Taw-Torridge
Mussel Stock Assessment 2020

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April 2021
V1.0

Contents

Version control history			
Author	**Date**	**Comment**	**Version**
KS	02/2021	Draft report	0.1
JS	02/2021	Comments on initial draft	0.2
LH	23/03/2021	Redraft of report, substantial revisions to methods, results, discussion and conclusions	0.3
JS/SC	31/03/2021	Final QA & addition of ecological requirements modelling information	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 and Worrall, 1980; Seed and 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 (Seed and Suchanek, 1992; 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 and Worrall, 1980; Seed and Suchanek, 1992; Handå *et al.*, 2011).

Current threats to *M. edulis* beds include commercial fishing, 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 annual surveys of the public mussel beds on the Taw-Torridge Estuary, to define where the mussel beds are and accurately map 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 Taw-Torridge Estuary and the development of shellfisheries in this part of the Devon & Severn IFCA's District.

2. Methodology

2.1 The Taw-Torridge Estuary

The Taw-Torridge estuary is located on the North Devon coast, within the Area of Outstanding Natural Beauty (AONB) and the North Devon UNESCO Biosphere Reserve (Figure 1).

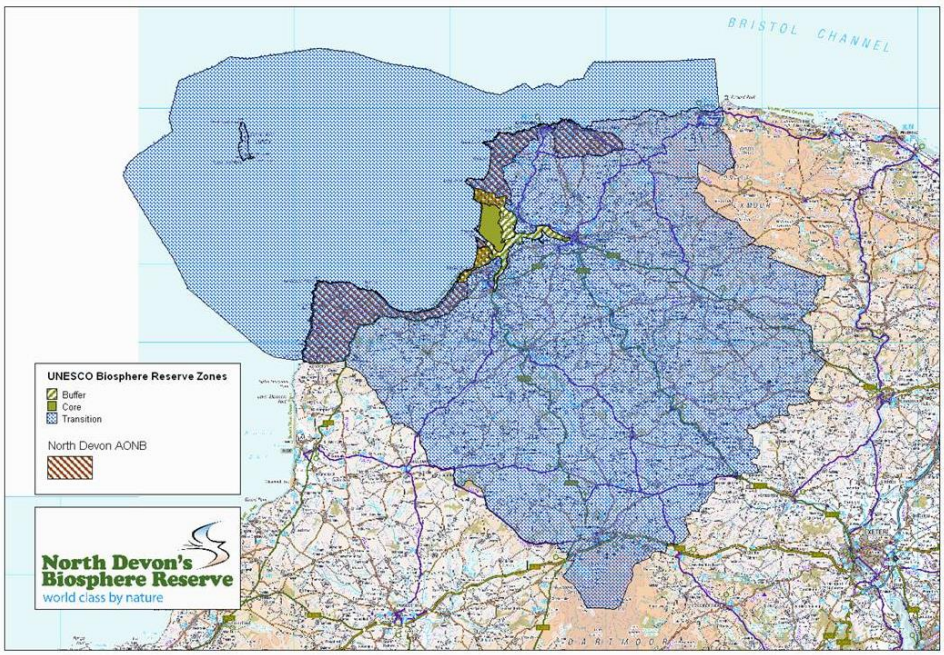

Figure 1 The location of the Taw Torridge Estuary (shown in yellow) within the North Devon Biosphere Reserve and the North Devon Coast AONB. (North Devon AONB and Biosphere Reserve Service, 2010)

The Taw Torridge Estuary is an important site for wildlife and has been designated a Site of Special Scientific Interest (SSSI) (Figure 1) for over-wintering and migratory populations of wading birds, and for the rare plants found on its shores. Upper reaches of the estuary were considered for designation as a Marine Conservation Zone (MCZ) by the Finding Sanctuary Regional Stakeholder Group (RSG) (Figure 3) for six Broad Scale Habitats; subtidal mud, subtidal sand, coastal saltmarshes and saline reed beds, intertidal coarse sediment, intertidal sand and muddy sand, low energy intertidal rock, and one Feature of Conservation Interest (FOCI) species the European eel (*Anguilla anguilla*). However, to date the site has not been designated. Parts of Taw-Torridge Estuary also lie within the Braunton Burrows Special Area of Conservation, also shown in Figure 3.

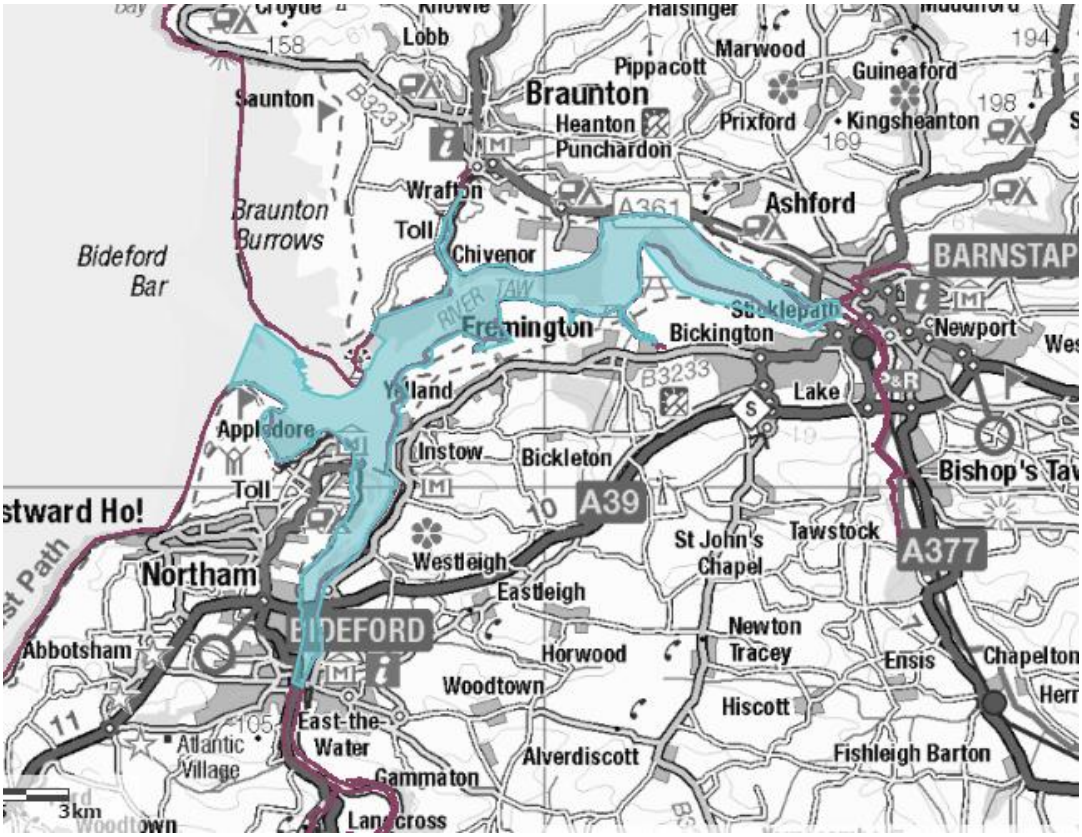

Figure 2 Taw-Torridge Estuary SSSI, shown in blue (Defra, 2020)

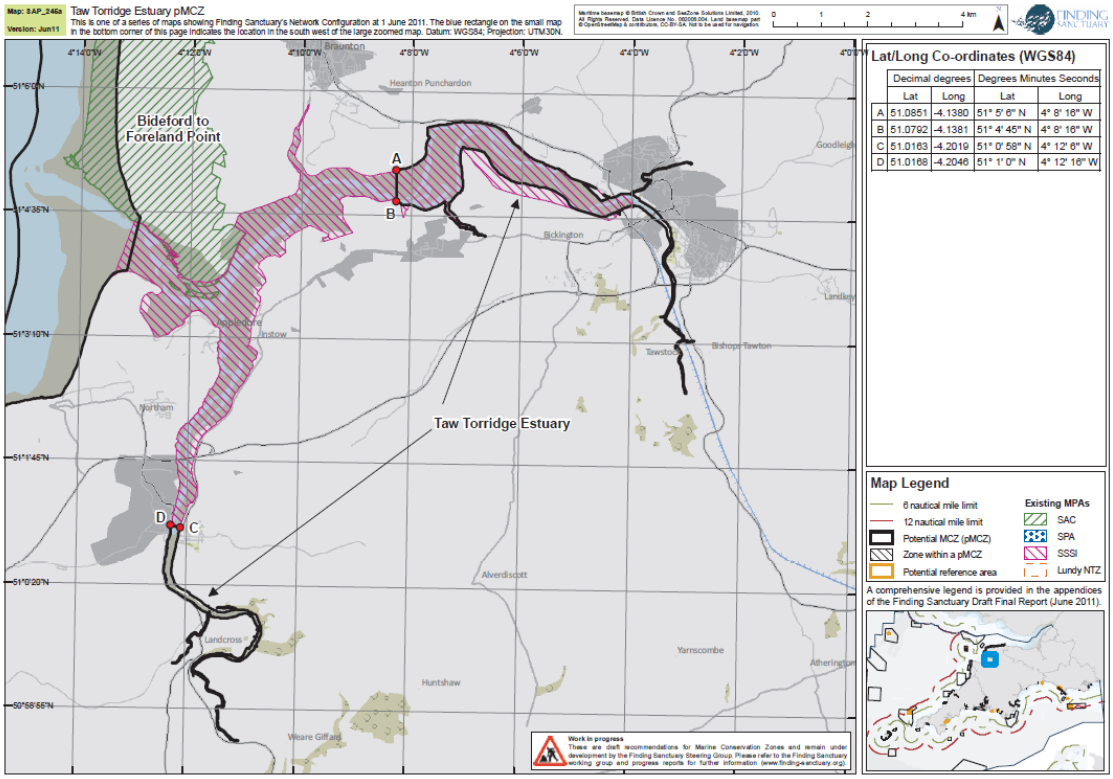

Figure 3 Area of rMCZ, outlined in black. Area of SSSI shown in red hatching, and area of SAC shown by green hatching. (Lieberknecht et al., 2011)

2.2 Survey Methodology

Surveys were conducted annually between 2012–2020. In 2020, all survey sites within the estuary (Figure 4) were sampled between 3rd and 20th September. Coolstone, Yelland and Lifeboat Slip are intertidal beds accessible on foot from land, whereas Pulleys, Sprat Ridge and The Neck are mid-channel and require access by boat. 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 Taw-Torridge 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, except for the Neck which was first visited in 2020 following consultation with a local fisher. The perimeters were subsequently mapped in QGIS v3.1(Figure 4). For subsequent visits the perimeter is determined by using the start and end coordinates of each 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 the 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 (one 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'.

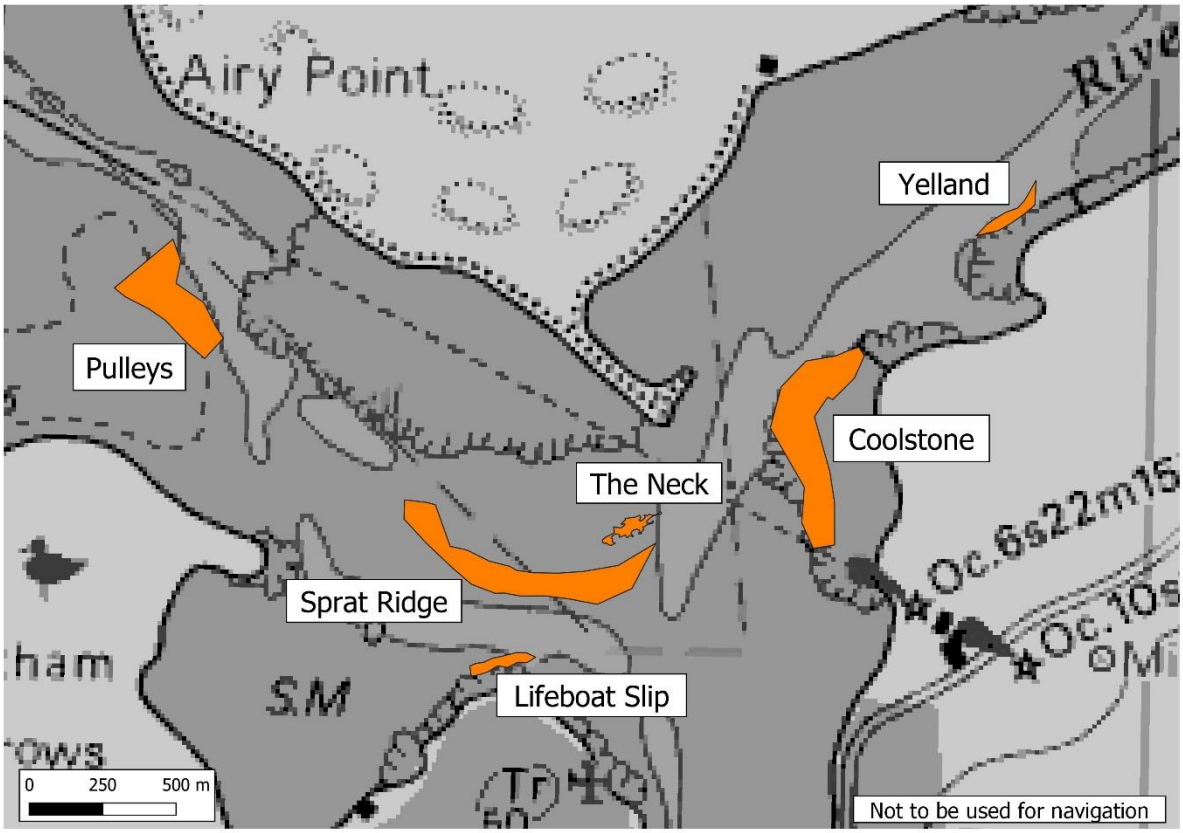

Figure 4 Area of each mussel bed (orange). Pulleys, Sprat Ridge, Lifeboat Slip, Coolstone and Yelland have been surveyed annually since 2012. One additional site (The Neck) was surveyed in 2020.

Once all transects were complete the mussel samples were sieved and cleaned. For each transect the total number of samples taken was recorded, and 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 (both including and excluding the additional 2020 survey site (the Neck)). The totals excluding the Neck were more easily comparable to previous years. A weighted average bed density and percentage cover across all mussel beds was calculated by weighting the values based on the relative total area of the respective beds. 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

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

2.3 Shellfish Ecological Requirement Model

Natural England has provided a mathematical model that allows an estimate to be made of the ecological requirements of wading birds (specifically oystercatchers, *Haematopus ostralegus*) feeding on mussel in the areas surveyed by D&S IFCA. Using this model, it is possible to calculate the tonnage of prey-sized (30-60 mm) mussel required to sustain the bird population, to compare this to the overall tonnage of prey-sized mussel on the surveyed beds, and thereby estimate the total mussel available to the fishery.

The mathematical modelling includes several parameters that may be changed between years to reflect changing conditions on the estuary. For 2020, the tonnage of prey sized mussel was calculated to be 775 tonnes (based on mussels 31 – 60 mm rather than 30 – 60 mm, due to the survey method), and the number of birds feeding on mussels on-site was estimated to be 999. This estimate was provided by Natural England based on Wetland Bird Survey (WeBS) counts, using the mean five year count for the overwinter period (September – March, 2015 – 2020). Natural England also advised that the proportion of these birds that should be assumed to be feeding on mussels should be set at 70% (0.7).

3. Results

3.1 Combined Survey Sites

Since 2019 the tonnage of mussel total stock across the estuary decreased by 15.22% (

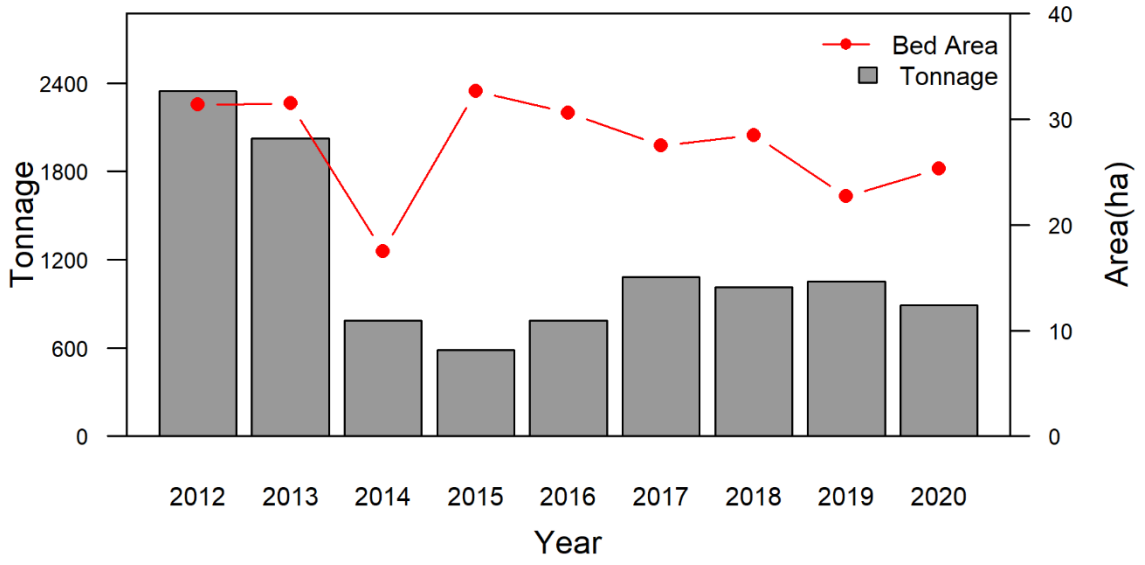

Figure **5**). The combined survey area containing live mussels increased by 11.5%. The 2020 survey included an additional survey site (The Neck), which makes direct comparisons of the total tonnage of mussels and total survey area difficult. Excluding The Neck from calculations, total tonnage of mussels decreased by 24.3%, and the total survey area increased by 8.85% since 2019. Total mean mussel density within the surveyed sites decreased 27.9% (35.66% excluding The Neck), whilst the percentage cover of mussels decreased by 30.16% (32.65% excluding The Neck)(Figure 6). The stock of marketable sized mussels (>41mm) was estimated to be 493.3 tonnes out a total 891.8 tonnes for all sites, i.e. 55% (Figure 7).

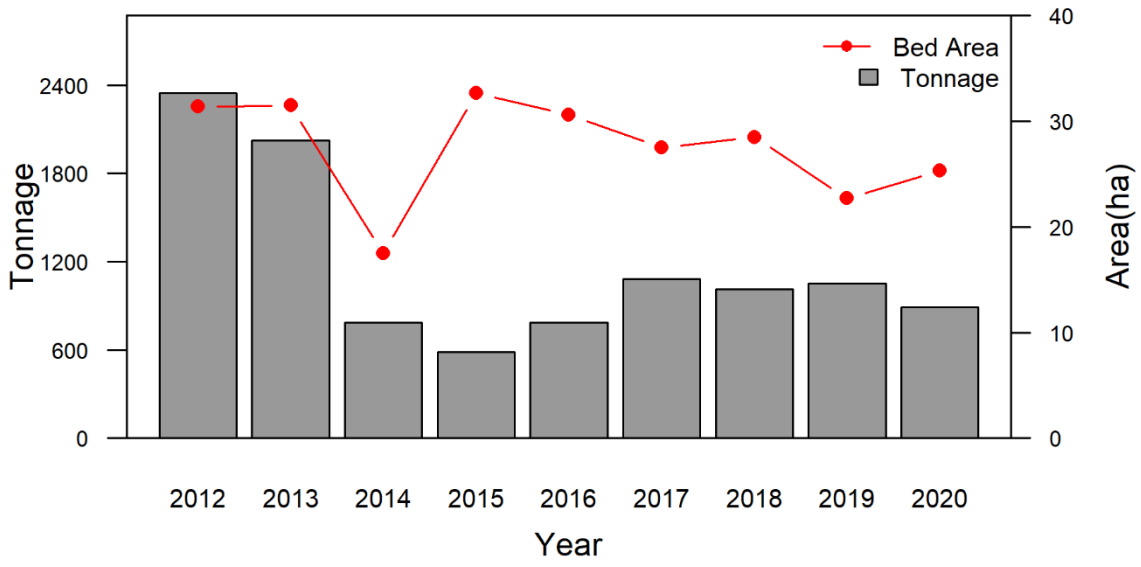

Figure 5 Total area surveyed plotted over tonnage of total stock within all survey areas 2012–2020. Pulleys, Sprat Ridge, Lifeboat Slip, Coolstone and Yelland have been surveyed annually since 2012. One additional site (The Neck) was surveyed and included in the 2020 analysis.

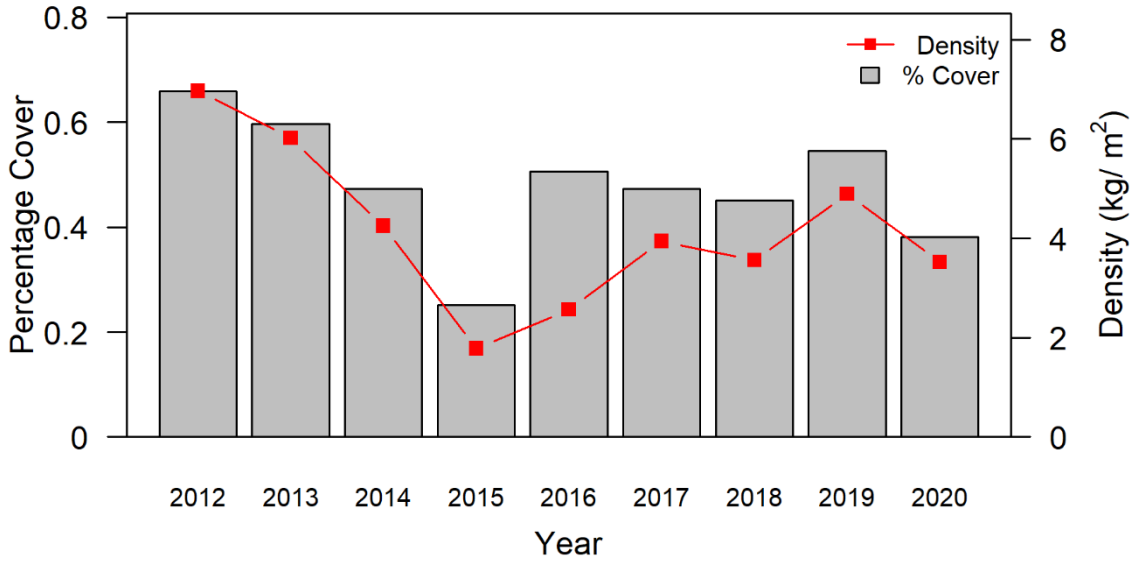

Figure 6 Percentage cover and density of mussel averaged across all sites 2012-2020. Pulleys, Sprat Ridge, Lifeboat Slip, Coolstone and Yelland have been surveyed annually since 2012. One additional site (The Neck) was surveyed and included in the 2020 analysis.

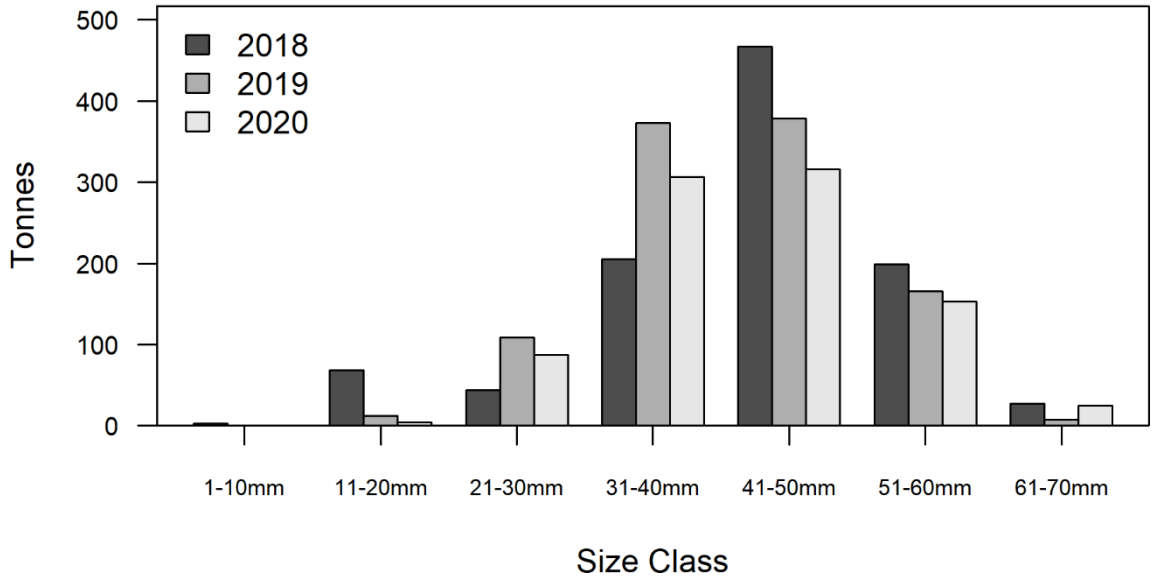

Figure 7 Total Combined 10mm size class for 2018-2020 stock. Pulleys, Sprat Ridge, Lifeboat Slip, Coolstone and Yelland have been surveyed annually since 2012. One additional site (The Neck) was surveyed and included in the 2020 analysis.

3.2 Coolstone

Coolstone was surveyed on 19th September 2020 with 30 samples collected from 18 transects. Since 2019 the total stock tonnage increased by 11.8% and the survey area containing live mussels increased by 38.1% (Figure 8). Total mussel density within the survey area decreased by 19%, whilst percentage cover decreased by 30% (Figure 9). The stock of marketable sized mussels (>41mm) was estimated to be 97.1 tonnes out a total 143 tonnes

on the bed, i.e. 67.8% (Figure 10). Data are averaged for 2012-14 when the Coolstone beds were separate prior to merging into one continuous bed in 2015.

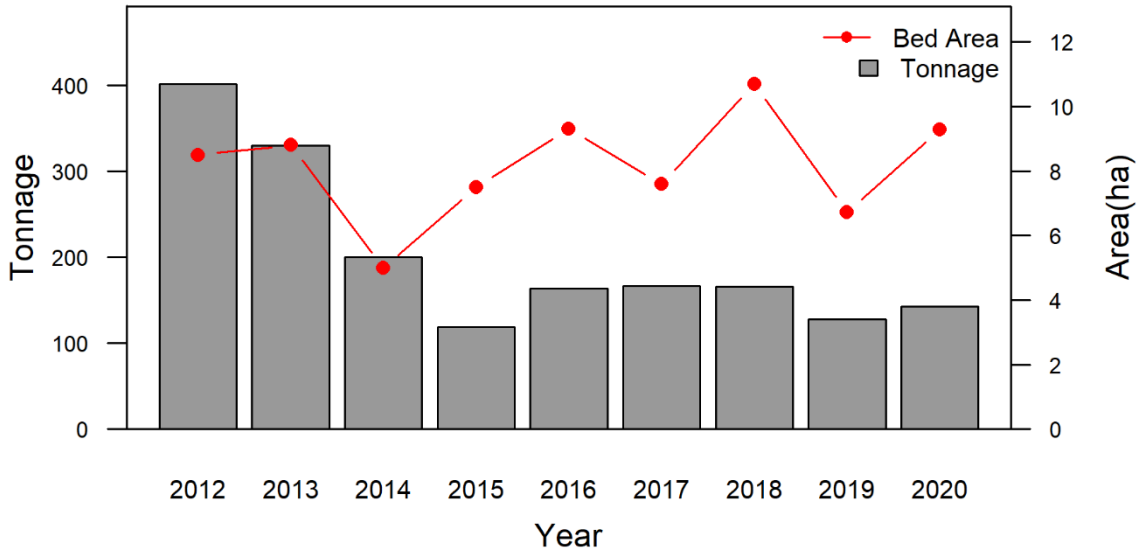

Figure 8 Total area surveyed plotted over tonnage of total stock within the Coolstone mussel bed between 2012–2020.

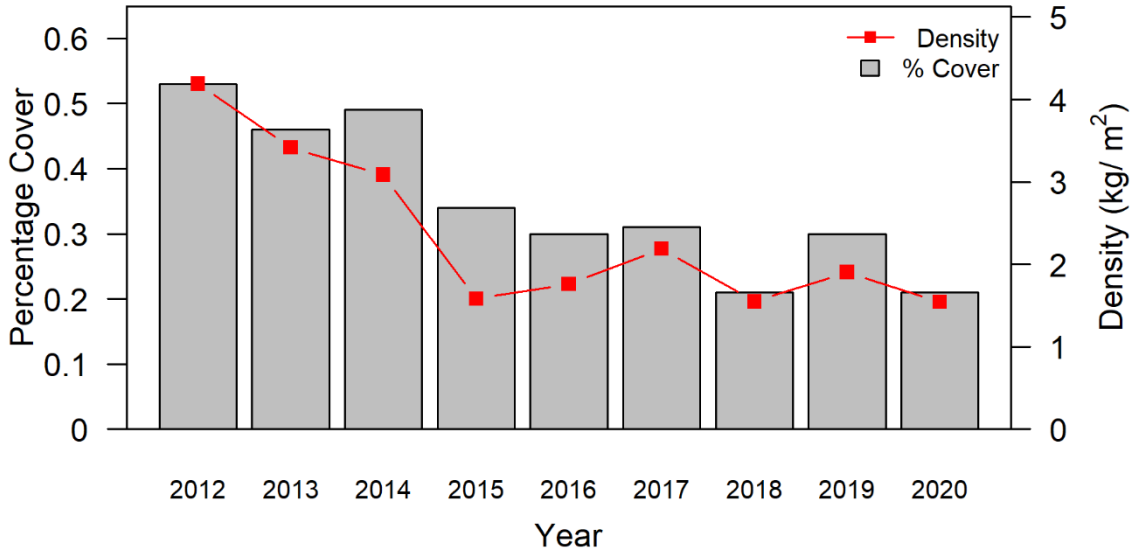

Figure 9 Percentage cover and density of mussels on the Coolstone bed 2012–2020.

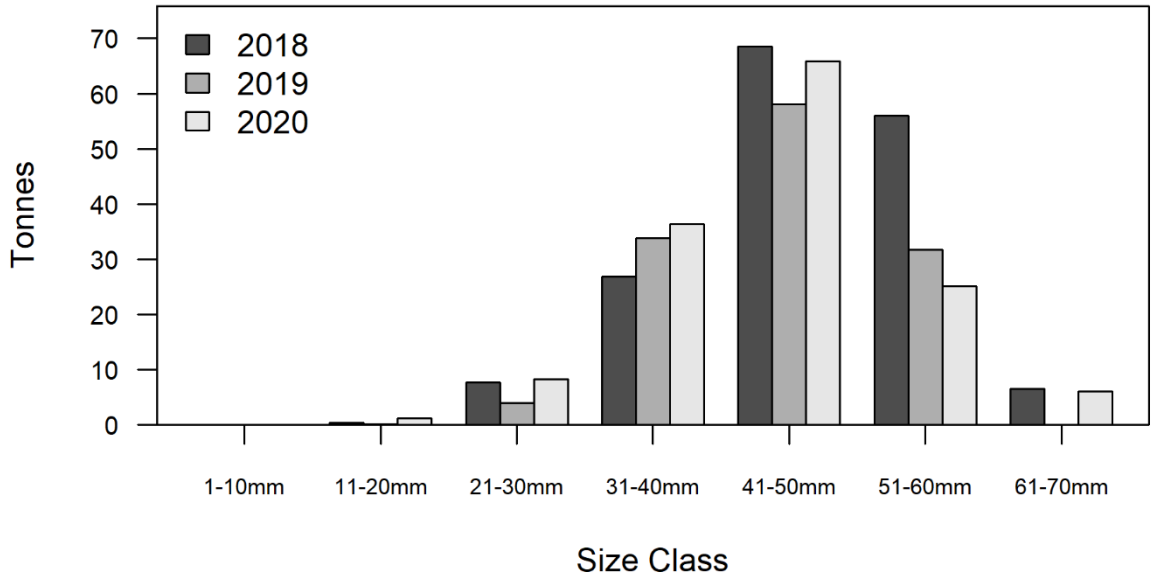

Figure 10 Tonnage of each 10mm size class for the Coolstone 2018–2020 stock.

3.3 Lifeboat Slip

Lifeboat Slip was surveyed on 18th September 2020. Six samples were collected from 14 transects. Since 2019 the tonnage total stock decreased by 13.2% and the survey area containing live mussels decreased by 4.88% (

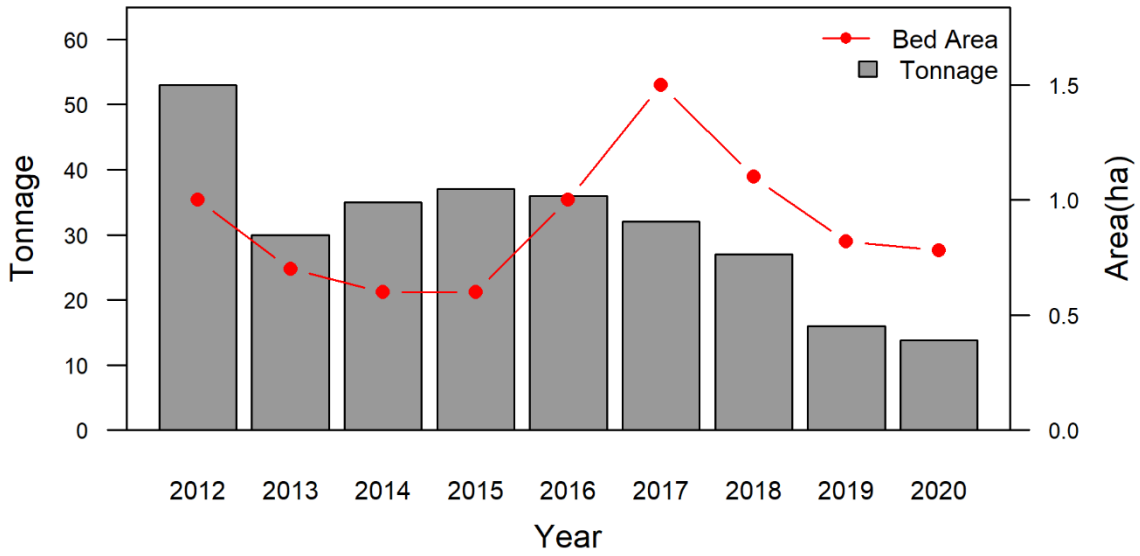

Figure 11). Total density within the survey area fell by 6.4%, whilst percentage mussel cover decreased by 3% (Figure 12). The stock of marketable sized mussels (>41mm) was estimated to be 13 tonnes out a total 13.8 tonnes on the bed, i.e. 93.7% (Figure 13).

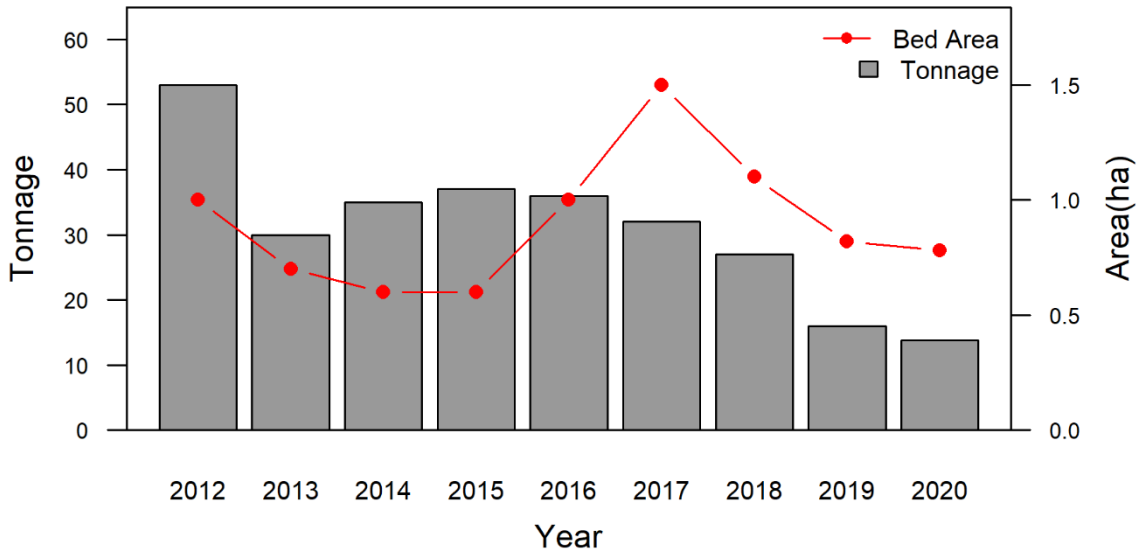

Figure 11 Total area surveyed plotted over tonnage of total stock within the Lifeboat Slip mussel bed between 2012–2020.

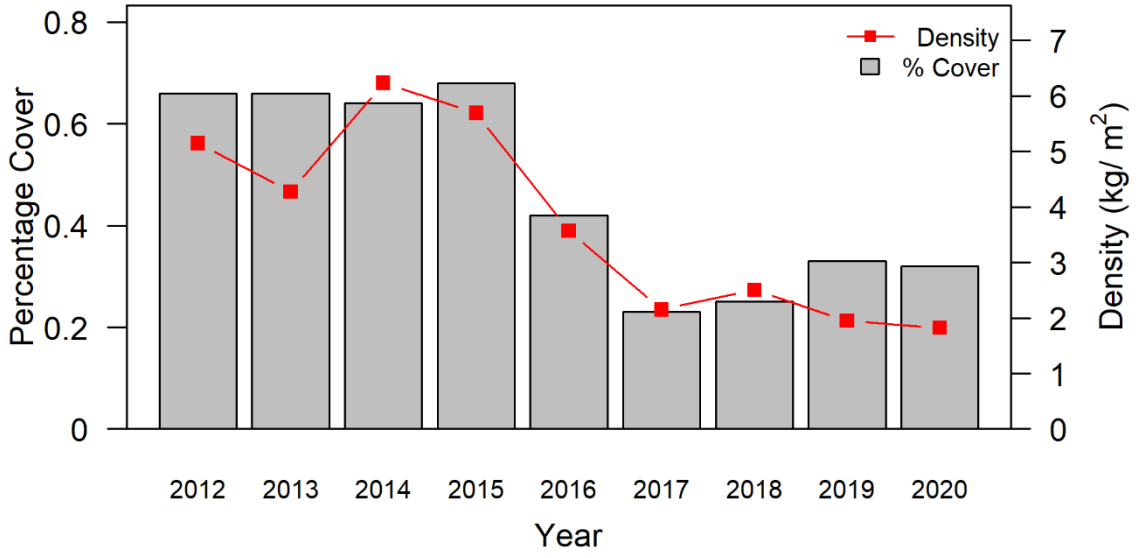

Figure 12 Percentage cover and density of mussels on the Lifeboat Slip bed 2012–2020.

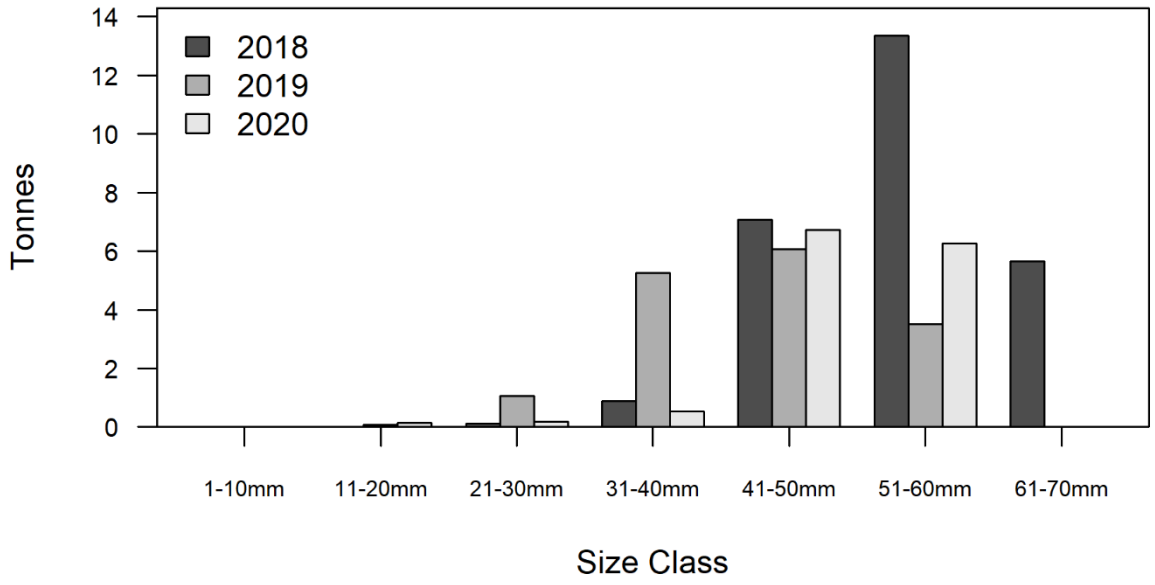

Figure 13 *Tonnage of each 10mm size class for the Lifeboat Slip 2018–2020 stock.*

3.4 Sprat Ridge

Sprat Ridge was surveyed on 18th September 2020; 69 samples were collected from 24 transects. Since 2019 the tonnage of total stock decreased by 25% and the survey area containing live mussels increased by 34.5% (Figure 14, Figure 15). Total density within the survey area declined by 44.2%, whilst percentage cover of mussels declined by 21.7% (Figure 15). The stock of marketable sized mussels (>41mm) was estimated to be 288 tonnes out a total 377 tonnes on the bed, i.e. 76% (Figure 17).

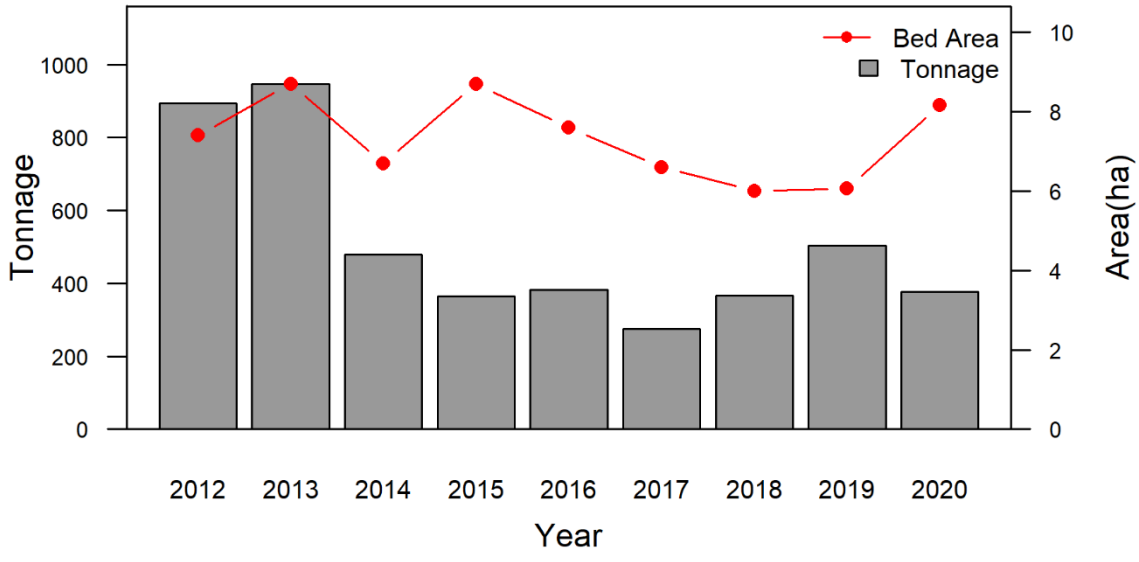

Figure 14 Total area surveyed plotted over tonnage of total stock within the Sprat Ridge mussel bed between 2012–2020.

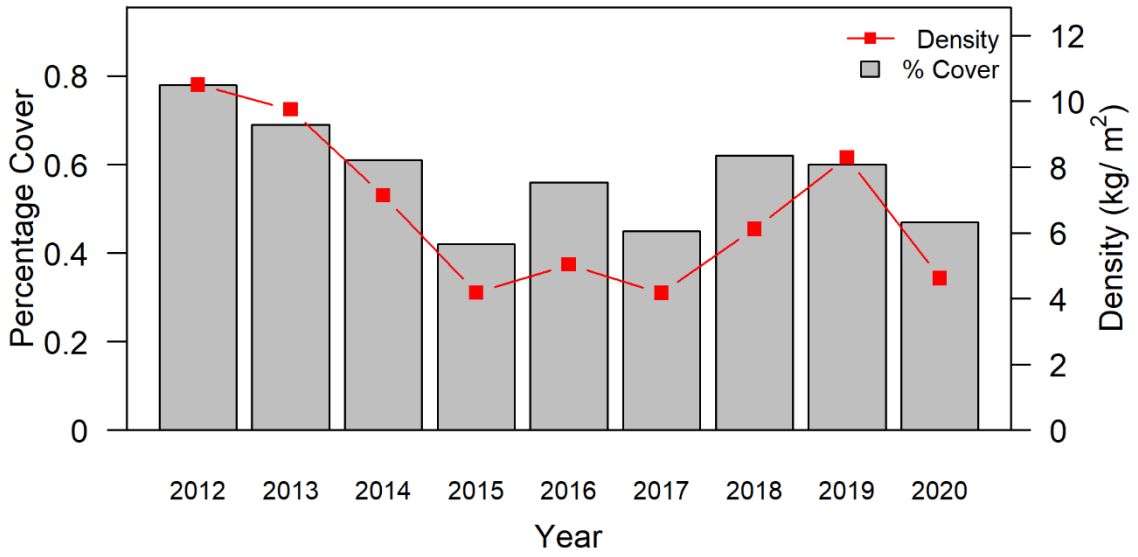

Figure 15 Percentage cover and density of mussels on the Sprat Ridge bed 2012–2020.

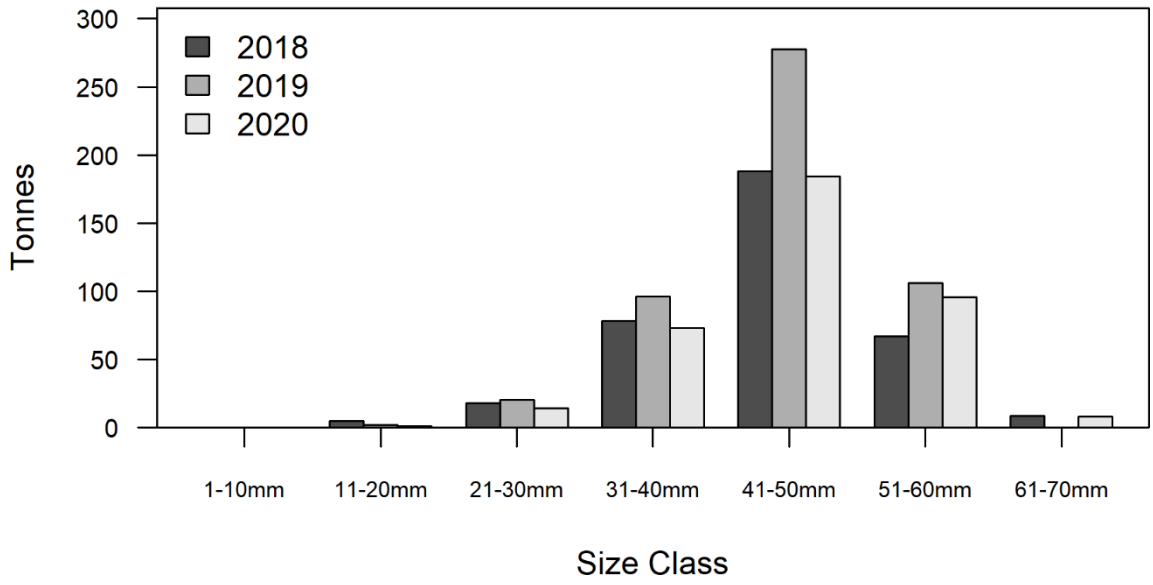

Figure 16 Tonnage of each 10mm size class for the Sprat Ridge 2018–2020 stock.

3.5 Pulleys

Pulleys was surveyed on 17th September 2020; 43 samples were collected from 10 transects. Since 2019 the total stock tonnage decreased by 41.8% and the survey area containing live mussels decreased by 31.8% (Figure 17). Total density within the survey area decreased by 26.8%, whilst percentage mussel cover decreased by 37% (

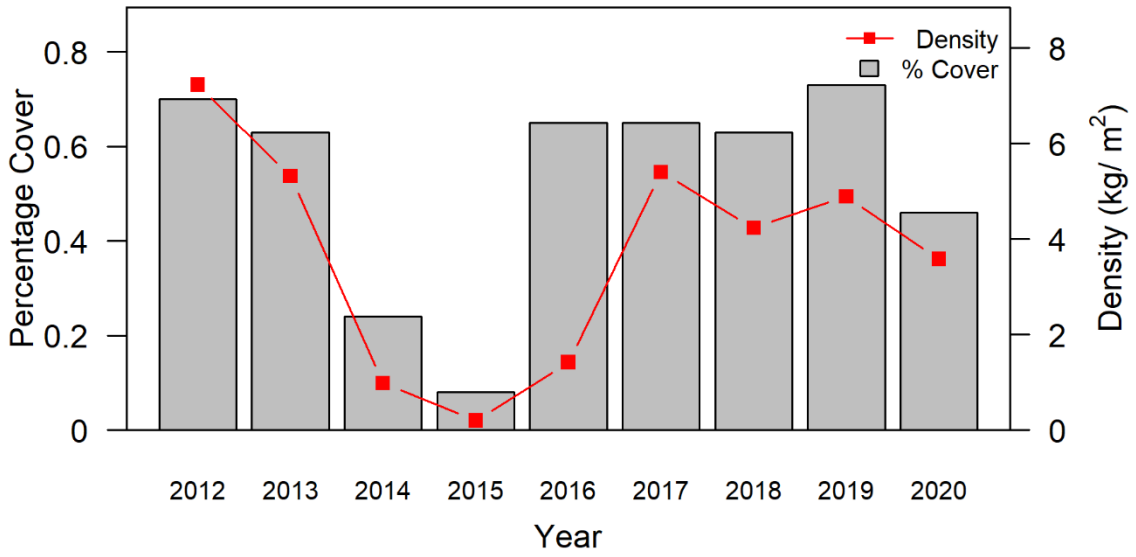

Figure 18). The stock of marketable sized mussels (>41mm) was estimated to be 11 tonnes out a total 203 tonnes on the bed, i.e. 5.3% (Figure 19).

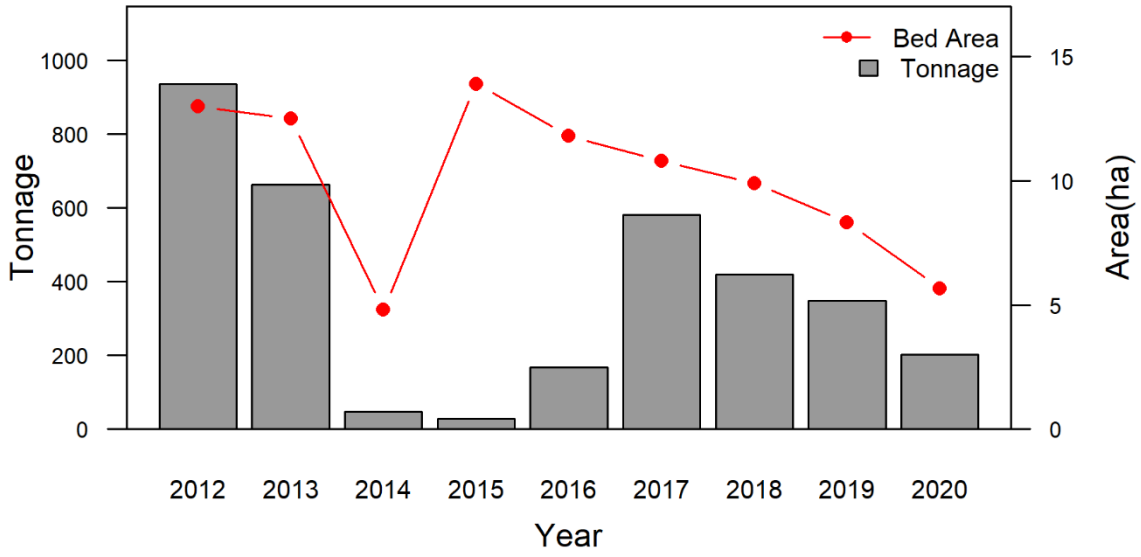

Figure 17 Total area surveyed plotted over tonnage of total stock within the Pulleys mussel bed between 2012–2020.

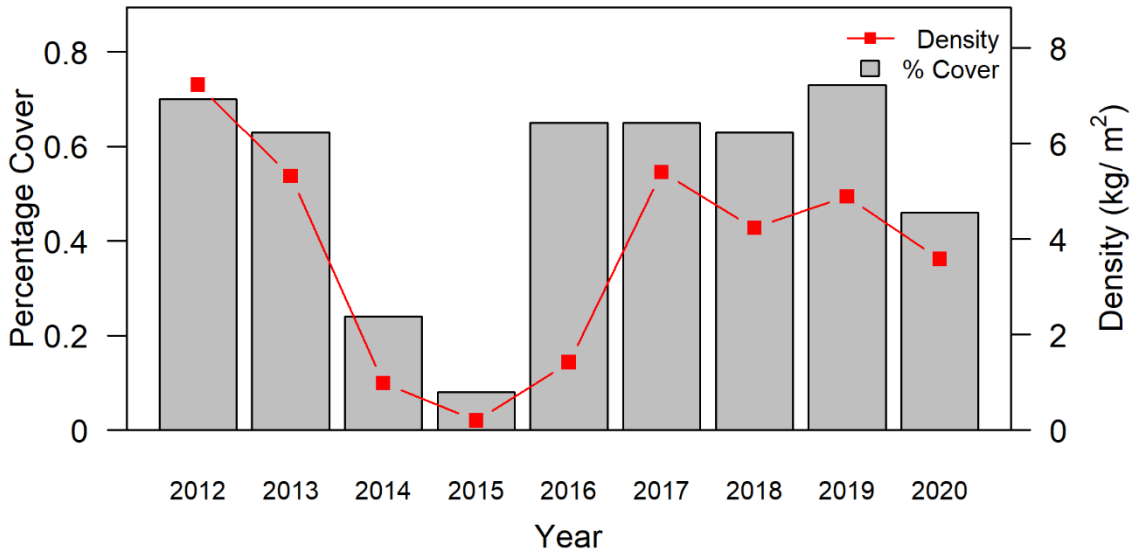

Figure 18 Percentage cover and density of mussels on the Pulleys bed 2012–2020.

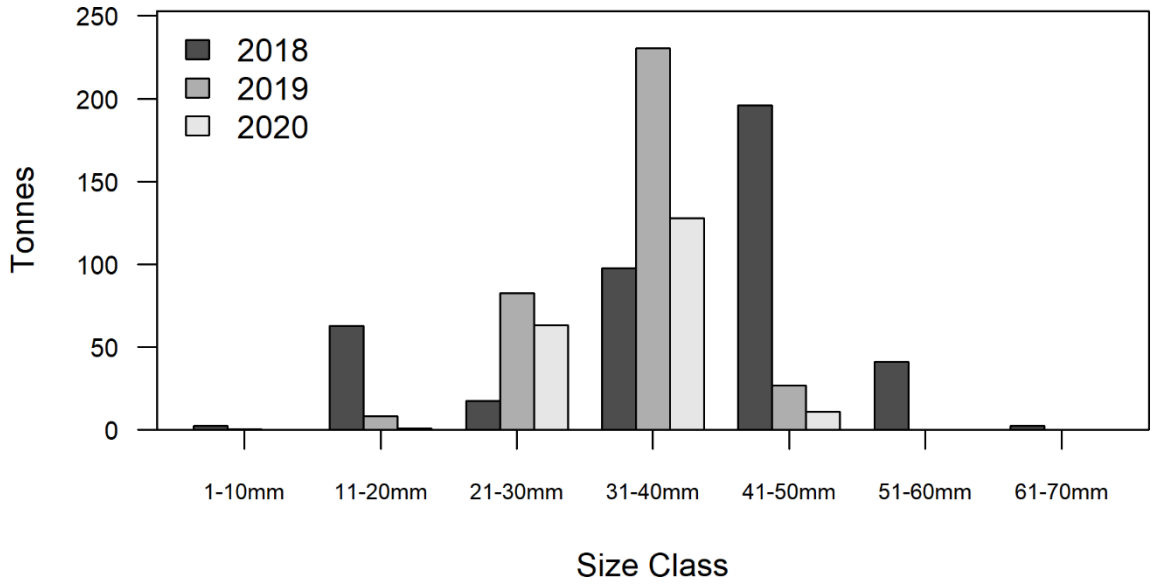

Figure 19 Tonnage of each 10mm size class for the Pulleys 2018–2020 stock.

3.5 Yelland

Yelland was surveyed on 3rd September 2020; 16 samples were collected from 11 transects. Since 2019 the total stock tonnage increased by 4.3% and the survey area containing live

mussels increased by 5.3%

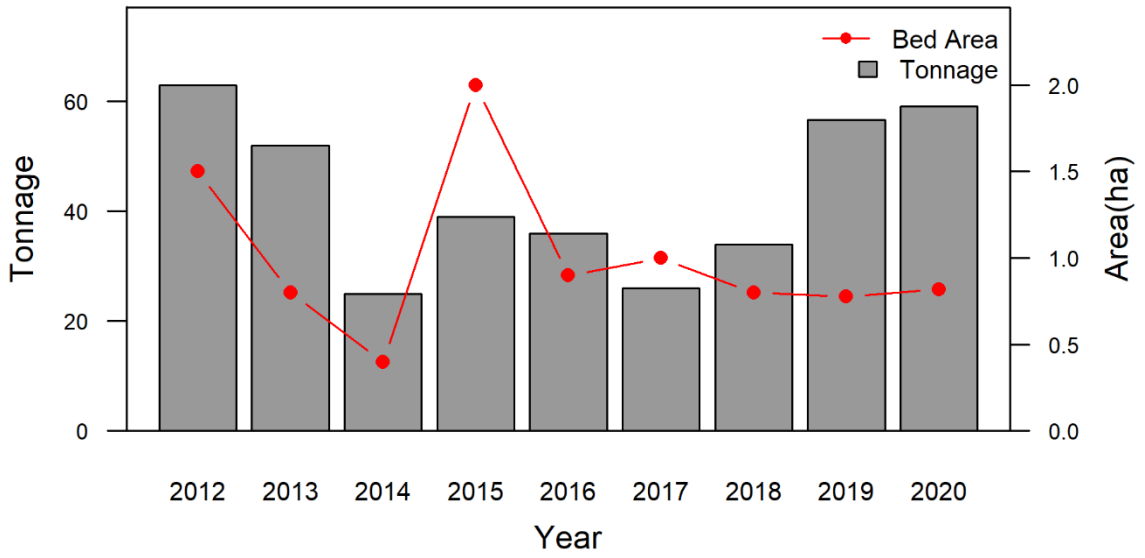

Figure 20). Total density within the survey area declined by 1.1%, whilst percentage mussel cover increased by 8.2% (Figure 21). The stock of marketable sized mussels (>41mm) was estimated to be 51.4 tonnes out a total 59 tonnes on the bed, i.e. 87% (Figure 22).

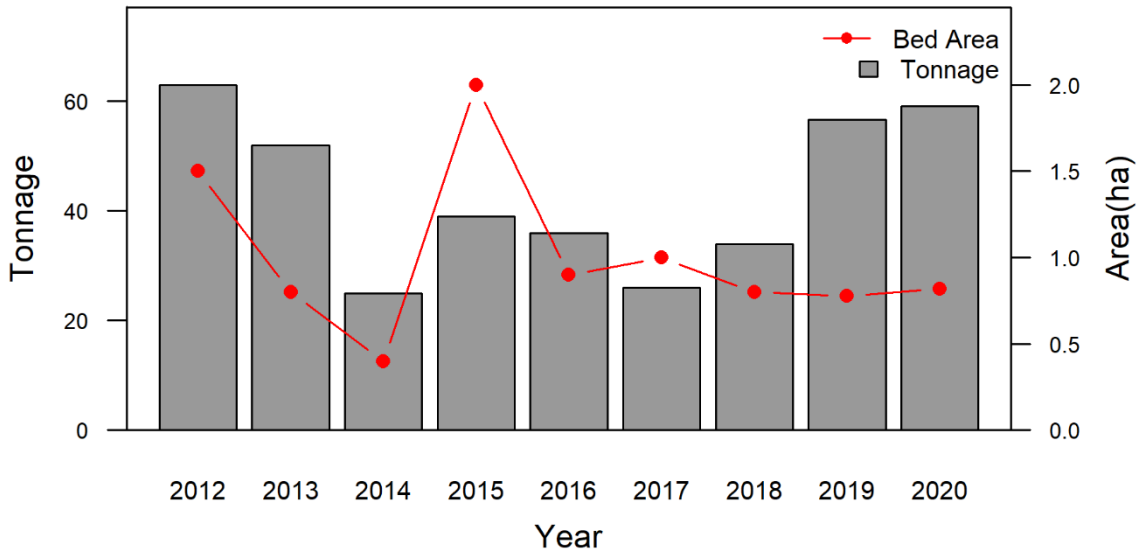

Figure 20 Total area surveyed plotted over tonnage of total stock within the Yelland mussel bed between 2012–2020.

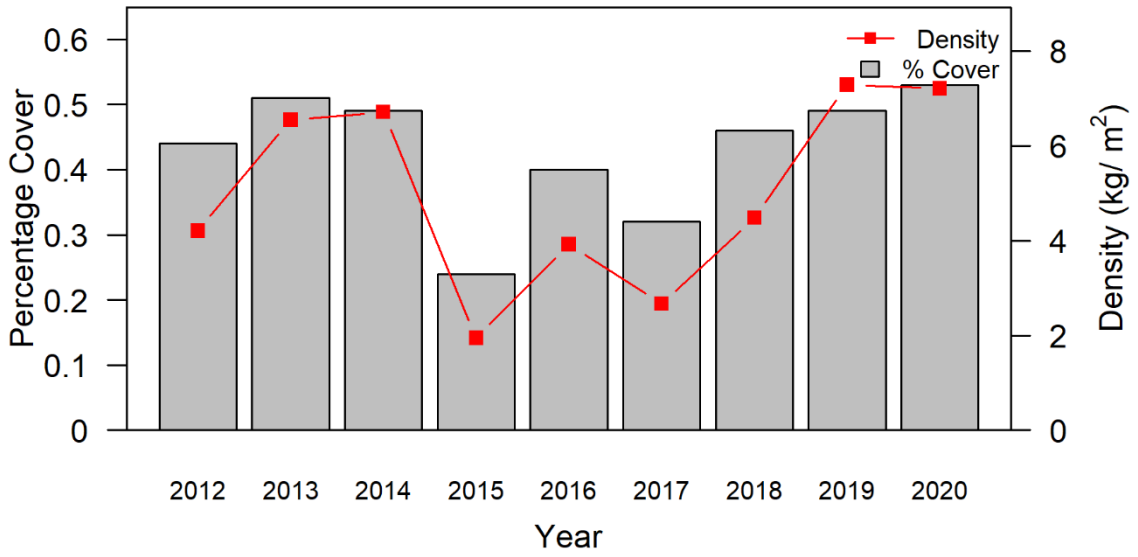

Figure 21 Percentage cover and density of mussels on the Yelland bed 2012–2020.

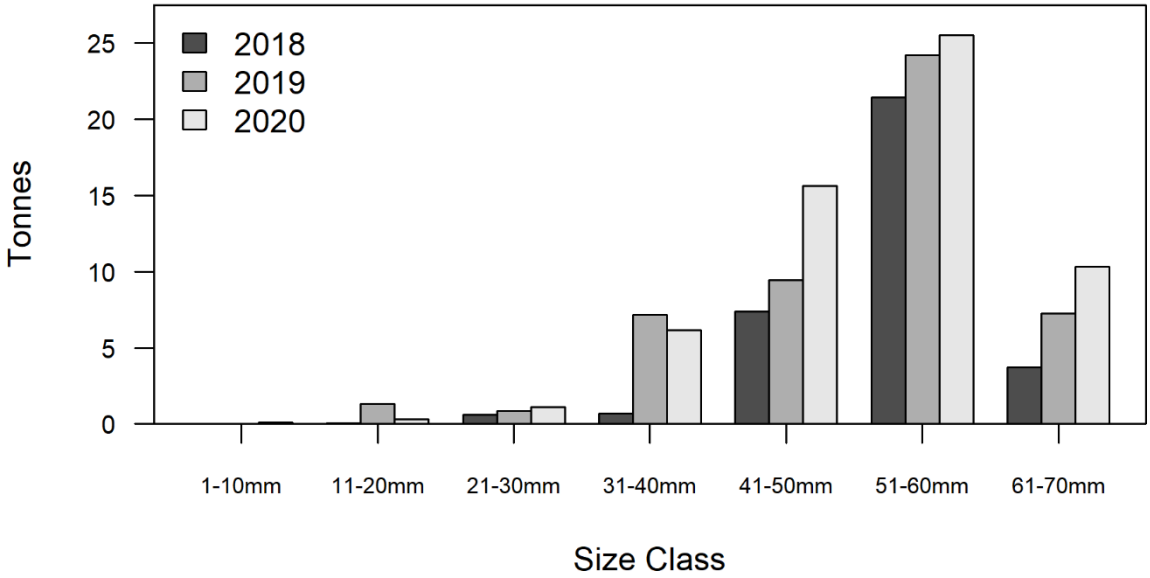

Figure 22 Tonnage of each 10mm size class for the Yelland 2018–2020 stock.

3.6 The Neck

The Neck is a new bed identified in 2020 and surveyed for the first time on 20th September 2020; 27 samples were collected from 10 transects. The total stock was 95.5 tonnes, of which 3.1 tonnes (32.6%) was of marketable size (>41mm) (Figure 24). The total survey area containing live mussel was 0.6 hectares. Total density of mussel within the survey area was 15.9Kg/m^2.

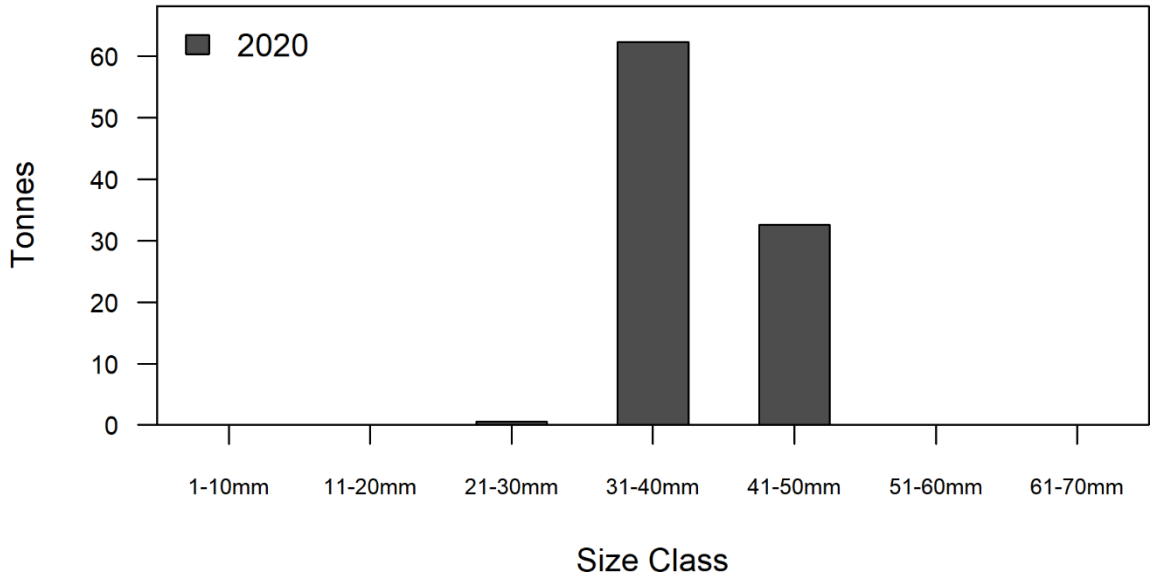

Figure 234 Tonnage of each 10mm size class for The Neck 2020 stock.

3.7 Shellfish Ecological Requirement Model Results

The mathematical model provided by Natural England projected that the ecological requirement of bird population obtained from prey-sized mussels was 731 tonnes. This leaves 44 tonnes potentially available to remain on the mussel beds and support the fishery.

4. Discussion

4.1 Combined Analysis of All Survey Sites

Overall, the total tonnage of mussel stock in the surveyed beds within the estuary appears to have remained relatively stable since 2017, with a slight decline in 2020 (

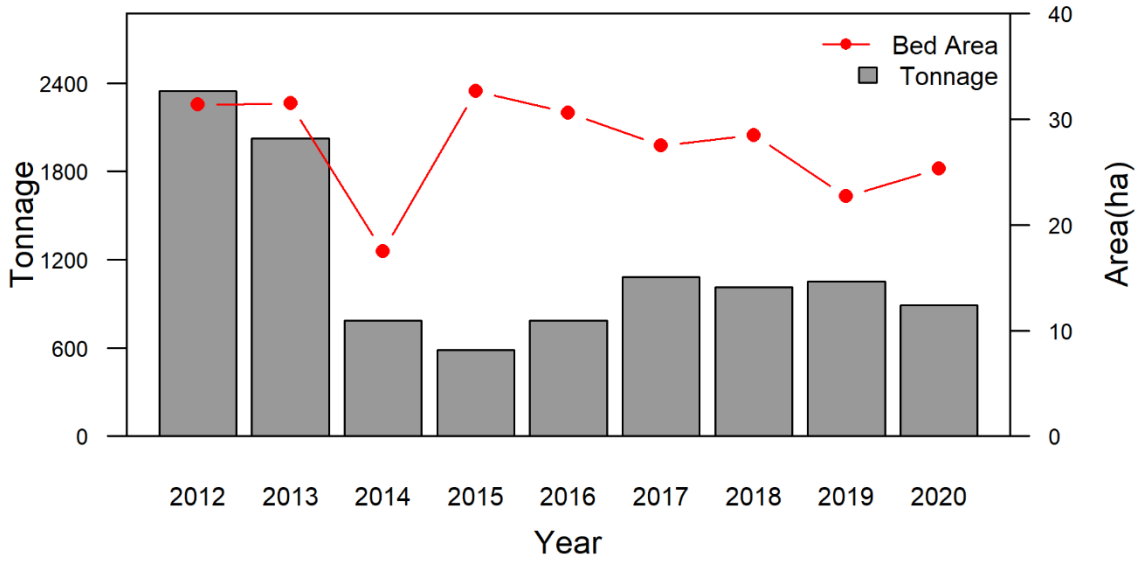

Figure **5**). This is despite the inclusion of a new survey site in 2020, where more than 90 tonnes of mussel were found. If the new survey site is excluded from the total tonnage of mussels across all sites, the decline in tonnage across all other beds is much greater (around 24%). The only size class of mussel to show an overall increase in tonnage across the estuary was 61-70mm, all others showed a decline. This suggests that while older

mussel is continuing to grow, there has not been as much new settlement or recruitment in the last year.

Although the total bed area surveyed has increased since 2019 (unsurprising given the addition of an extra survey site), the average density and percentage cover of mussels across all beds has declined. The decline in average density and percentage cover of mussels is exacerbated when the additional, more densely covered, 2020 survey site (the Neck) is removed from the analysis.

4.2 Analysis of Individual Beds

4.2.1. Coolstone

Since around 2016, the tonnage of mussels on the Coolstone bed appear to have remained relatively stable, whereas the bed area has fluctuated between around 6 and 11 hectares. Following a decline in both area and tonnage in 2019, both metrics have shown an increase in 2020, although not yet back up to the levels seen in 2018. The density and percentage cover of mussel across the bed has decreased since 2019, similar to the levels seen in 2018. The percentage cover of mussed, on the other hand seems to have shown a continued overall trend of decline since the onset of surveys in 2012. However, the density of the Coolstone bed has been fluctuating between around 1.5 and 1.9 kg/m^2 since 2015 (Figure 9), which is when the previously separate beds were first considered to be one merged bed. Coolstone is a patchy bed due the substrate that mussel is settled on; the areas of gravel where mussel grows best are broken up by outcrops of rock running through them. The patchy nature of this bed may explain the fluctuations in the measures seen year-on-year, as the values obtained will depend on whether the transects happen to cross over the denser patches of mussel.

Recruitment of mussel spat <30mm increased from 4.2 tonnes in 2019 to 9.6 tonnes in 2020. The only size class to show a reduction in tonnage was 51-60mm, whilst the 61-70mm class increased from zero to 6 tonnes. This suggests that as well settlement of mussel spat taking place, the more mature mussel is continuing to grow on into the next size class.

4.2.2. Lifeboat

Similar to Coolstone, the Lifeboat Slip survey area is also patchy and thinly populated by mussels due to being broken up by rocky outcrops. The area of mussel bed, tonnage, density and percentage cover of mussels remained similar to the 2019 levels. This is despite considerable drops in the tonnage of mussels <40 mm. The tonnage of mussels >41 mm has increased compared to the 2019, particularly driven by those in the 51–60 mm size class. The greater tonnage of mussels seen <30 mm last year may have resulted in the increased tonnage of mussels seen in the larger size categories this year.

4.2.3. Sprat Ridge

Sprat Ridge has seen decreases in total mussel tonnage density and percentage cover, but the mussel bed has increased by 34%. Sprat Ridge is dense and homogenous enough (~50% live mussel cover) to be considered a true mussel bed, therefore changes in survey area are more indicative of the change in bed size than some of the less homogeneous sites. This also means that the reductions in the other measures are less likely to be due to chance (i.e. from a transect mainly crossing patches with no mussel coverage. There were declines in the tonnage of all mussel size classes (apart from 61–70 mm) compared to the

2019 level, which has likely led to the declines in overall bed tonnage, density and percentage cover.

4.2.4. Pulleys

There has been a decrease in the area of the Pulleys mussel bed as well as a decline in the tonnage, density and percentage cover of mussels since 2019.However, as the percentage cover of Pulleys has been around 50% or higher since 2016, this bed is still more clearly defined than some of the sparser, patchier sites.

Declines in tonnage were seen across all size classes since 2019, which is reflected in the decline to the overall tonnage of the site. New settlement and recruitment could be difficult on Pulleys due to its proximity to the estuary mouth, where it is less sheltered, and the fast-flowing nature of the estuary. Despite declines seen in this bed over the past couple of years, the high homogeneity and stable mussel density suggest the bed may stabilise over the coming year (Bayne & Worrall 1980, Seed & Suchanek, 1992). With a large population, recruitment though relatively low in 2020, may continue in the coming months.

4.2.5. Yelland

Yelland has seen an increase of mussel biomass since 2017, now up to levels greater than prior to the 2014 storm event, almost back up to the levels recorded in 2012. Meanwhile the area of the bed has remained relatively stable since 2016. Percent cover continued to increase this year, while density over survey area has remained stable. The mussel population at Yelland is more homogeneous than Coolstone or Lifeboat (as the percentage cover is now around 50%) and its limits more clearly defined. This suggests that the observed increases may be less likely to be due to chance and could be a result of both increased growth and successful spat recruitment. This is evidenced by the fact that biomass of mussel in most size classes sampled in 2020 exceeded those of 2019 levels. If these positive trends and recruitment levels continue it is possible that the percentage cover or density of mussels on the Yelland bed may continue to increase.

The Yelland mussel bed is one of the only beds on the Taw-Torridge showing signs of improvement. However, it is one of the smallest beds in total area, meaning its influence on broader bed dynamics may be small.

4.2.6. The Neck

The Neck is a newly surveyed bed, identified following consultation with a local fisher and surveyed for the first time in 2020. The data collected this year will form a baseline, against which future years' data will be compared.

All stock on the Neck was between 21-50mm, suggesting it is around 2-4 years old (Bayne & Worrall, 1980, Handå et al., 2011). The Neck was densely populated and homogenous, however it also extended into the subtidal meaning that some areas could not be included in this survey. Therefore, the measures calculated from the survey may not reflect the true composition of the full bed.

4.3 Ecological Requirements and The Local Fishery

The shellfish ecological requirement model indicated that 44 tonnes of mussel is excess to the requirements of the oyster catchers on-site and therefore is both available to the fishery and to remain on the surveyed beds as brood stock and for further recruitment within the estuary. Under current regulations agreed by Natural England and D&S IFCA, the fishery is

currently limited to 500 kg per month (six tonnes per year), which is substantially less than the 44 tonnes identified as available here. However, it should be highlighted that 95 tonnes of the prey-sized mussel identified was present on the newly-surveyed bed, The Neck, which may only be accessible on spring tides. It is not clear how this would affect fishing or bird feeding activity.

4.4 Conclusions

Following the loss of mussels between 2013 and 2014 and an increase in interest from numerous commercial harvesters, Natural England, as the regulatory body for SSSIs, working with D&S IFCA, introduced management measures to ensure that enough mussels would be available to provide an adequate food supply for the birds for which the SSSI is designated. No more than 500kg of mussels can be removed from the SSSI per month, and any business wishing to remove mussels must notify Natural England and D&S IFCA of their intentions to do so by 23rd of the month prior to the month when mussel harvesting is proposed. This allows Natural England and the IFCA to determine if the planned removal will, in combination with other planned activities, be likely to result in the 500kg limit being exceeded. If this is the case, planned removal by all individuals will need to be reduced accordingly. Records of the amount of mussel removed (including location) together with copies of movement documents are submitted to Natural England and the IFCA within 14 days of harvesting.

This year's assessment highlighted that overall mussel bed area, tonnage, density, and percentage cover mostly show declines form the levels observed in 2019. The smaller mussel beds (e.g. Yelland) showed signs of improvement, but the influence on broader bed dynamics is likely to be small as a result of its small size. The new survey site (the Neck) also had a relatively high density and percentage cover of mussels, but was also one of the smaller beds.

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 difference in spat recruitment levels between previous years 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.

4.5 Recommendations

It is recommended that the Taw Torridge Estuary mussel stock assessments continue to be carried out on an annual basis, to monitor any future changes to the stock of the beds. This will help to inform any future management D&S IFCA may bring in for the collection of mussels, as part of their review of existing byelaws and development of a possible Hand Working Byelaw, as well as working with Natural England to ensure the mussel harvesting limit remains suitable to balance the environmental and economic interests in the mussel stocks.

In addition to this the use of a fine mesh sieve is recommended for next year's surveys to help establish whether spat recruitment <20mm is being underestimated due to survey technique. A second bi-annual 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.

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