Teign Estuary
Mussel Stock Assessment 2026



Sarah Curtin

Environment Officer

Devon and Severn Inshore Fisheries and Conservation Authority

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Devon & Severn IFCA
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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 (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 may help inform future management of the mussel beds on the Teign and the development of shellfisheries in this part of the D&S IFCA's 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's (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*) has historically occurred within the Teign Estuary under the River Teign Mussel Fishery Order 1966 and the River Teign Mussel Fishery (Variation) (Oysters) Order 1995, (Teign Estuary Partnership, 2004), though these Orders expired in 2026. 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.

2.2 Survey methodology

This document reports on surveys conducted at the Salty in 2012, 2018-2020, and biennially between 2022-2026; and at Salty East biennially between 2022-2026. The Salty and Salty East were last surveyed on 17th July 2026 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. Due to the absence of live mussel, Polly Steps was not surveyed.

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 was first visited in 2012 and the perimeter was subsequently mapped in QGIS v3.2 (Figure 2).

Part of the survey methodology has changed for the 2026 surveys. Whereas traditionally to determine coverage and mussel density, transects were walked in a zig-zag pattern across the survey area, in 2026 pre-defined survey transects were walked, approximately parallel to the shoreline and each other. The perimeter of the beds from the 2024 survey was used to create transect lines in QGIS five meters apart, running the length of the perimeter.

The pre-determined transect lines were followed as closely as possible using a handheld GPS device, which was also used to record the start and end coordinates of each transect. Figure 3 shows the transects walked in 2026. A 4ft 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.

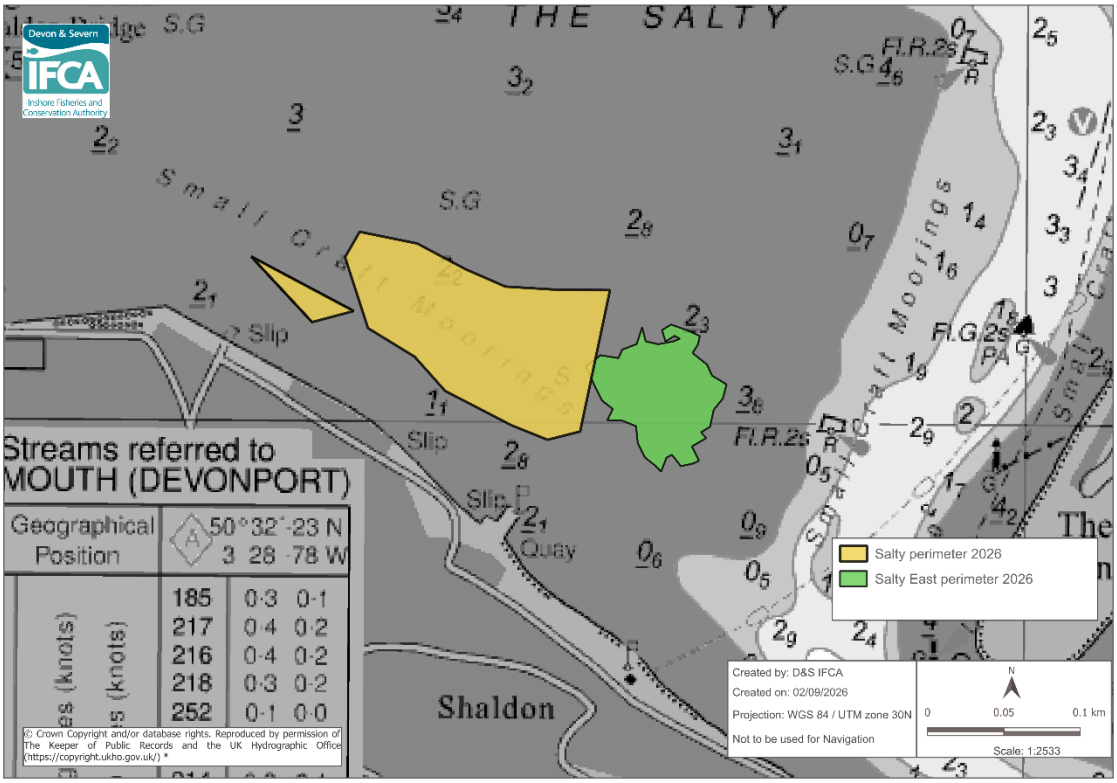


Figure 2 Area of mussel bed at the Salty (Yellow) in 2026). Bed area for the Salty was mapped generating a minimum convex polygon around the transect lines based on the 2024 survey. The Salty East bed (Green) area was mapped using coordinates recorded of the edge of the bed walked by Officers in 2022, within which mussel was present. * www.ukho.gov.uk/copyright

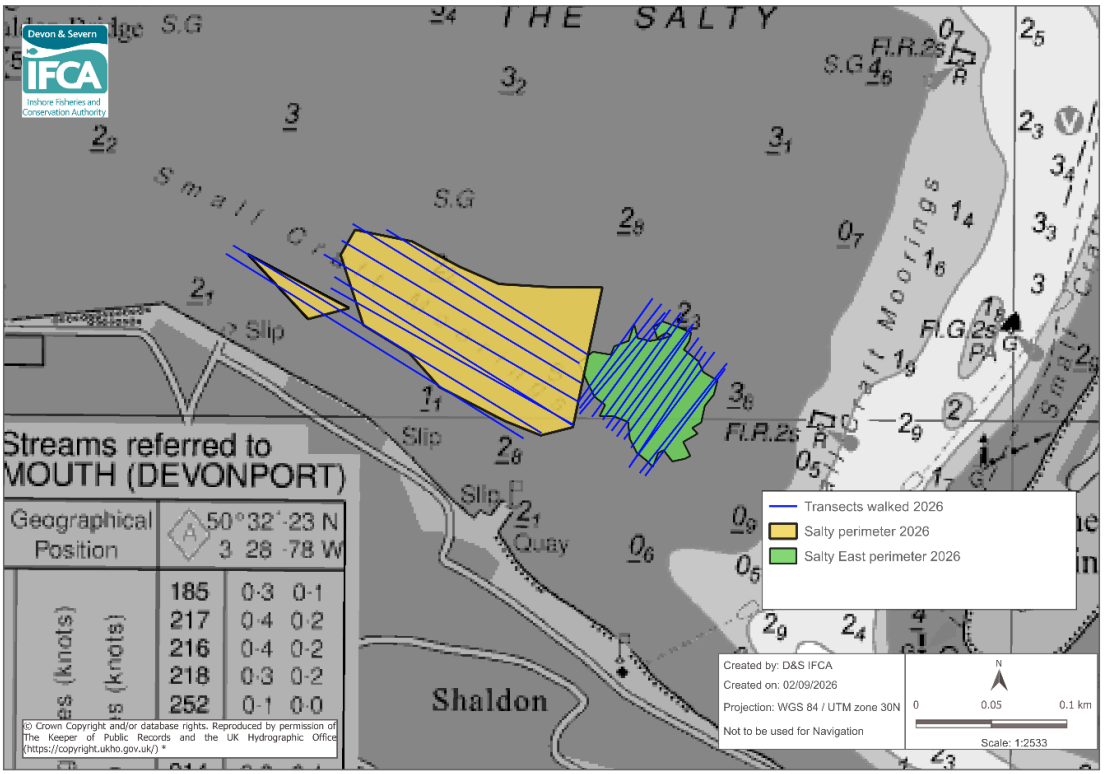


Figure 3 Area of mussel bed at the Salty (Yellow) and Salty East (Green) in 2026. Transect lines walked are shown in blue. Bed area mapped by generating a minimum convex polygon around the transect lines based on the 2024 survey for the Salty and Salty East. * www.ukho.gov.uk/copyright

2.3 Data analysis

Transect and sample data 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 mussel tonnage per bed (Equation 3).

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

The results presented here focus on the areas in which mussels were found (The Salty and Salty East) and which were surveyed using the transect methodology outlined in section 2.2.

3.1. The Salty

A total of 32 samples were collected across 8 transects at the Salty mussel bed. In 2026, the surveyed mussel bed covered the same area as in 2024 (1.4 ha). Mean mussel density was 3.9 kg m^{-2}, corresponding to an estimated total stock of 54 tonnes, compared with 53 tonnes in 2024, representing a 1.9% increase (Figure 4). Mussel density in 2026 was similar to that recorded in 2024, while percentage cover was higher (Figure 5).

Of the estimated 54 tonnes of mussel stock in 2026, approximately 80% comprised mussels >41 mm in length, with the greatest proportion occurring in the 51–60 mm size class (Figure 6). Mussels classified as spat (<30 mm) accounted for approximately 5.6% of the total stock.

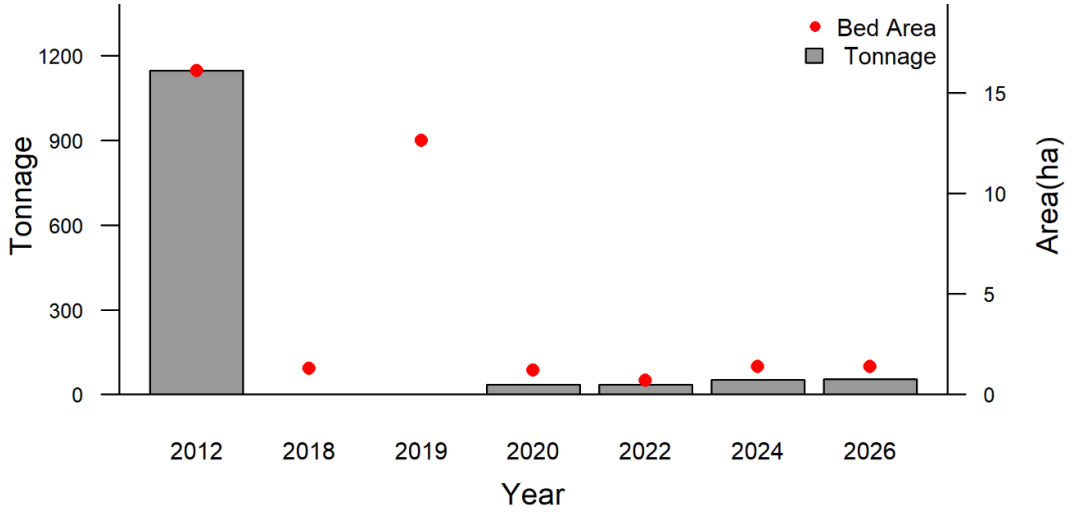


Figure 4 Bed area and tonnage of total stock on the Salty in 2012 and 2018–2026. "Bed Area" is a polygon covering surveyed transects conducted over what was deemed the mussel bed by the presence and absence of live mussel.

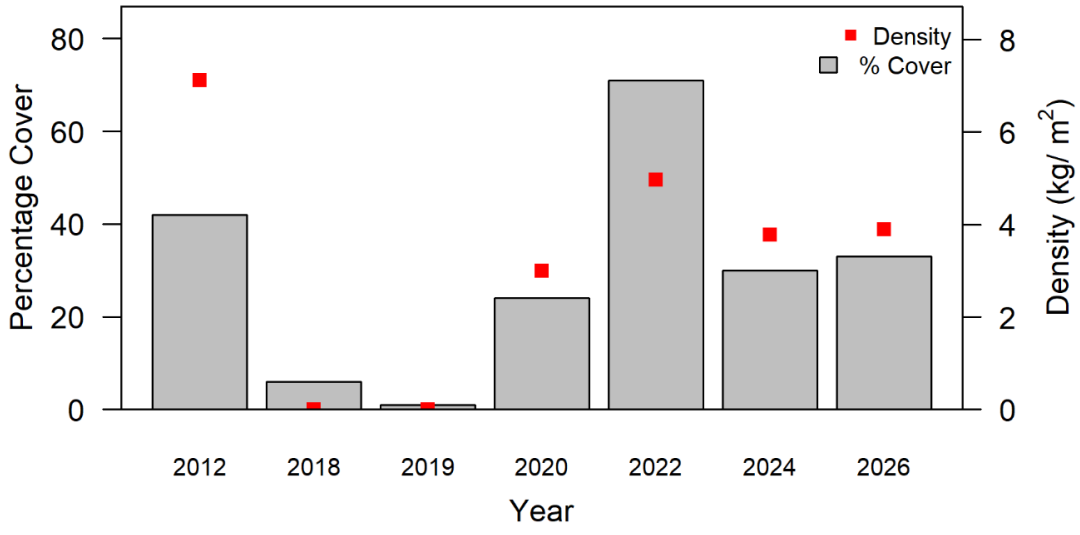


Figure 5 Percentage cover and density of mussel across the Salty in 2012 and 2018-2026.

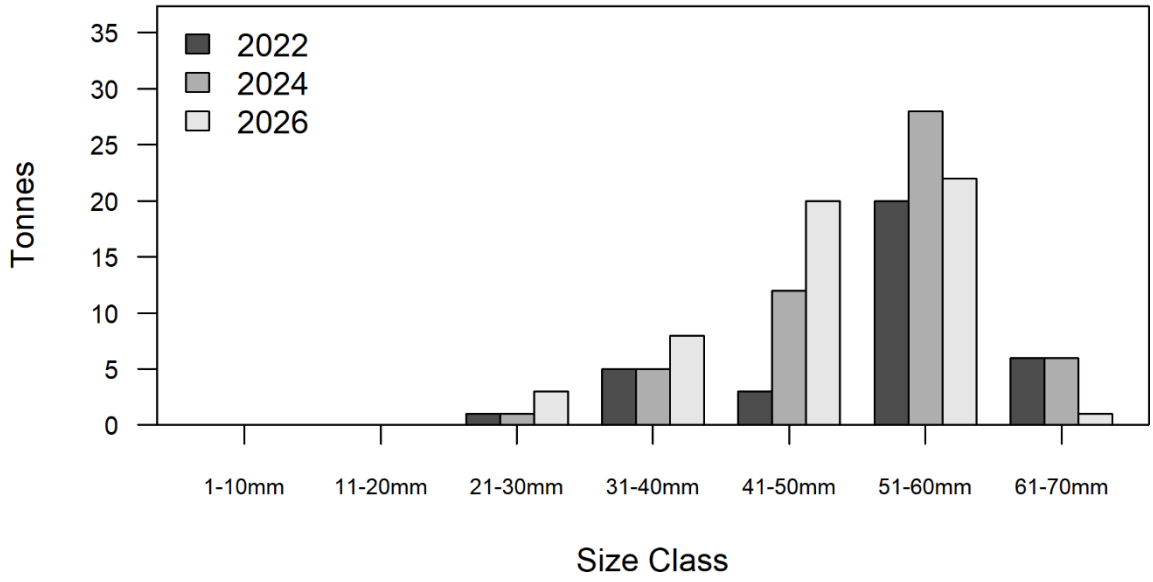


Figure 6 Tonnage of each 10mm size class for the Salty 2022, 2024 and 2026 stock.

3.2. Salty East

A total of 39 samples were collected from 14 transects on Salty East. In 2026 the surveyed mussel bed covered the same area as 2024 (0.5 ha) and contained a calculated 52 tonnes of mussel, compared with 43 tonnes in 2024, representing a 20.93% increase (Figure 7). The surveyed area has increased in density to 10.31kg m^{-2} of mussel compared to just 8.67 kg m^{-2} in 2024 and increased to 63% coverage compared to 47% in 2024 (Figure 8). Of the 52 tonnes of stock observed in 2026, 92% of this was >41mm in length and 1.9% was spat (<30mm) (Figure 9).

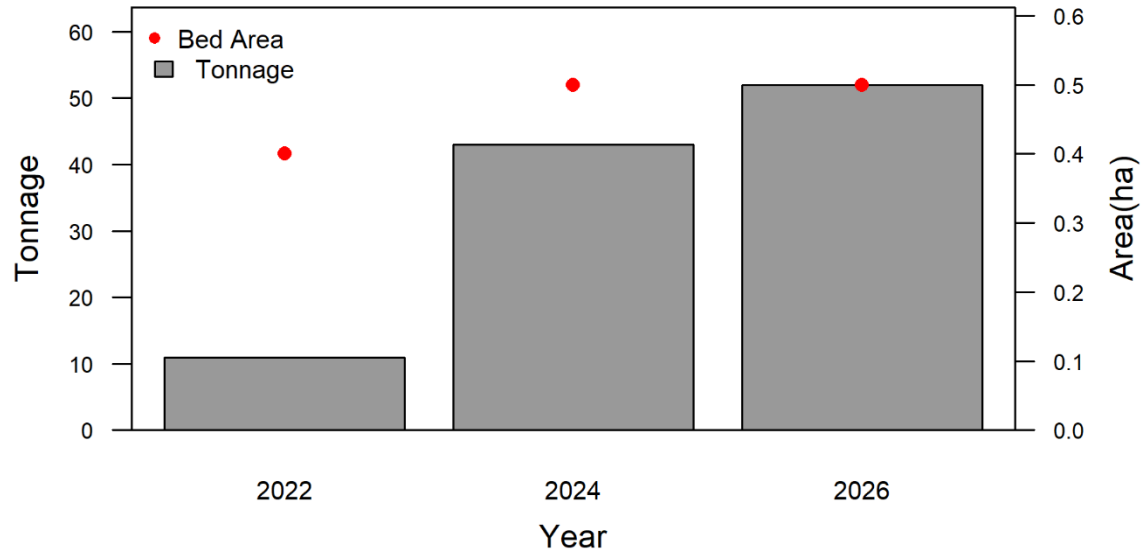


Figure 7 Total area surveyed plotted over tonnage of total stock within the Salty East mussel bed in 2022, 2024 and 2026. The “Bed Area” represents the perimeter of the bed walked by Officers in which mussel was present.

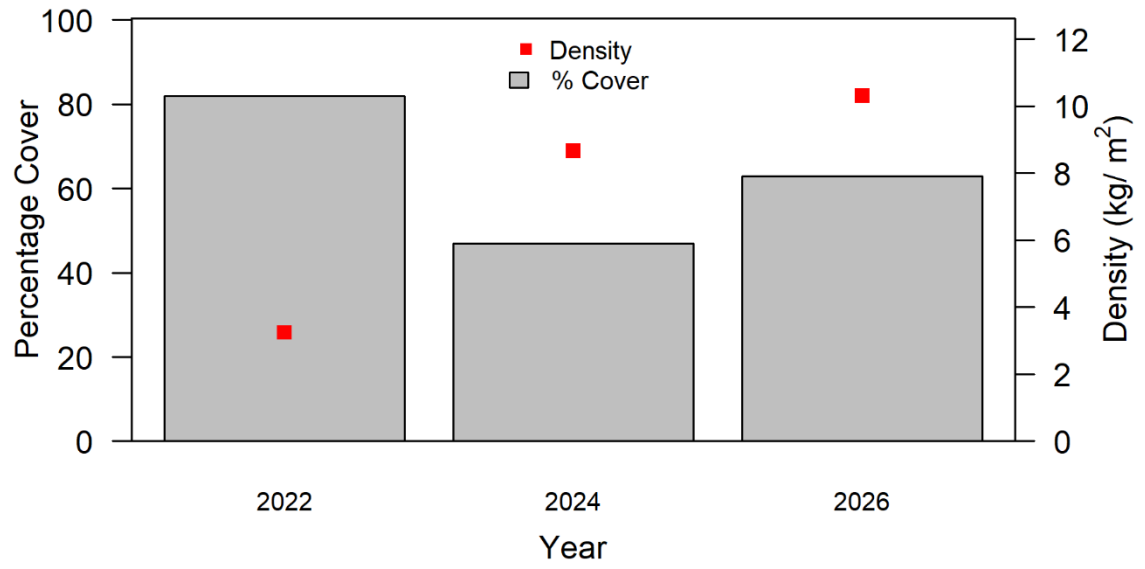


Figure 8 Percentage cover and density of mussel across Salty East in 2022, 2024 and 2026.

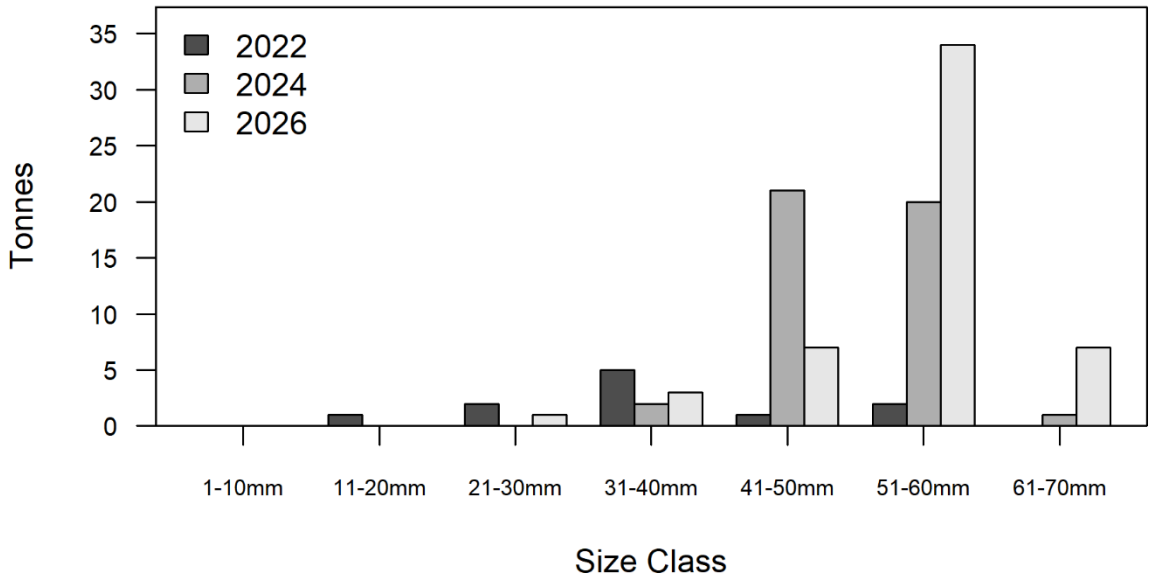


Figure 9 Tonnage of each 10mm size class for the Salty East 2022, 2024 and 2026 stock.

4. Discussion

Mussel populations within the Teign Estuary have undergone a substantial decline since the 2012 stock assessment. In 2012, mussel beds covered approximately 42% of the Salty, with an estimated stock of 1,148 tonnes (Gray, 2012). By the 2018 assessment, this population had declined considerably. The subsequent decline in mussel stock may have been associated with the large storms experienced in 2014, which could have scoured and destabilised previously established mussel beds, as well as the intentional removal of raised mussel areas around boat moorings on the Salty. Since this period there has been little evidence of recovery towards the population levels recorded in 2012.

Recent surveys indicate that the Salty no longer supports the extensive areas of dense, continuous live mussel that were present in 2012, while mussel abundance at Polly Steps has remained negligible since 2020, with little to no mussel recorded since 2022. Although percentage cover recorded in recent surveys can appear relatively high, this represents mussel occupying a substantially smaller area than in 2012. Consequently, percentage cover alone does not reflect the overall reduction in mussel bed extent or stock size across the Salty. Overall, while live mussel remains present on the Salty, the bed has undergone a marked long-term decline since 2012, and mussel populations at Polly Steps appear to have been effectively lost.

The density estimates for the Salty further demonstrate the substantial changes in mussel abundance since 2012. In 2012, mussel density was approximately 7.0 kg/m², indicating that where mussel beds were present, they supported relatively high biomass. Density subsequently fell to very low levels in 2018 and 2019, coinciding with the wider decline in mussel abundance across the Salty. A partial increase was observed in 2020, when density reached approximately 3.0 kg/m², followed by a further increase to approximately 5.0 kg/m² in 2022. Density subsequently declined to around 4.0 kg/m² in 2024 and 2026. Although the 2022–2026 estimates suggest that relatively dense patches of mussel remain within the Salty, they remain below the density recorded in 2012. This supports the observation that the current mussel bed is considerably less developed than the extensive bed present at the beginning of the assessment period.

The relatively high density recorded in 2022 should also be interpreted alongside the percentage-cover results. Percentage cover reached approximately 71% in 2022, before declining to around 30% in 2024 and 33% in 2026. This indicates that, although areas of the Salty continue to support relatively dense mussel, the spatial distribution of those mussels may have become more restricted. The combination of density and percentage cover therefore reflect that recent mussel populations may be concentrated within discrete patches rather than forming the extensive, continuous beds observed in 2012. This distinction is important when interpreting the condition of the stock, as high density within a small area can coexist with a relatively low total stock across the wider assessment area (Erlandsson, McQuaid, and Sköld 2011).

The size-class distribution of mussel on the Salty also provides an indication of changes in population structure between assessments. In 2022, the stock was predominantly composed of mussels in the 51–60 mm size class, with approximately 20 tonnes recorded in this category, while around 3 tonnes were present in the 41–50 mm class and approximately 6 tonnes in the 61–70 mm class. By 2024, there was approximately 12 tonnes in the 41–50 mm class and 28 tonnes in the 51–60 mm class, while the 61–70 mm class remained around 6

tonnes. In 2026, the contribution of the 41–50 mm class increased further to approximately 20 tonnes, while the 51–60 mm class decreased slightly to around 22 tonnes. The 61–70 mm class also declined substantially, to approximately 1 tonne.

The increase in the 41–50 mm size class between 2024 and 2026 may indicate continued growth and survival of mussels within the Salty population, with individuals potentially progressing from smaller size classes into the intermediate size range. The decline in the 61–70 mm class, however, suggests a reduction in the largest mussels present within the sampled stock. This could potentially result from natural mortality, physical disturbance or removal, although the survey data cannot distinguish between these mechanisms. Importantly, the relatively small contribution of mussels below 30 mm in all three years suggests there has been limited recent recruitment. The population therefore appears to be supported primarily by intermediate and larger mussels rather than by a large influx of newly recruited individuals.

The increase in the 41–50 mm class is nevertheless potentially encouraging because these mussels represent a substantial component of the current stock and may contribute to future biomass as they grow into larger size classes. However, if recruitment remains limited, the eventual loss of these larger individuals through mortality or removal could result in a subsequent decline in biomass. The size-frequency distribution should therefore continue to be monitored, particularly for evidence of increasing numbers of mussels in the smaller 1–20 mm classes, which would provide stronger evidence of successful recruitment and population renewal.

The Salty East mussel bed provides a contrasting pattern to the wider Salty population. Salty East was first surveyed in 2022 as a newly identified survey site, meaning that the 2022 assessment provides the initial baseline for this bed and there is no earlier assessment against which to assess longer-term change. Nevertheless, comparison of the three available surveys indicates a substantial increase in estimated stock, from approximately 11 tonnes in 2022 to 43 tonnes in 2024 and 52 tonnes in 2026. This represents a considerable increase in biomass over a relatively short period and suggests that the Salty East bed has developed considerably since it was first surveyed.

The size-class distribution at Salty East shows an important change in the composition of this increasing stock. In 2022, only approximately 2 tonnes of mussel were recorded in the 51–60 mm size class, with the remaining stock distributed across smaller size classes. By 2024, there had been a substantial increase in both the 41–50 mm and 51–60 mm classes, with approximately 21 tonnes in the 41–50 mm class and 20 tonnes in the 51–60 mm class. This indicates that the increase in total stock between 2022 and 2024 was associated with a substantial increase in the biomass of intermediate and larger mussels.

A further shift in population structure occurred between 2024 and 2026 at Salty East. The biomass within the 51–60 mm class increased considerably from approximately 20 tonnes to 34 tonnes, while the 41–50 mm class declined from approximately 21 tonnes to only 7 tonnes. At the same time, there was a slight increase in the 31–40 mm class, reaching approximately 3 tonnes in 2026. This pattern is consistent with the possibility that mussels present in the 41–50 mm class in 2024 subsequently progressed into the 51–60 mm class through growth, providing a possible explanation for the decline in biomass within the former and increase within the latter. However, changes in mortality, recruitment, sampling variability or the spatial distribution of mussel could also contribute to the observed differences, and the size-frequency data alone cannot establish the cause (Dolmer 1998).

The increasing proportion of larger mussels in 2026 is particularly important when considering the increase in total stock. Much of the estimated biomass is now concentrated within the 51–60 mm size class, meaning that the current stock is strongly influenced by the survival and persistence of these larger individuals. This could represent a positive development if these mussels remain within the bed and continue to contribute to the reproductive population. However, a population heavily weighted towards larger individuals may also be vulnerable to future declines if recruitment into the smaller size classes is insufficient to replace mortality.

The relatively low biomass recorded in the smallest size classes suggests there has been limited recent recruitment within Salty East. Although the increase in the 31–40 mm class in 2026 may indicate the presence of younger mussels progressing through the population, the quantity remains small compared with the biomass contained within the 51–60 mm class. Future surveys will therefore be important for determining whether these smaller individuals continue to increase and progress into the larger size classes. Evidence of sustained recruitment would provide greater confidence that the increase in stock represents the development of a stable population rather than a temporary accumulation of larger mussels.

The density estimates provide further evidence of the development of the Salty East bed. Density increased from approximately 3.2 kg/m² in 2022 to 8.7 kg/m² in 2024 and 10.3 kg/m² in 2026, indicating that the increase in total stock has been accompanied by increasing biomass within areas supporting mussel. Percentage cover, however, showed greater variation, declining from approximately 82% in 2022 to 47% in 2024, before increasing to approximately 63% in 2026. The combination of increasing density and fluctuating percentage cover suggests that the increase in stock cannot simply be attributed to an expansion in the area occupied by mussel. Instead, increasing biomass within occupied areas, particularly through the development of larger mussels, appears to have been an important component of the recent increase.

Differences in survey methodology between assessment years should also be considered when interpreting changes in mussel density, percentage cover and estimated stock. In 2012 and 2019, the majority of the accessible area of the Salty was surveyed, regardless of whether mussel was visibly present. In contrast, surveys undertaken in 2018, 2020, 2022 and 2024 were more targeted towards areas where mussel presence was obvious. Consequently, estimates of mussel density and percentage cover from these years are likely to be biased towards areas of higher mussel abundance and should not be considered directly comparable with surveys covering a larger proportion of the Salty. However, the broader survey areas used in 2012 and 2019 were useful in demonstrating the widespread decline of mussel across areas the Salty more broadly.

A further consideration is that the use of the same zig-zag transect approach across survey areas of different sizes may itself have influenced comparability. Longer transects increase the likelihood of obtaining the five mussel ‘hits’ required for sampling and may therefore result in differences in sampling effort between years. Conversely, shorter or more targeted surveys reduce survey time but are more likely to focus sampling on areas where mussel is already known to be present, potentially resulting in an overestimation of mussel density and percentage cover at the wider bed scale.

In 2026, the survey methodology was revised again, with pre-determined transects used to provide more consistent and representative coverage of the surveyed area rather than targeting areas based on the apparent presence of mussel. This approach was introduced to

improve spatial coverage and reduce the potential for sampling bias towards areas of higher mussel abundance. The 2026 survey therefore provides a more representative assessment of the surveyed area than the targeted surveys undertaken in several previous years. However, the change in methodology means that some caution is still required when making direct comparisons between the 2026 results and those from earlier surveys, particularly where previous assessments covered different spatial extents or used different approaches to selecting transects.

The revised approach also highlights the importance of balancing survey coverage with the practical time constraints associated with these assessments. Although longer transects and wider transect spacing can increase the area surveyed, they may leave substantial areas of unsurveyed bed between transects. Conversely, a greater number of pre-determined transects can provide more consistent spatial coverage but requires additional survey effort. Maintaining a consistent survey design in future assessments will therefore be important for improving the reliability of inter-annual comparisons and for distinguishing genuine changes in mussel populations from differences arising from survey methodology.

Recruitment and potential sources of new mussel

The limited representation of mussels within the smaller size classes suggests that recent recruitment has been relatively low within the established mussel beds. However, this does not necessarily indicate an absence of recruitment within the wider Teign Estuary. In summer 2025 D&S IFCA was advised of a new area of mussel seed settlement within the estuary, indicating that suitable conditions for settlement and recruitment can occur outside the established beds. On 15th September 2025 D&S IFCA Officers walked the perimeter of the bed which has been mapped in QGIS and is presented in Figure A1 (Annex A). The settlement appeared to be a dense homogenous bed consisting of mussels <30mm presented in Figures B1-4 (Annex B).

The reported seed settlement, however, did not persist or develop into an established mussel bed. Several significant storm events occurred following settlement, which are considered to have caused substantial physical disturbance and loss of the newly settled mussel. For example, in January 2026 Storm Ingrid caused significant damage to Teignmouth Pier and the sea wall (BBC News, 2026), which demonstrates the severity of the environmental conditions experienced around the estuary during this period. The failure of the settlement to establish highlights the vulnerability of newly recruited mussel to physical disturbance during the early stages of population development. Consequently, while the occurrence of the settlement provides evidence that recruitment can occur locally, it does not provide evidence of successful recruitment into the established stock.

The presence of suitable settlement areas elsewhere within the estuary may nevertheless be important for the longer-term recovery of the Teign Estuary mussel population. Recruitment may occur intermittently and may be spatially variable, with newly settled mussel potentially being lost before reaching a size at which it contributes substantially to the standing stock. Future assessments should therefore consider not only recruitment within existing mussel beds but also evidence of new settlement elsewhere in the estuary. Understanding the location, extent and subsequent persistence of newly settled mussel would help determine whether such events represent a potential mechanism for population recovery or are instead short-lived recruitment events that are subsequently removed by environmental disturbance.

In conclusion, the Teign Estuary mussel population remains considerably reduced relative to the 2012 baseline, and there has been little evidence of substantial recovery. However, the recent results indicate some improvement in mussel abundance within the Salty, with relatively dense patches remaining despite the substantial reduction in overall bed extent. The size-class distribution suggests that the current Salty population is supported predominantly by intermediate and larger mussels, with limited evidence of recent recruitment.

Continued monitoring using a consistent survey methodology will be essential for determining whether recent increases represent sustained population development. Future surveys should continue to assess stock biomass alongside bed extent, density, percentage cover and size structure, with particular attention to the smallest size classes as an indicator of recruitment.

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 2027 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 may help 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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Annex A

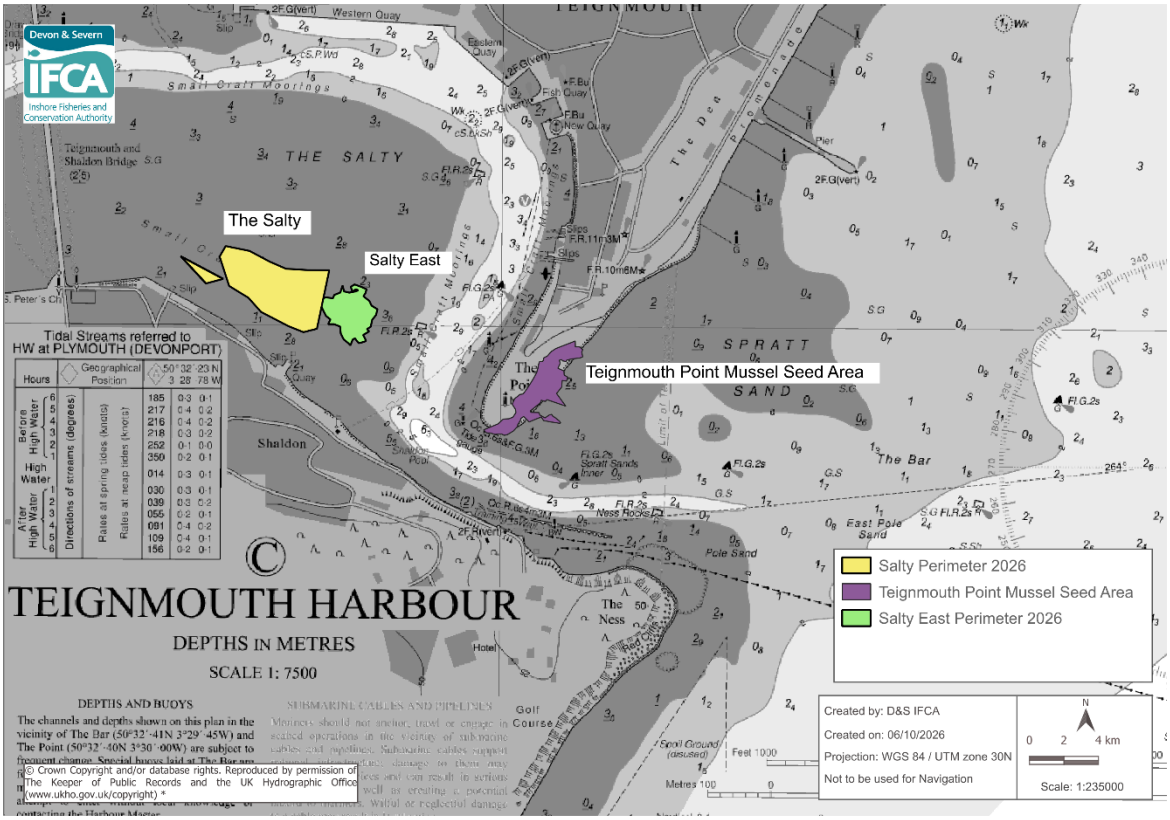


Figure A1. Area of mussel bed at the Salty (Yellow) and Salty East (Green) in 2026. Teignmouth Point Mussel Seed area in purple from walk-over survey conducted in September 2025. * www.ukho.gov.uk/copyright

Annex B

Photos taken of the seed settlement from the walk-over survey conducted in September 2025.



Figure B1. Edge of mussel settlement; mussel byssus threads holding small sediment grains in loose matrix.



Figure B2. Example of mussel sizes observed within settlement.



Figure B3. Small mussel settled within sediment, with zoomed inset showing edge of shell visible among sediment particles.



Figure B4. Examples of range of mussel sizes seen within settlement area. Scalebar is approximate.