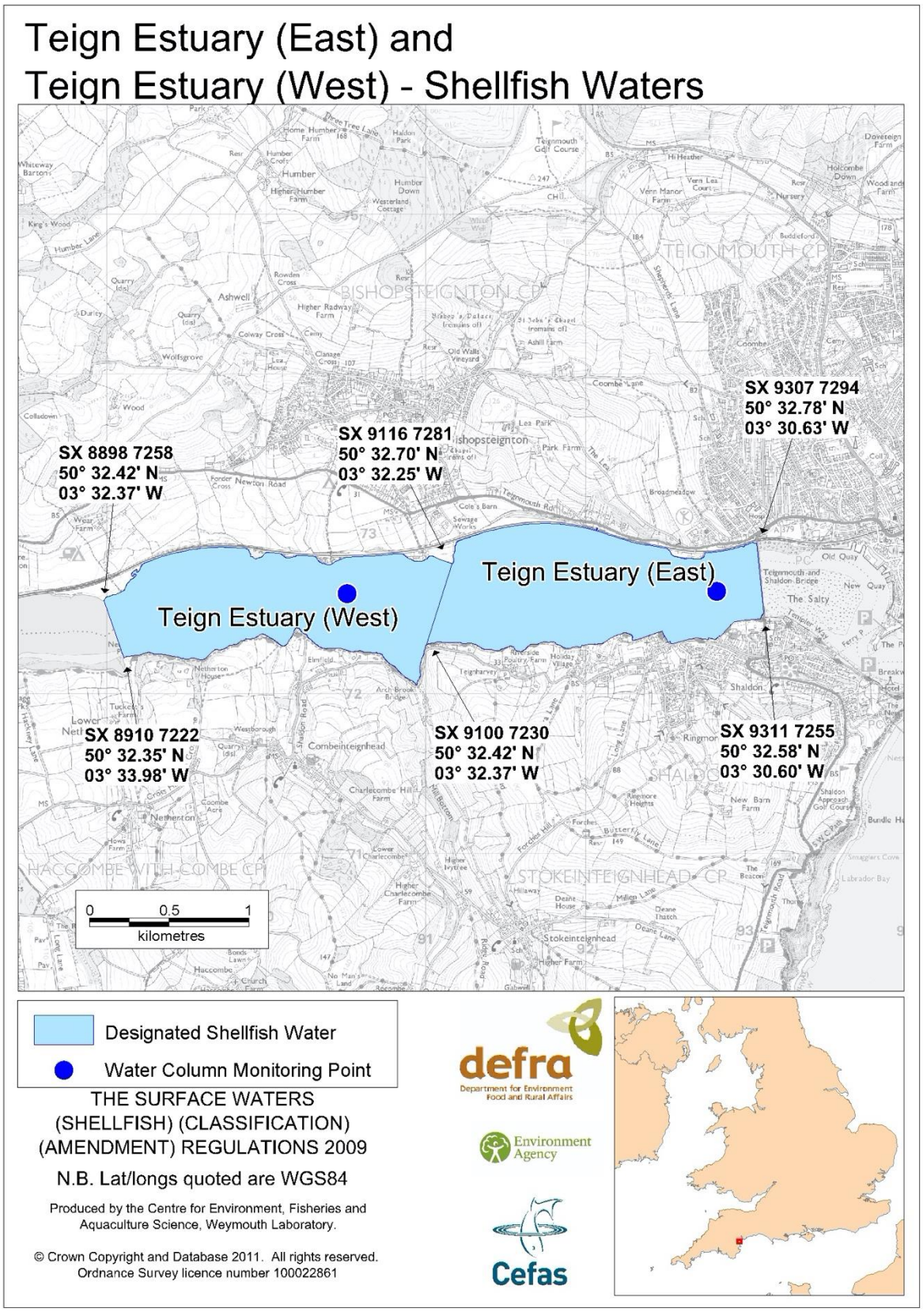

Figure 3 Designated Shellfish Waters within the Teign Estuary (Cefas, 2011)

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 at 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).

2. Methods

Study Site

All surveys were conducted on intertidal beds in the Teign estuary, East of the Teignmouth and Shaldon bridge. Surveys focused on three named areas (Figure 4): Polly Steps (on the north bank of the Teign), The Salty (a large sediment bank to the south of the main river channel) and Shaldon (adjacent to the south bank of the Teign).

Survey techniques

Due to the varying levels of mussel patchiness and density the area surveyed is not always indicative of the size of a true mussel 'bed' and is, instead, a representation of the area in which live mussels were located. The perimeter of this survey area was recorded by walking the extent of the local live mussel distribution, and recording the geographic coordinates with a handheld GPS. These were later plotted using QGIS software (Figure 4). Where live mussels were present, but in densities too low to be surveyed effectively, the perimeter of the survey area was mapped and a qualitative visual assessment was carried out.

To determine coverage and patch density, where appropriate, transects were walked in a zig-zag pattern across the survey area, right up to the perimeter, providing optimum coverage across the transect. The start and end coordinates of each transect were recorded using a handheld GPS. The Dutch Wand technique was used to determine mussel coverage on each transect: a 4ft bamboo cane with an 11cm ring attached to the end (Dutch wand), 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 along each transect the cane was flicked out to one side and it was recorded whether it was a "hit" if the ring contains live mussels, or a "miss" if the ring did not contain live mussels. The hit/miss data were used to calculate the percentage cover of live mussels over the survey area. On every fifth hit 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.

Data analysis

Once all transects were complete, mussel samples were sieved and cleaned. For each transect the number of samples taken was recorded, all mussels were 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. The data collected from both the transects and samples were used to calculate the coverage, density and area of the survey area (Box 1), which was then used to estimate the mussel tonnage on each site. Size distribution data were obtained from the length measurements of mussels in the retained samples. The Dutch wand hit and miss data can be used to work out average density of denser mussel patches across the whole survey area.

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

$$\text{Density across bed} = \frac{\text{total mussel weight/surface area sampled}}{\% \text{ cover}}$$

Box 1 Calculations used for mussel coverage on bed, and density of mussels across bed.

3. Results

Polly Steps was surveyed on the 28th of September 2019. No evidence of any established mussel beds was seen, and a walkover of the site found instead several areas containing very sparse occurrences of live mussels, (0.18 ha in total, Figure 4). Due to the very low densities of live mussel the area was not surveyed using the Dutch wand technique and no samples were taken. The substrate was majoritively sandy/gravel and not homogenous across the surveyed site.

The Salty was surveyed on the 29th of September 2019 using the Dutch wand technique. There was negligible evidence of live mussels within the transect area (12.6 ha, Figure 4), save for two small (0.02 ha) patches at the east and south western extents. Due to low mussel density no samples were taken. Mussel covered an approximate 1% of the total survey area. The substrate was predominantly sandy/gravel with observably high amounts of mussel shell detritus.

Shaldon was surveyed on the 28th of November 2019. Live mussels were found in two distinct zones. The smaller of the two zones (Figure 4: orange, 0.01 ha) contained very low densities of live mussel whilst the larger of the two zones (Figure 4: blue, 0.3 ha) contained very dense mussel aggregations. The dense mussel at Shaldon was surveyed using the Dutch wand technique. This dense mussel area was found to cover 60% of the transect area and contain an approximate 31 tonnes of mussel. Mussel density in patches reached 17.08 kg/m^2, whilst density over the whole bed was 10.28 kg/m^2. Nine samples were taken in total, the mussels from which ranged between 31-60mm in shell length (Figure 6). Mussels ranging between 41-50mm in length contained the highest biomass and mussels ranging between 31-40 containing the lowest biomass. This dense bed was found in a shallow channel between Shaldon and The Salty, with the mussels only becoming exposed at the low water mark over the spring tide. Total mussel tonnage in the surveyed section of the estuary increased in 2018-2019 from 0 to 31 tonnes, due entirely to the discovery of the subtidal bed at Shaldon, whilst the area across all survey zones containing live mussels decreased from 1.5 hectares to 0.57 hectares, despite the inclusion of the new Shaldon bed (Figure 5).

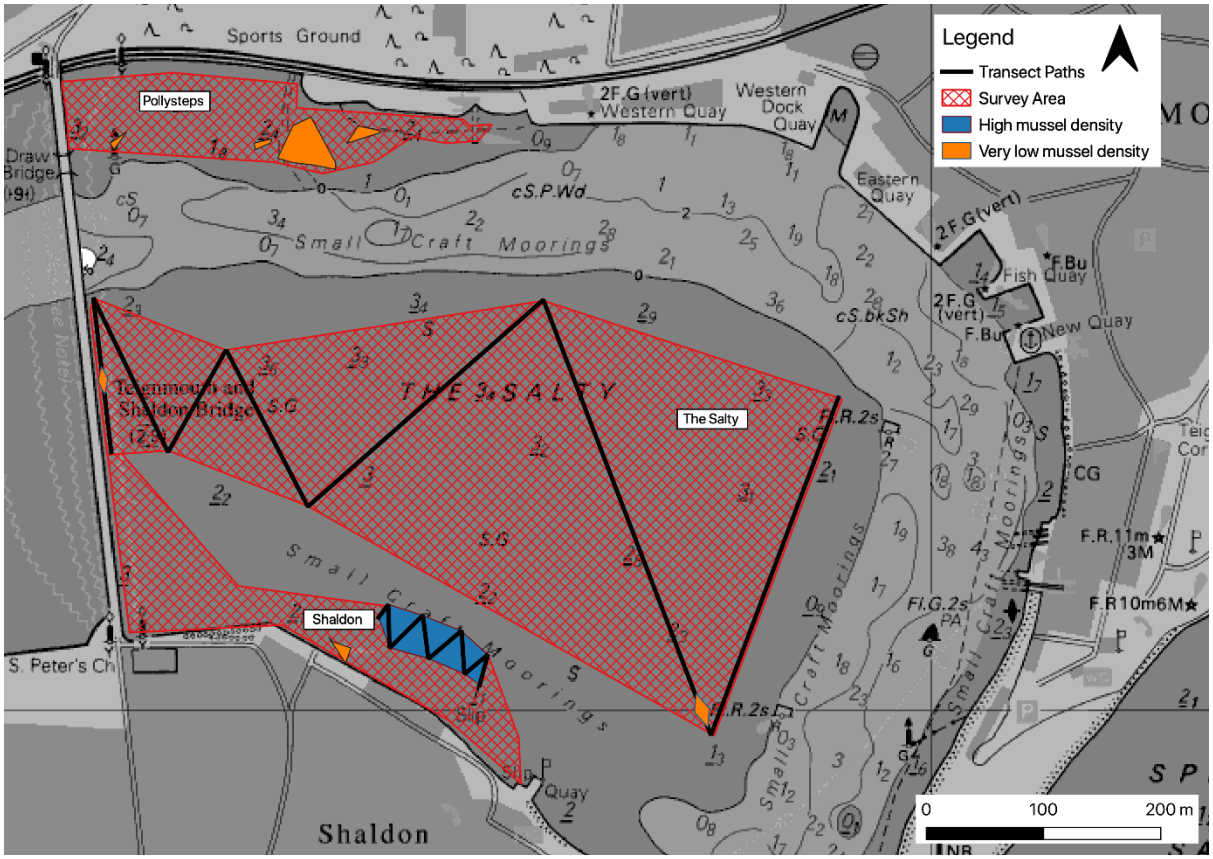

Figure 4 Map of area surveyed and location of live mussel

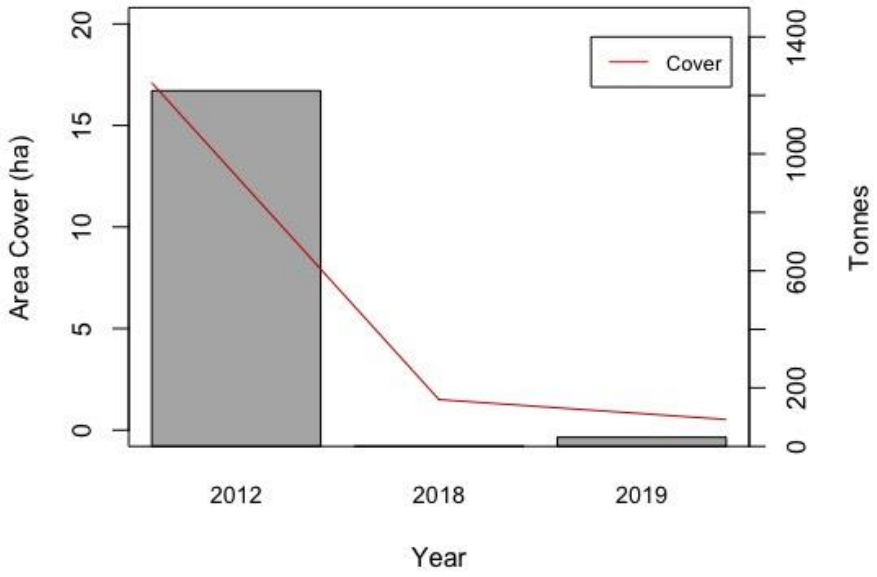

Figure 5 Total survey area found to contain live mussels plotted over total stock 2012-2019.

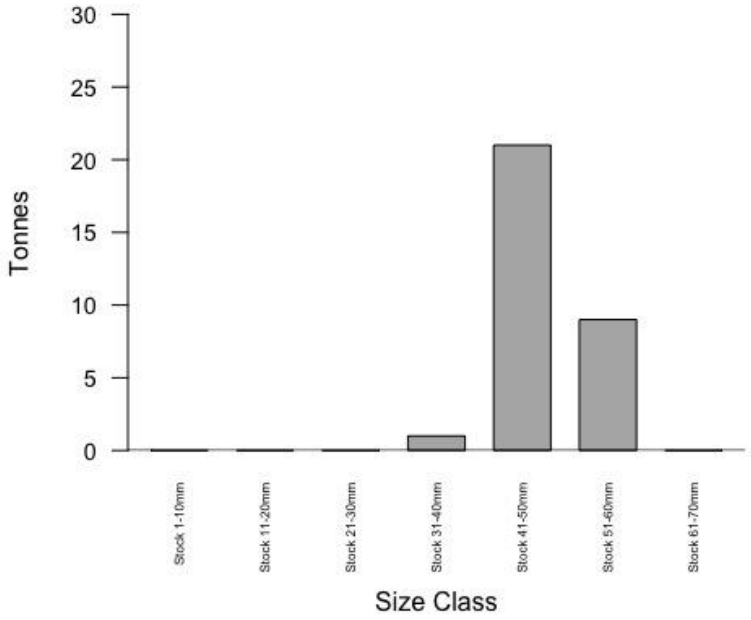

Figure 6 Biomass of mussels by size class. Mussels sampled from the dense Shaldon bed 2019.

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 (Grey, 2012). On Polly Steps, although the tonnage of mussels in 2012 was considerably less than on the Salty at 68 tonnes, this is still 68 tonnes more than the current state of affairs. Both The Salty and Polly Steps are no longer habitats on which live mussel reefs can be found, indeed live mussel is nearly entirely absent from both areas except for very small areas where patchy occurrences of lone non-reefing live mussel can be found. Cockles are now the prevailing bivalve species in zones surveyed within the Teign Estuary by D&SIFCA, dominating much of The Salty and Polly Steps (Thomas, 2019).

Of particular interest, in 2019, was the discovery of a mussel bed at Shaldon that had remained undiscovered in any of D&S IFCA's previous surveys. The bed most likely escaped detection due to it being almost permanently submerged apart from at extreme low water during the spring tide. The bed is relatively dense and homogenous containing an estimated 31 tonnes of mussel. The presence of this bed is a positive sign, as there is the potential over time for it to aid the recovery and reclamation of previous mussel habitat by being a stable brood resource for the recruitment by mussel larvae (Andrews et al., 2011). The successful settlement of these larvae will be constrained by the physical and hydrodynamic conditions of the estuary, for example scour on the substrate from tidal currents limiting successful larval settlement (Dalrymple & Rhodes, 1995). Therefore, even if this newly discovered bed does increase the larval load with the estuary, successful seed development on areas like The Salty could be inhibited unless the hydrodynamic profile of the estuary facilitates successful larval settlement. It is also worth noting, despite optimism about the bed's potential for larval recruitment, that the majority of the mussel found within

this small bed was relatively large, with no mussel <30mm being identified (Figure 6). New seed settlement within the bed will be essential for its continued survival and continued delivery of larval recruitment, further annual surveys will confirm presence or absence of new settlement.

The long-term impacts of ocean warming are another significant pressure that could limit the successful re-establishment of large dense mussel reefs within the Teign Estuary. The Teign Estuary, like many western European estuaries and coastal waters, has been subject to gradual warming since the industrial revolution, with UK estuaries seeing sea surface temperature increases of 0.7°c between the years 1971 - 2010 with temperatures projected to rise a further 1.5°c - 4°c within the 21st Century (Robins et al., 2016, IPCC 2014, Lowe et al., 2009). *Mytilus edulis* typically occupies a temperature range from 5-20° C (Bayne et al., 1976, Bayne and Worrall 1980), with tolerances of higher and lower temperature extending to 29°C and -30°C degrees respectively (Seed & Suchanek, 1992, Read & Cumming, 1967). Although estuarine temperatures are survivable by both juvenile and adult mussels, mussel larvae are significantly more susceptible to raised temperature and salinity pressures than mussels' post larval stages (Rayssac et al., 2010, Qiu et al., 2002). With increasing temperatures, the larvae suffer not only higher mortalities, but also when subjected to temperatures over 18°C, slower growth rates (Rayssac et al., 2010). Milder winters have been shown to delay spawning on mussel populations in the Wadden sea (Nehls et al., 2006). This has the compounded effect of larvae and juvenile mussel settling later in the year when predator abundances are higher. As a result, the mussel seed and larvae are subject to increased levels of predation. Decreased settlement in turn can limit successful recruitment, inhibiting rejuvenation of established mussel populations. Thus, the long-term implications of increased estuarine warming may negatively impact mussel populations within in the Teign and other UK estuaries.

Recommendations

It is recommended that:

- Additional metrics on annual temperatures within the Teign should be obtained from external organisations. This data should be included in these annual reports as a matter of record to help account for climatic drivers that may influence long term changes in estuarine mussel populations.

- Stock assessments continue to be carried out on an annual 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 2019 temporary closure of the Teign Estuary's public shellfish beds remains 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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