Exe Estuary
Mussel Stock Assessment 2018

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Devon & Severn IFCA
Inshore Fisheries and Conservation Authority

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1. Introduction

1.1 The 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, 2014). 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 in particular are important in supporting the wintering wader and wildfowl assemblages to enable them to acquire sufficient energy reserves to ensure population survival (Natural England, 2015). 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 & Verboven, 1993).

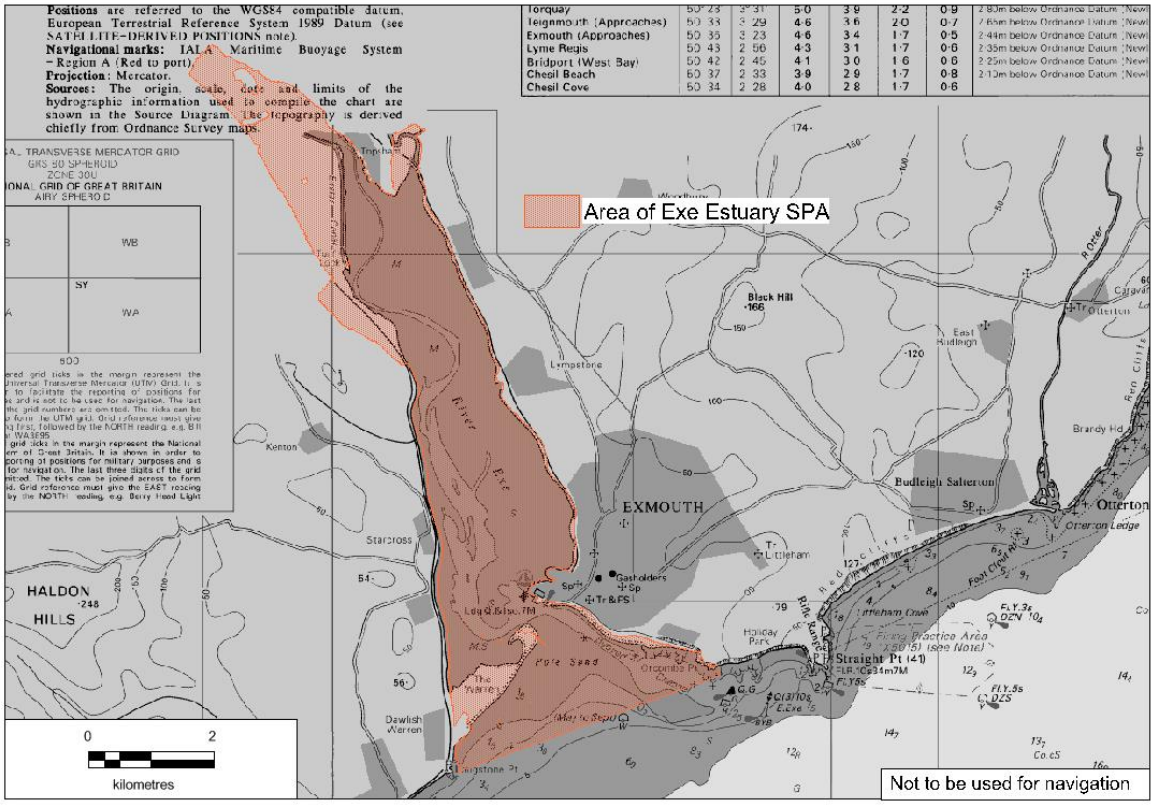
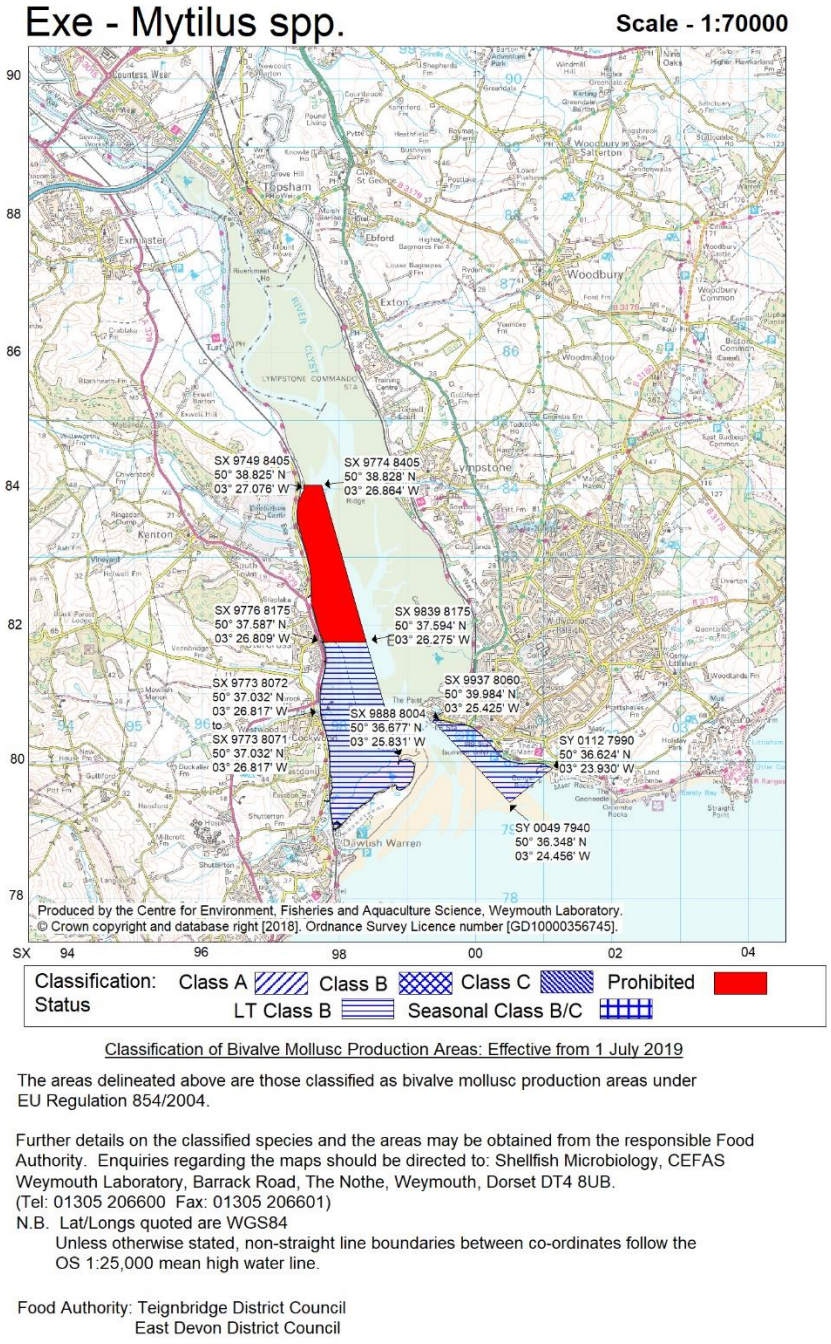


Figure 1 Area of the Exe Estuary SPA

The main commercial fishing activity occurring within the Exe Estuary SPA is the mussel fishery, worked by the Exmouth Mussels Limited. Exmouth Mussels Ltd. collect up to 2000 tonnes of mussel seed per year, from sites at the mouth of and outside the estuary. The seed mussel is then 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. The main fishing activity 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 IFCA's stock assessments focus on the public fishery beds of Bull Hill and Starcross and the beds at Lympstone when access is possible. These areas are popular for recreational shellfish collection.



Classification of Bivalve Mollusc Production Areas: Effective from 1 July 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.

Food Authority: Teignbridge District Council
East Devon District Council

Figure 2 Classified mussel harvesting areas on the Exe Estuary (Cefas, 2019)

1.2 *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. *M. edulis’* ability to occupy such a range of habitats results from its ability to withstand wide variation in salinity, desiccation, temperature and oxygen concentration (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). 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, 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 & Worrall, 1980).

Current threats to *M. edulis* beds include commercial fishing, water quality, coastal developments, anchoring and bait digging (Maddock, 2008). On the Exe Estuary other threats are the age of the mussel beds and changes in hydrodynamics of the freshwater river flow into the system.

1.3 Objectives

The objective is to carry out annual surveys of the public 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. Devon and 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 Exe and the potential development of shellfisheries in this part of the Devon & Severn IFCA District. Results are also used by Natural England to look at the available food source of mussels for the overwintering bird populations on the estuary.

2. Method

The method deployed for estimate the population of mussels on the beds is the Dutch Wand Method. The area of the bed is recorded by walking its perimeter and marking points with a handheld GPS, which are then plotted onto QGIS software.

To determine coverage and patch density transects are walked in a zig-zag across the bed, right up to the perimeter, to provide optimum coverage through the bed. The start and end point of each transect is recorded using a handheld GPS, to be mapped later using GIS software (Figure 3). A 4' bamboo cane with an 11cm ring attached to the end, so that the ring sits flat on the ground when held out to one side, is used to determine the mussel coverage for each transect. Every three paces along each transect the cane is flicked out to one side and it is recorded whether it is a "hit" if the ring contains live mussel, or a "miss" if the ring doesn't contain live mussel. On every fifth hit the contents of the ring is taken as a sample, using an 11cm diameter corer. All mussel samples from the same transect are collected together in one bag, but kept separate from those of other transects.

Figure 4 Transects walked (blue) and area of each mussel bed (red).

Once all transects are complete the mussel samples are sieved and cleaned. For each transect the number of samples taken is recorded, all mussels are measured recording sizes on the survey form, and divided into size groups; 1-10mm, 11-20mm, 21-30mm, 31-40mm, 41-50mm, 51-60mm, 61-70mm, 70+mm. Each size group is weighed separately and the total weight of each group is recorded. The data collected are used to calculate the coverage, density and area of the mussel bed (Figure 4), which are then used to estimate the mussel tonnage on each bed. Size distribution is obtained from the length measurements of mussels in the retained samples. The hit/miss data is also pooled, to

calculate the average coverage and patch density for the whole bed, compensating for the possibility of some transects being longer than others.

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

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

Figure 4 Calculations used for mussel coverage on bed, and density of mussels across bed.

3. Results

3.1 Bull Hill

- Area: 5.5ha
- Coverage: 0.08%
- Mean density: 0/m^2
- Total stock: 0 tonnes
- Stock ≥51mm: 0 tonnes

Bull Hill was surveyed on 2nd May 2018. No samples were taken as there were only a total of two hits from the 9 transects. Table 1 shows the difference in stock composition relative to previous surveys. Figures 5 and 6 show the total stock and the stock for each size class, respectively, for each year.

Table 1 Summary of Bull Hill stock composition from 2013 to 2018.

	2013	**2014**	**2016**	**2017**	**2018**	Difference since last survey
Area (ha)	10.9	11.1*	11.2*	12.7*	5.5	-57%
Density (kg/m^2)	11.25	0.14	0.16	0	0	0%
Total stock (tonnes)	1222	16	18	0	0	0%
Stock 1-10mm	0	0	0	0	0	0%
Stock 11-20mm	1	0	0	0	0	0%
Stock 21-30mm	13	0	0	0	0	0%
Stock 31-40mm	142	3	0	0	0	0%
Stock 41-50mm	504	13	10	0	0	0%
Stock 51-60mm	478	0	8	0	0	0%
Stock 61-70mm	84	0	0	0	0	0%

* This refers to the area where mussel was found, as it would probably no longer be considered a mussel “bed”.

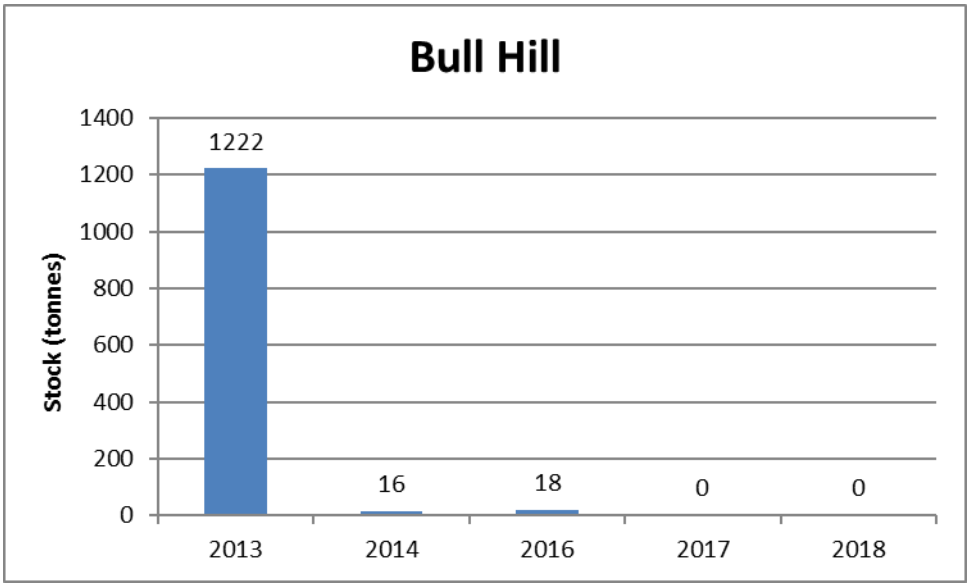


Figure 5 Bull Hill total stock, 2013-2018.

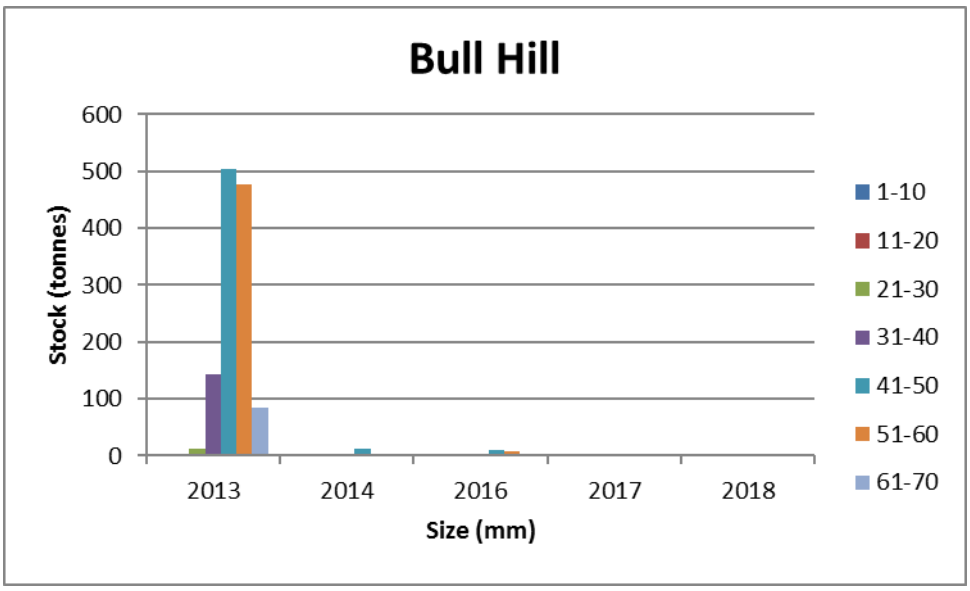


Figure 6 Bull Hill stock per size class, 2013-2018.

3.2 Starcross 1

- Area: 1.8 ha
- Coverage: 11%
- Mean density: 0.52kg/m^2
- Total stock: 10 tonnes
- Stock ≥51mm: 8 tonnes

Starcross 1 was surveyed on 3rd May 2018. Four samples were taken from eleven transects. The stock of marketable sized mussels was estimated to be 8 tonnes on the bed. Table 2 shows the difference in stock composition relative to previous surveys. Figures 7 and 8 show the total stock and the stock for each size class, respectively, for each year.

Table 2 Summary of Starcross 1 stock composition from 2013 to 2017.

	2013	2014	2016	2017	2018	Difference since last survey
Area (ha)	4.4	5.1	3.6	3.8	1.8	-53%
Density (kg/m^2)	3.06	1.00	0.8	0.67	0.52	-22%
Total stock (tonnes)	136	50	29	25	10	-60%
Stock 1-10mm	0	0	0	0	0	0
Stock 11-20mm	0	0	0	0	0	0
Stock 21-30mm	0	0	0	0	0	0
Stock 31-40mm	0	1	0	0	2	0
Stock 41-50mm	9	0	1	0	0	0
Stock 51-60mm	62	42	15	25	2	-92%
Stock 61-70mm	65	7	13	0	6	+100%

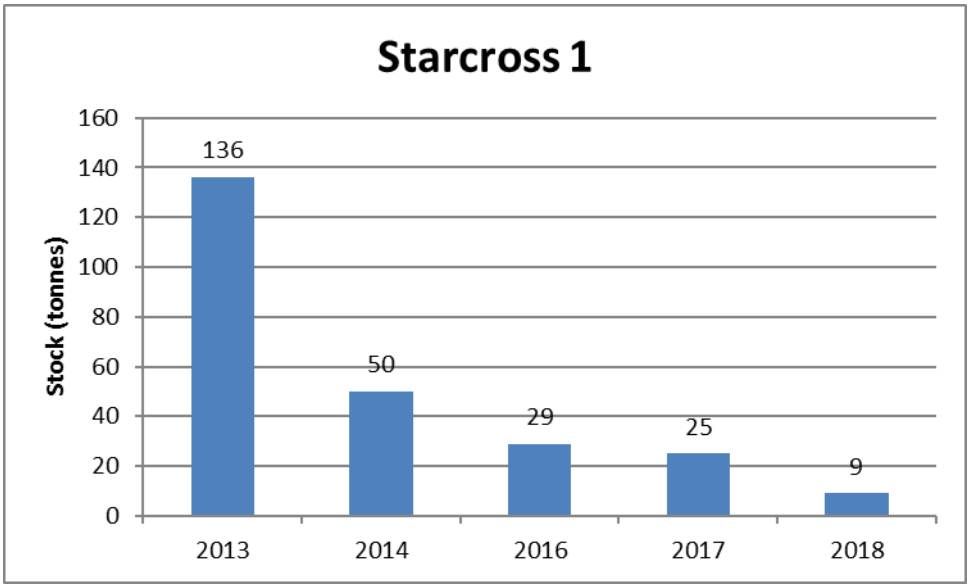


Figure 7 Starcross 1 total stock, 2013-2018.

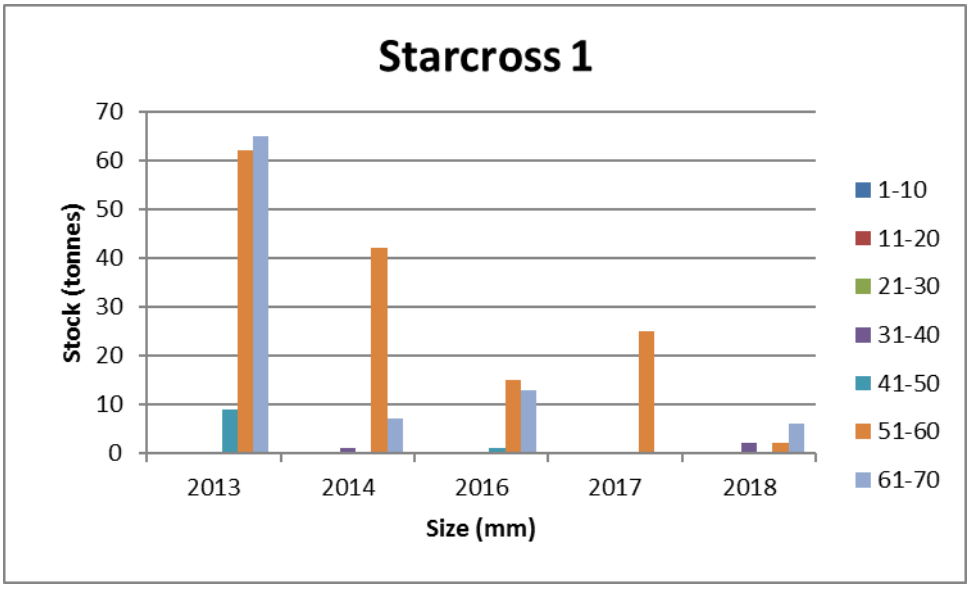


Figure 8 Starcross 1 stock per size class, 2013-2018.

3.3 Starcross 2

- Area: 3.5ha
- Coverage: 5%
- Mean density: 0.08kg/m^2
- Total stock: 2 tonnes
- Stock ≥51mm: 2 tonnes

Starcross 2 was surveyed on 27th April 2017. Fourteen samples were taken from ten transects. The stock of marketable sized mussels was estimated to be 2 tonnes out of a total 2 tonnes on the bed. Table 3 shows the difference in stock composition relative to previous surveys. Figures 9 and 10 show the total stock and the stock for each size class respectively for each year.

Table 3 Summary of Starcross 2 stock composition from 2013 to 2018.

	2013	**2014**	**2016**	**2017**	**2018**	Difference since last survey
Area (ha)	3.0	2.3	3.7	3.5	2.8	-20%
Density (kg/m^2)	3.72	1.45	0.57	0.37	0.08	-78%
Total stock (tonnes)	113	33	21	13	2	-85%
Stock 1-10mm	0	0	0	0	0	0%
Stock 11-20mm	0	3	0	0	0	0%
Stock 21-30mm	2	2	0	0	0	0%
Stock 31-40mm	2	5	1	0	0	0%
Stock 41-50mm	9	11	4	2	2	0%
Stock 51-60mm	82	11	3	8	0	-100%
Stock 61-70mm	18	2	13	3	0	-100%

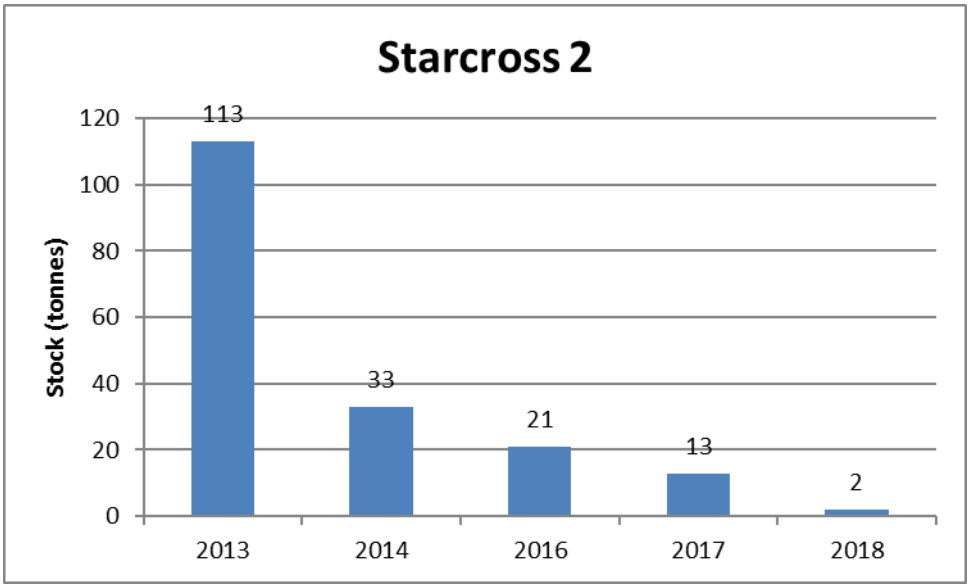


Figure 9 Starcross 2 total stock, 2013-2018.

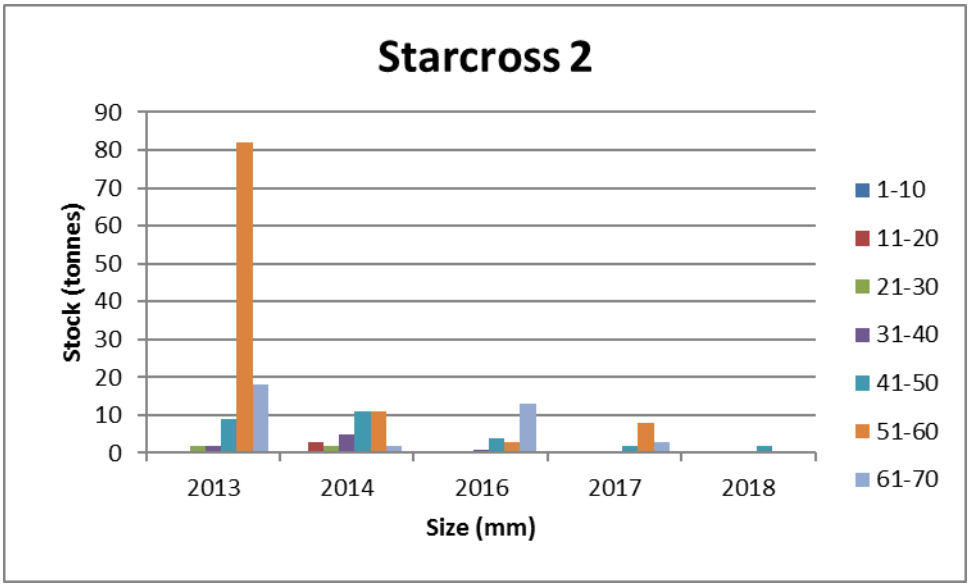


Figure 10 Starcross 2 stock per size class, 2013-2018.

4. Discussion

During the winter of 2014 there was a dramatic loss of mussel from Bull Hill (approximately 99%). Starcross 1 and Starcross 2 both suffered mussel loss over the same period, although not to the same extent (63% and 71%, respectively). This extreme loss of mussel stock is not unique to the Exe Estuary, the Taw-Torridge and Teign estuaries, also in the Devon & Severn IFCA's District, have suffered similar losses (D&S IFCA observations). Figure 12 shows the changes in area of the mussel beds and the tonnage of mussel within the Exe Estuary. (It must be noted that the area in 2018 is not a true reflection of 'mussel beds', this is because the mussel communities in areas surveyed are too low in density and non-homogeneous in structure to be classed as a typical 'mussel bed').

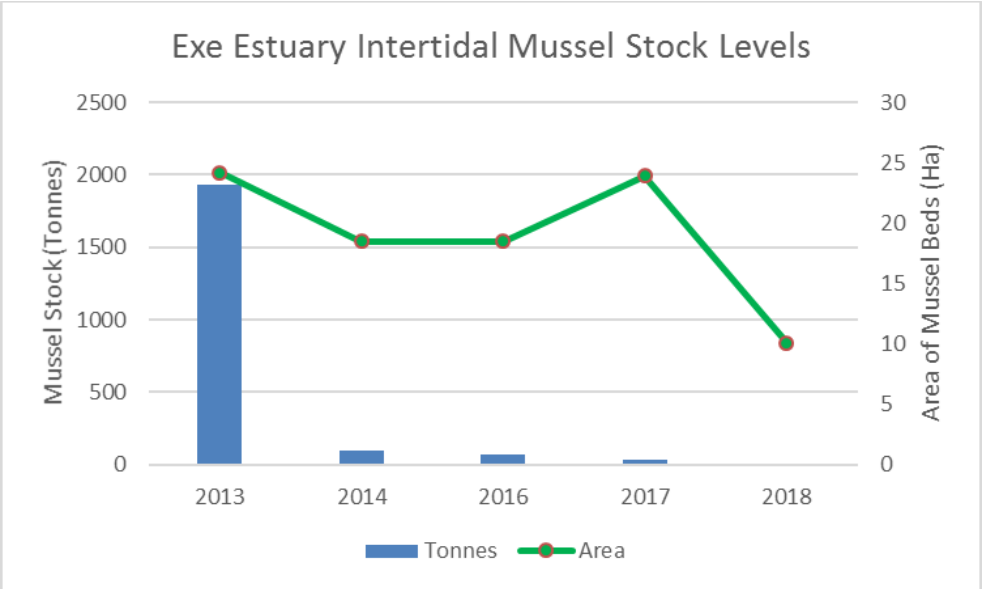


Figure 12: Mussel bed stock and Area – 2013-2018

Large mussel loss has also been reported around the UK for a similar time period, such as in Wales and in estuaries on the east coast. It is widely believed that these declines in mussel stock are the result of poor spat settlement over the last few years (local mussel fishers, pers. comms.) which has resulted in aging beds. When this factor was coupled with the increased water flow and wave action through estuaries during the storms of winter 2013/2014 the mussels were scoured away. The results of the 2013 Devon & Severn IFCA's stock assessments demonstrate that the beds were largely composed of mature mussel with little younger mussel present; 89% of the combined stock from the three beds was over 40mm in length.

All the Exe beds show indications of further decline since 2017 with stock levels on both Starcross beds at their lowest densities since 2013. Bull Hill Bank's stock levels remained at zero, the area coverage of visible mussels decreased by 57%. Starcross 1 did see an increase in stock (six tonnes) in the 61-70mm size class, this however is mirrored by a loss of 23 tonnes in the 51-60MM size category. This suggests that although mussel growth into the 61-70mm size class accounted for some of the loss of the 51-60mm class, it is largely irrelevant as the combined loss across both classes 2017-18 is the equivalent of 17 out of 25 total tonnes. Starcross 2 saw heavy losses between 2017-18 with only 2 out of 13 tonnes of stock remaining. The negligible recruitment of sprat in both the Starcross beds and the thinning density and reduction of area suggests that chances for recovery of the beds in the immediate future is minimal and will more likely be subject to further decline.

The Lympstone site, typically surveyed in previous years was not surveyed this year based on the negligible amount of observable mussels seen in 2016. It was noted then that the area had shifted to a predominantly oyster (*Magallana gigas)* dominated regime.

It is recommended that the stock assessments continue to be carried out on an annual basis, to monitor any future changes to the stock of the beds and particularly to detect any signs of recovery. This will help to inform any future management Devon & Severn IFCA may bring in for the collection of mussels, as part of their review of existing byelaws. Devon and Severn IFCA introduced a temporary closure, for 18 to 24 months, on the public shellfish beds in the Exe Estuary due to the stocks being severely depleted.

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