Taw-Torridge
Mussel Stock Assessment 2018

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1. Introduction

1.1 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).

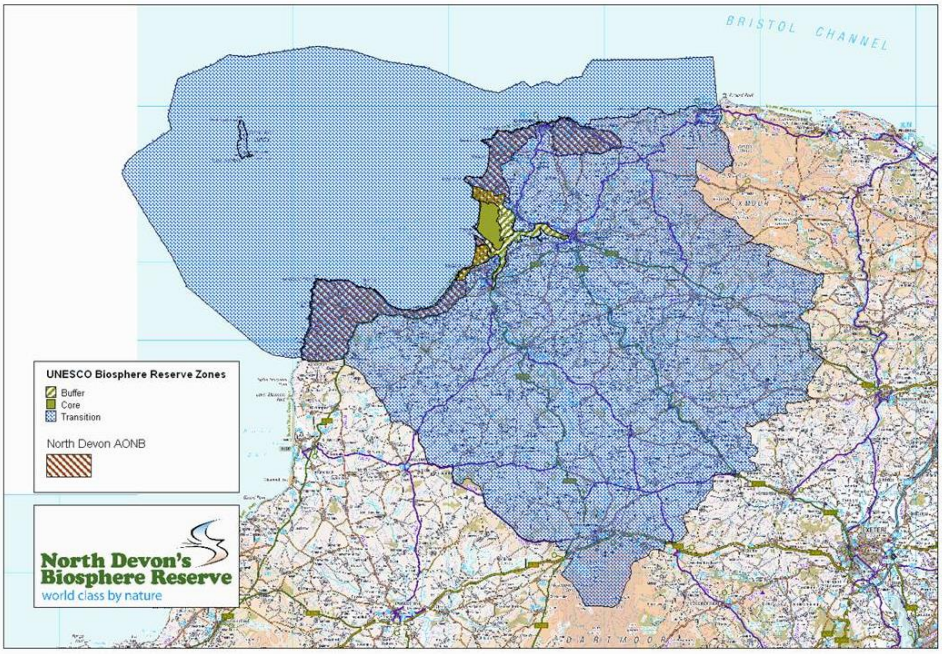

Figure 1 The location of the Taw Torridge Estuary (shown in yellow) within the North Devon Biosphere Reserve and the North Devon Coast AONB. (Taw Torridge Estuary Management Plan, 2010)

The 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 Finding Sanctuary (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 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.

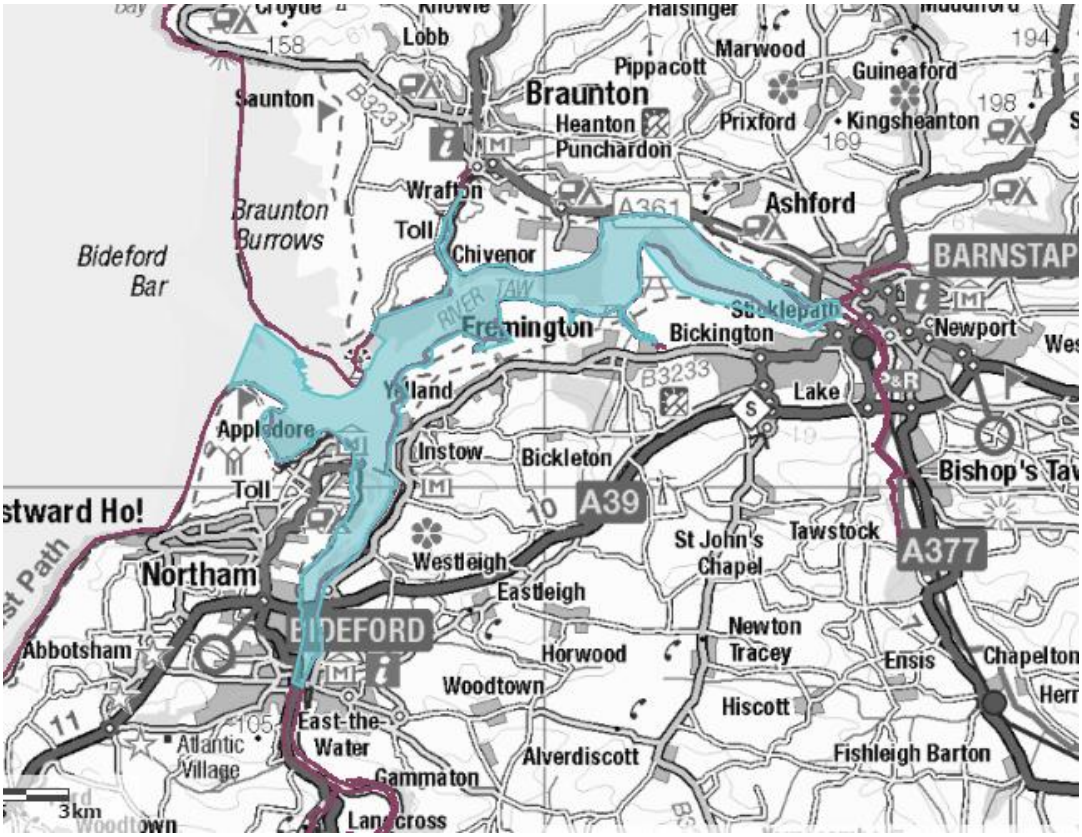

Figure 2 Taw-Torridge Estuary SSSI, shown in blue (Defra, 2016)

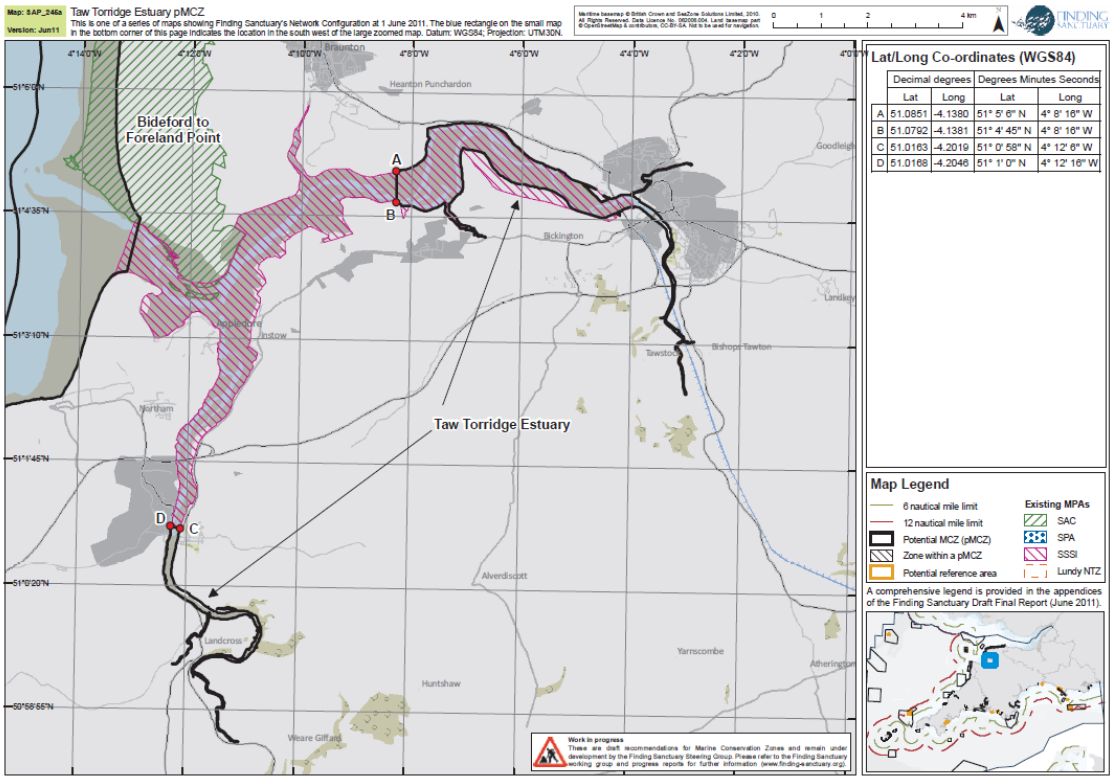

Figure 3 Area of rMCZ, outlined in black. Area of SSSI shown in red hatching, and area of SAC shown by green hatching. (Finding Sanctuary, 2011)

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 (Bayne & Worrall 1980, Seed & Suchanek, 1992, Andrews et al., 2011).

M. edulis beds play an important part 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, 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, Seed & Suchanek 1992, Handå at al., 2011).

Current threats to *M. edulis* beds include commercial fishing, water quality, coastal developments, anchoring and bait digging, and intensive recreational hand gathering (Maddock, 2008).

1.3 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, using GIS, and 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 and the development of shellfisheries in this part of the Devon & Severn IFCA’s District.

2. Methodology

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. The perimeter of this survey area was recorded by walking the extent of the live mussel habitat and marking coordinates with a handheld GPS. These were later plotted using QGIS software (Figure 4).

To determine coverage and patch density transects were walked in a zig-zag across the survey area, right up to the perimeter, to provide optimum coverage across the transect. The start and end coordinates of each transect were recorded using a handheld GPS (***Figure 4***). 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 along each transect the cane was flicked out to one side and it was recorded whether it was a "hit" if the ring contained live mussels, or a "miss" if the ring did not contain live mussels. 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.

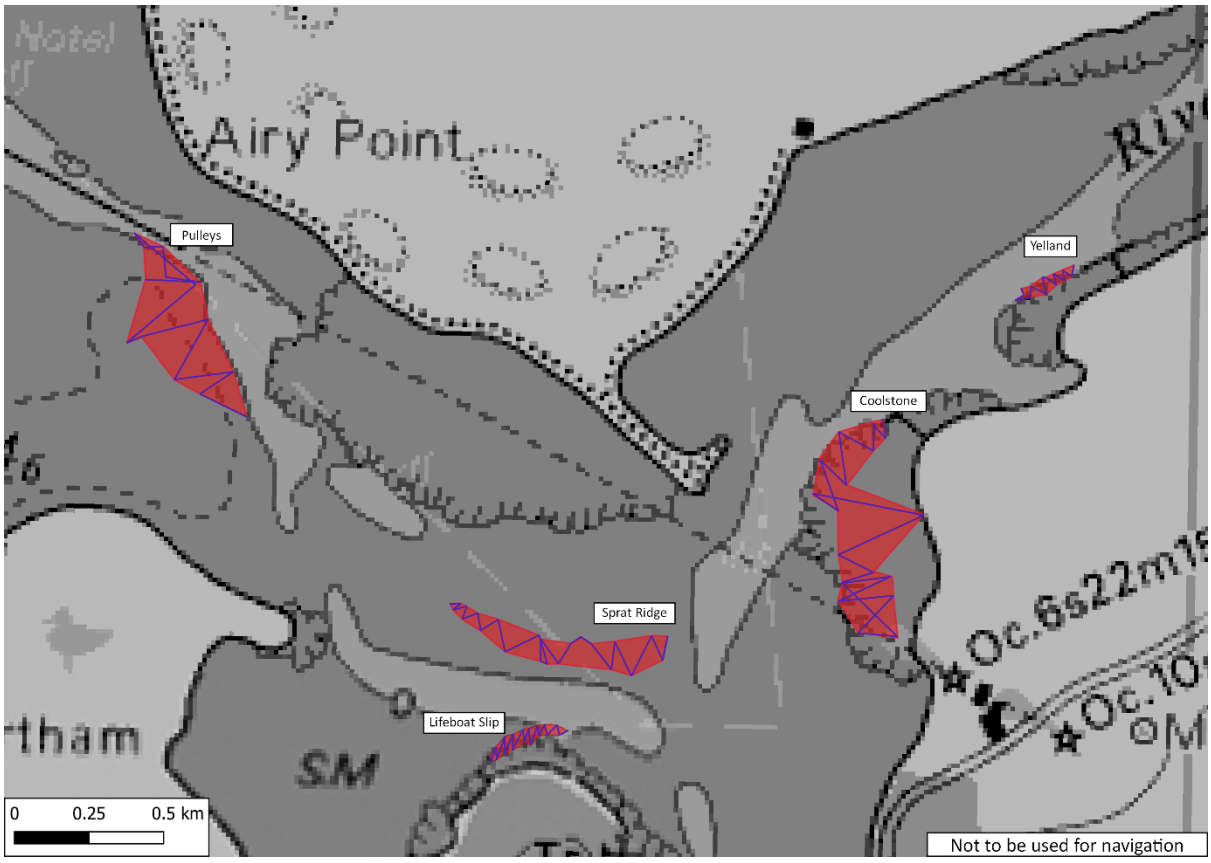

Figure 4 Transects walked (blue) and area of each mussel bed (red).

Once all transects were complete the mussel samples were sieved and cleaned. For each transect the number of samples taken was recorded, 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. The data collected from both the transects and samples were used to calculate the coverage, density and area of the survey area (***Figure 5***), which were 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 hit/miss dataonce pooled, were used to calculate the percentage cover of live mussels over the survey area.

The hit data were then used to work out average density of patch density for the whole survey area, 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 5 Calculations used for mussel coverage on bed, and density of mussels across bed.

3. Results

3.1 Combined survey sites across the Estuary.

All sites within the estuary were sampled between the 16th and 30th of May 2018 with a compiled 156 samples collected from a total 78 transects. Since 2017 the tonnage of mussel total stock across the estuary decreased by 6% (Figure 6). The combined survey area containing live mussel increased in spatial coverage by 11%. Total mean mussel density within the surveyed sites increased 14% whilst mean patch density increased by 2% (Figure **7**). The stock of marketable sized mussels (>41mm) was estimated to be 693 tonnes out a total 1013 tonnes for all sites, i.e. 68 %.

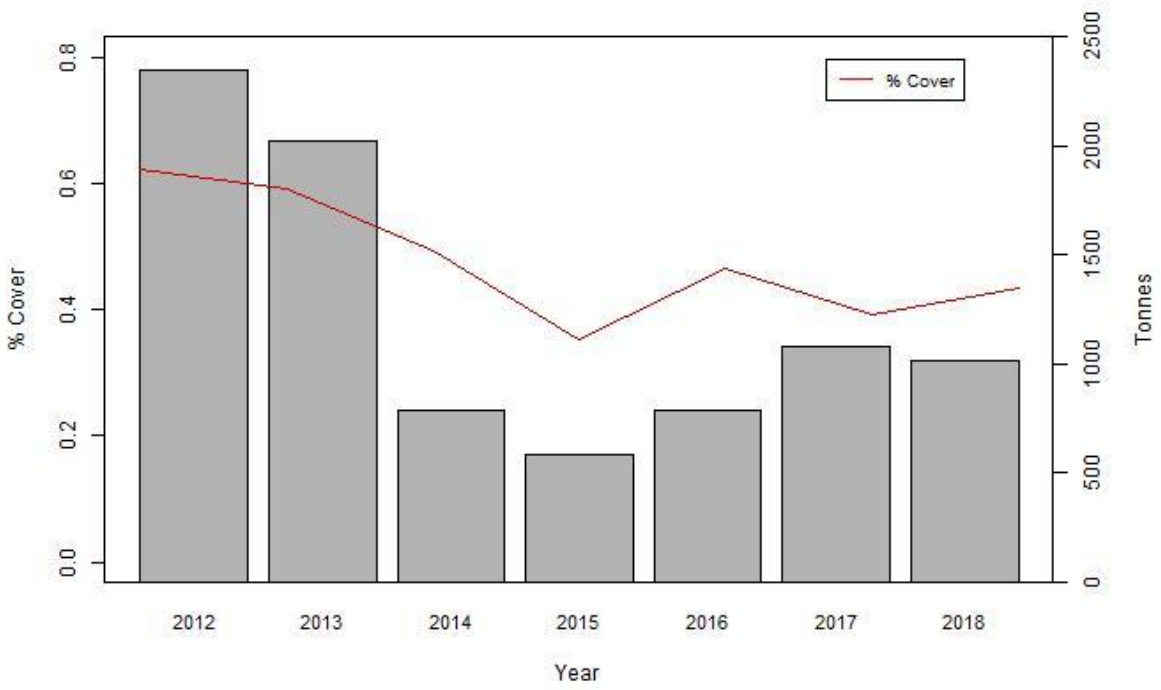

Figure 6 Mean percentage cover of live mussels plotted over tonnage of total stock within all survey areas 2012-2018.

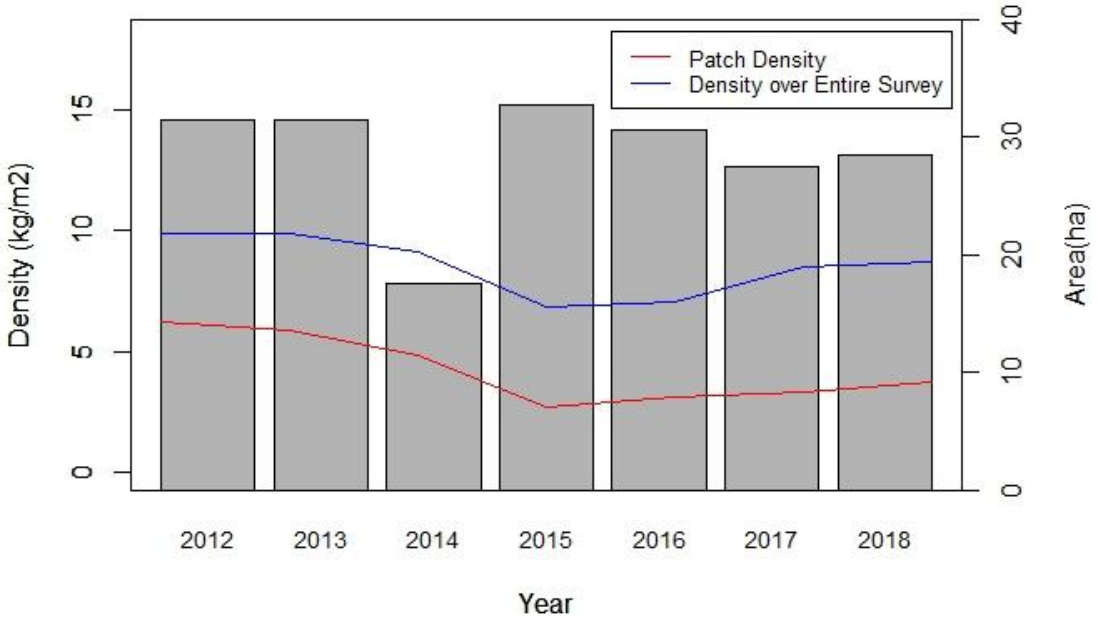

Figure 7 Mean mussel density data for patches and total area plotted over total area surveyed for all sites 2012-2018.

3.2 Coolstone

Coolstone was surveyed on 30th May 2018 with 30 samples collected from 16 transects. Since 2017 the tonnage of the total stock decreased by 0.6% and the survey area containing live mussel increased in spatial coverage by 41% (Figure 8, Figure 9). Total mussel density within the survey area decreased by 29% whilst patch density decreased by 2% (Figure 9). The stock of marketable sized mussels (>41mm) was estimated to be 131 tonnes out a total 166 tonnes on the bed, i.e. 79 % (

Figure 11). Data are averaged for 2012-14 when the Coolstone beds were separate prior to merging into one continuous bed in 2015.

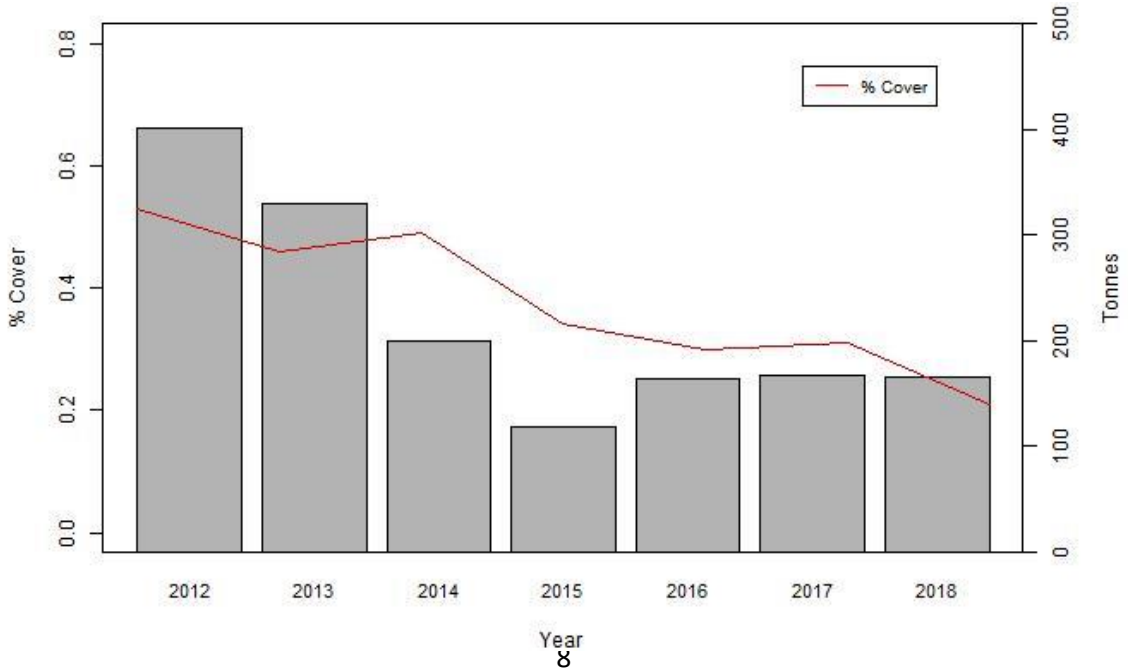

Figure 8 Percentage cover of live mussels plotted over total stock within the Coolstone survey area 2012-2018.

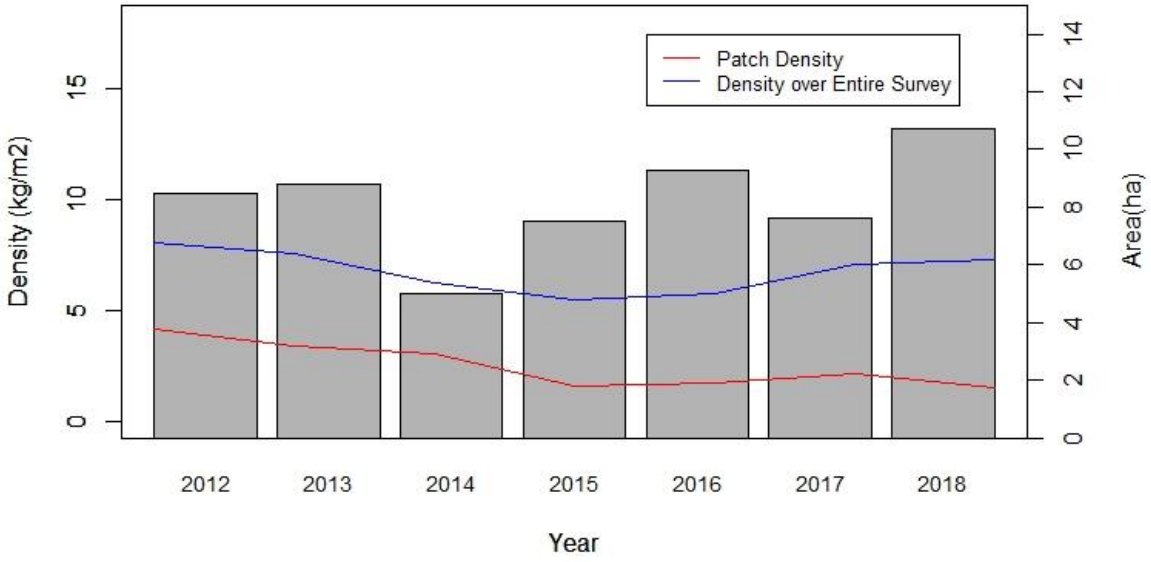

Figure 9 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Coolstone 2012-2018.

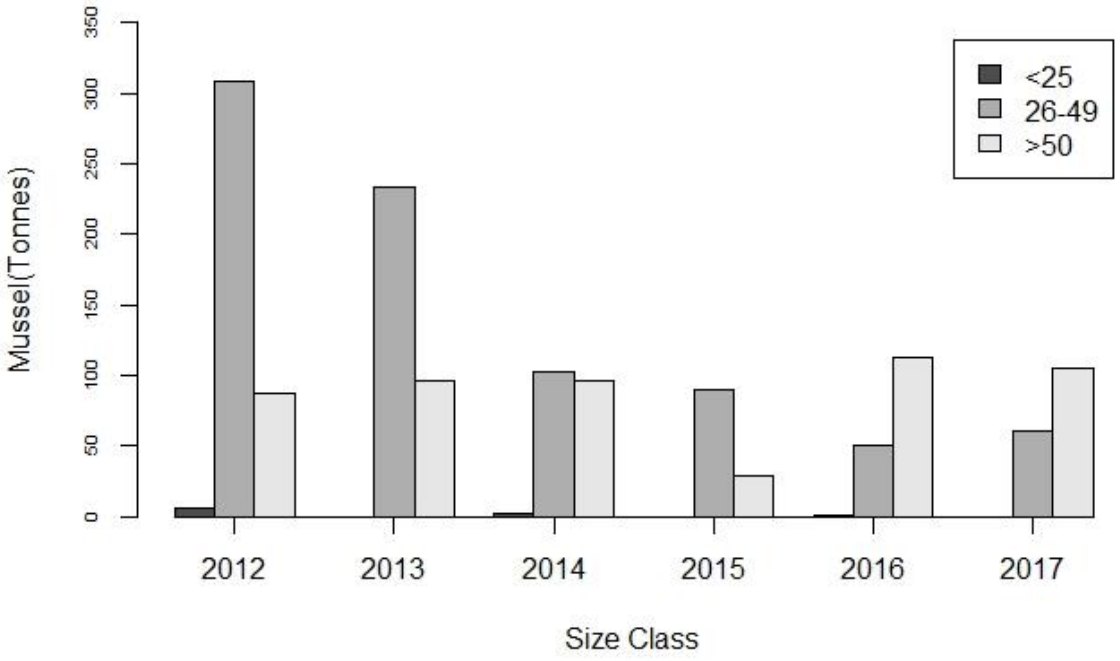

Figure 10 Coolstone stock size class comparison 2012-2017.

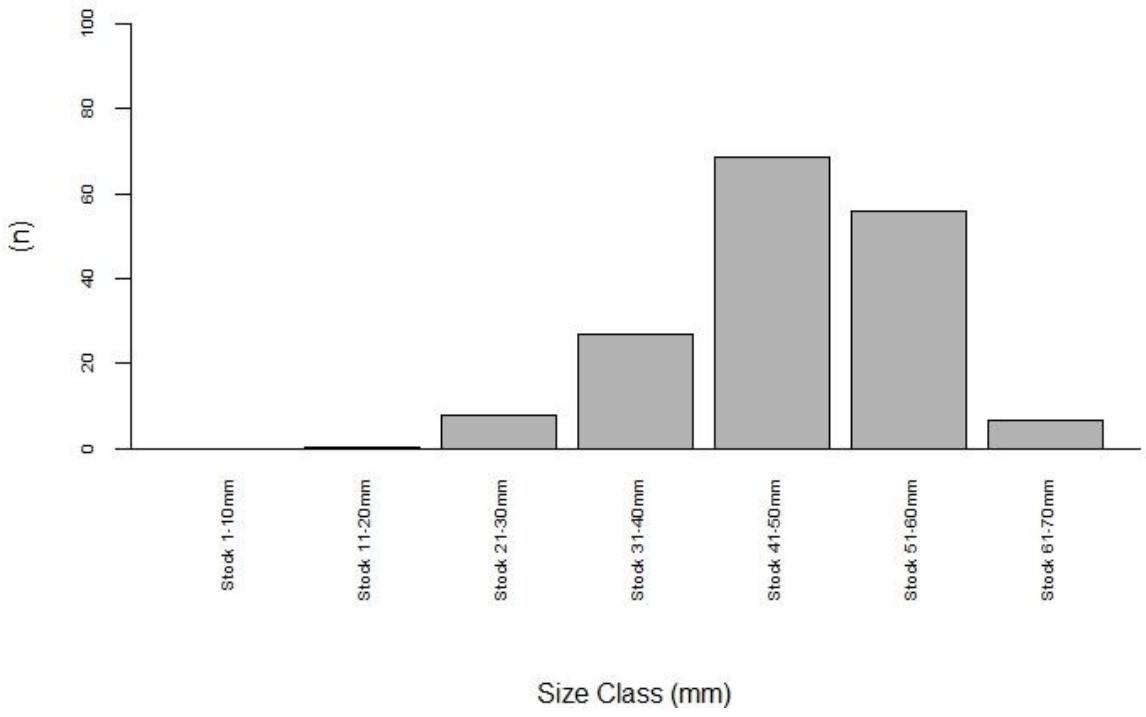

Figure 11 Coolstone 10mm size class for 2018 stock.

3.3 Lifeboat Slip

Lifeboat Slip was surveyed on 16th May 2018. Eight samples were collected from 18 transects. Since 2017 the tonnage total stock decreased by 16% and the survey area containing live mussels decreased in spatial coverage by 27% (Figure 12). Total density within the survey area rose by 17% whilst patch density decreased by 4% (Figure 14). The stock of marketable sized mussels (>41mm) was estimated to be 26 tonnes out a total 27 tonnes on the bed, i.e. 96 % (Figure 15).

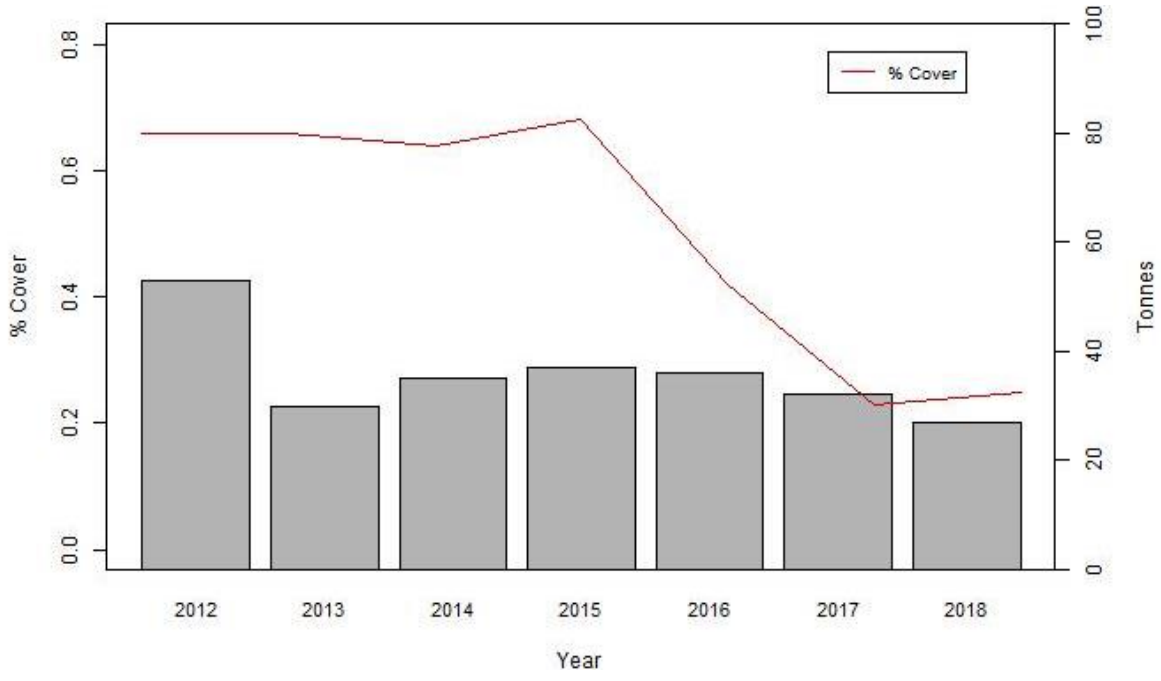

Figure 12 Percentage cover of live mussels plotted over total stock within the Lifeboat Slip survey area 2012-2018.

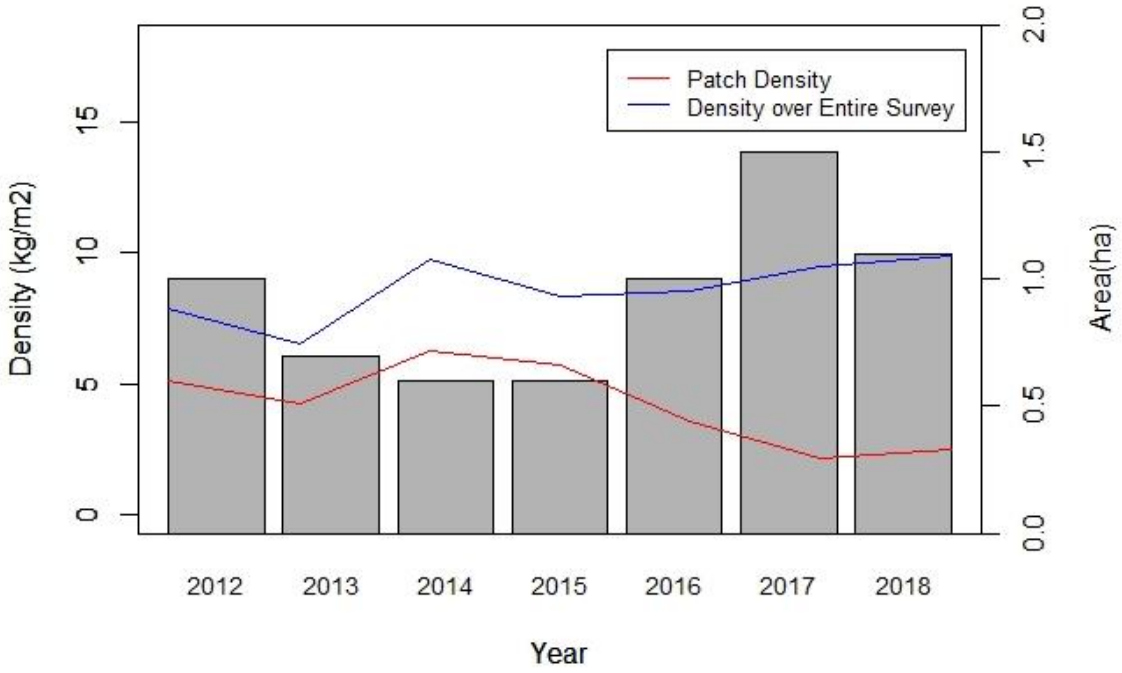

Figure 13 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Lifeboat Slip 2012-2018.

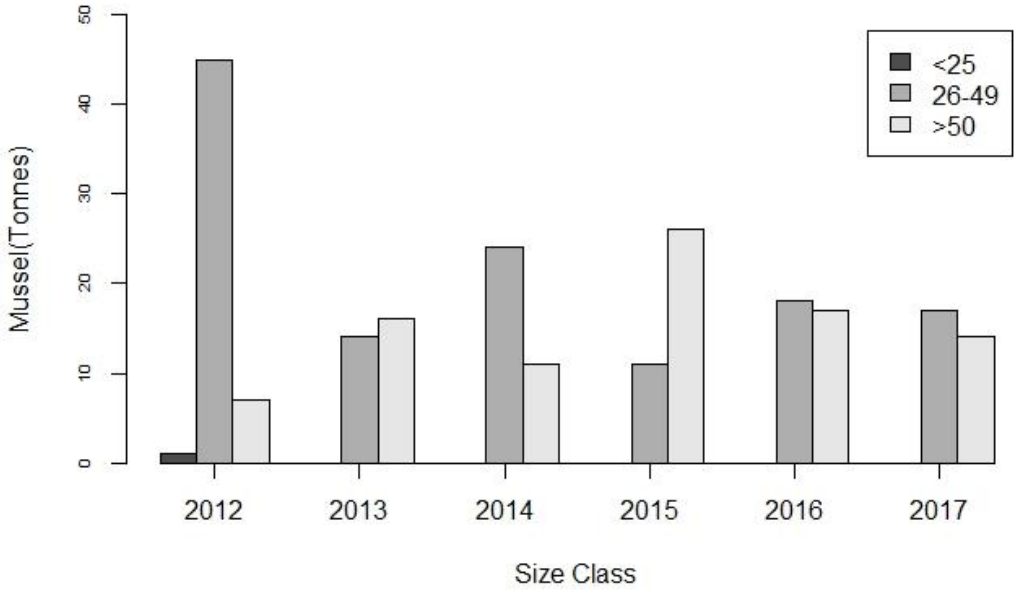

Figure 14 Lifeboat Slip size class comparison of stock 2012-2017.

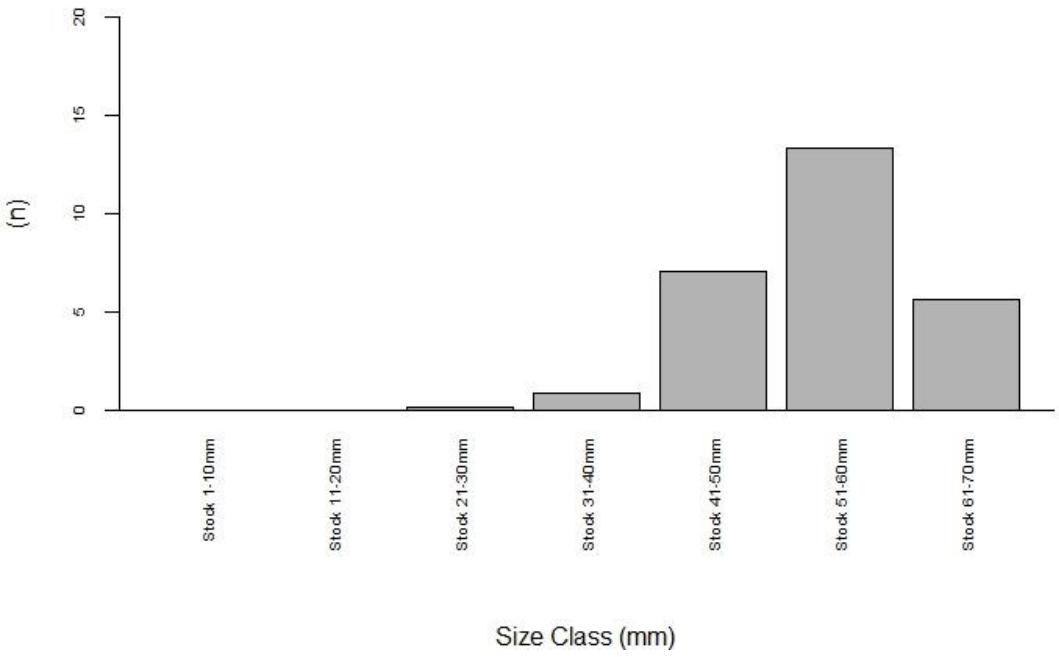

Figure 15 Lifeboat Slip 10mm size class for 2018 stock.

3.4 Sprat Ridge

Spat Ridge was surveyed on 16h May 2018. Fifty-four samples were collected from 21 transects. Since 2017 the tonnage of total stock increased by 33% and the survey area containing live mussels decreased in spatial coverage by 9% (Figure 16, Figure 17). Total density within the survey area rose by 47% whilst patch density increased by 7% (Figure 17). The stock of marketable sized mussels (>41mm) was estimated to be 264 tonnes out a total 366 tonnes on the bed, i.e. 72 % (Figure 20).

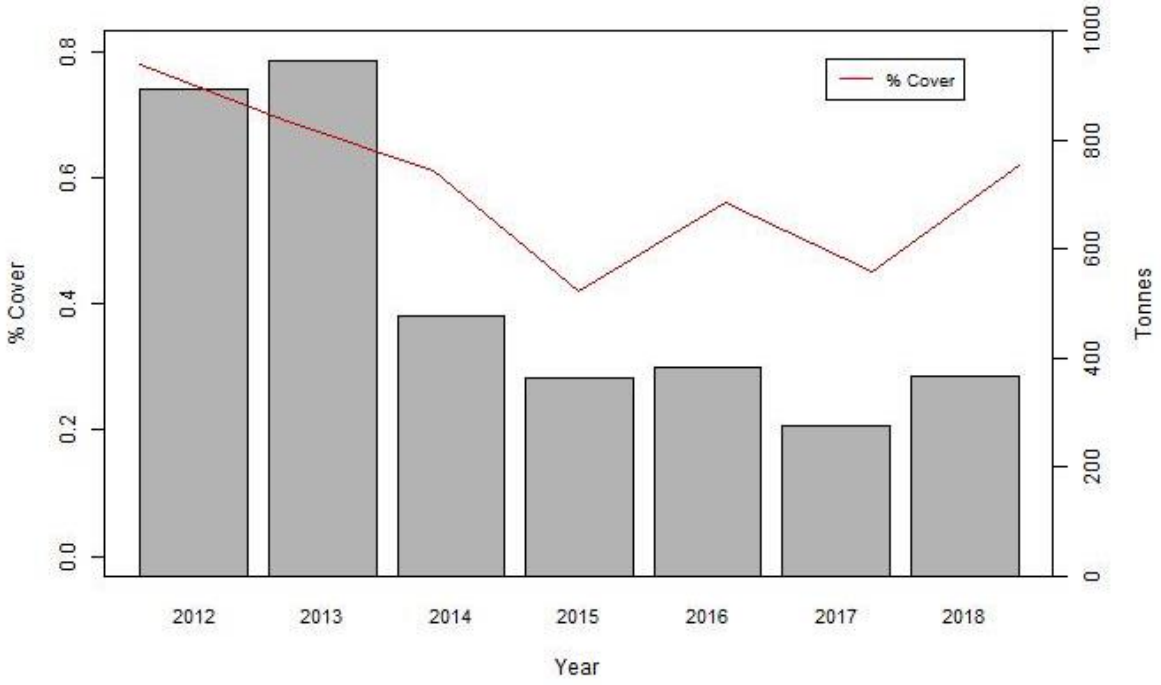

Figure 16 Percentage cover of live mussels plotted over total stock within the Sprat Ridge survey area 2012-2018.

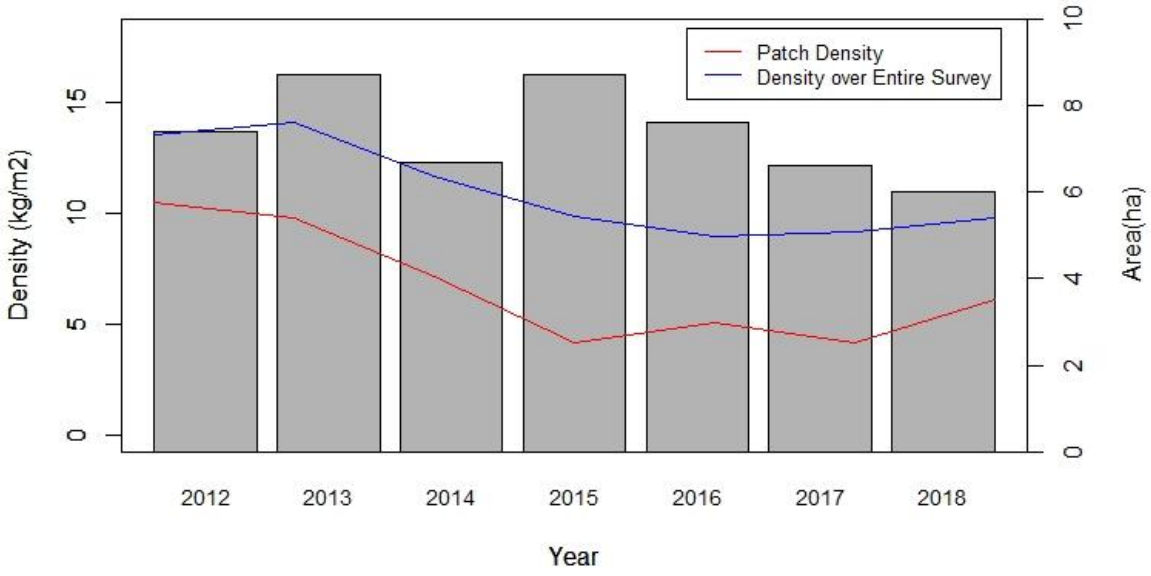

Figure 17 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Sprat Ridge 2012-2018.

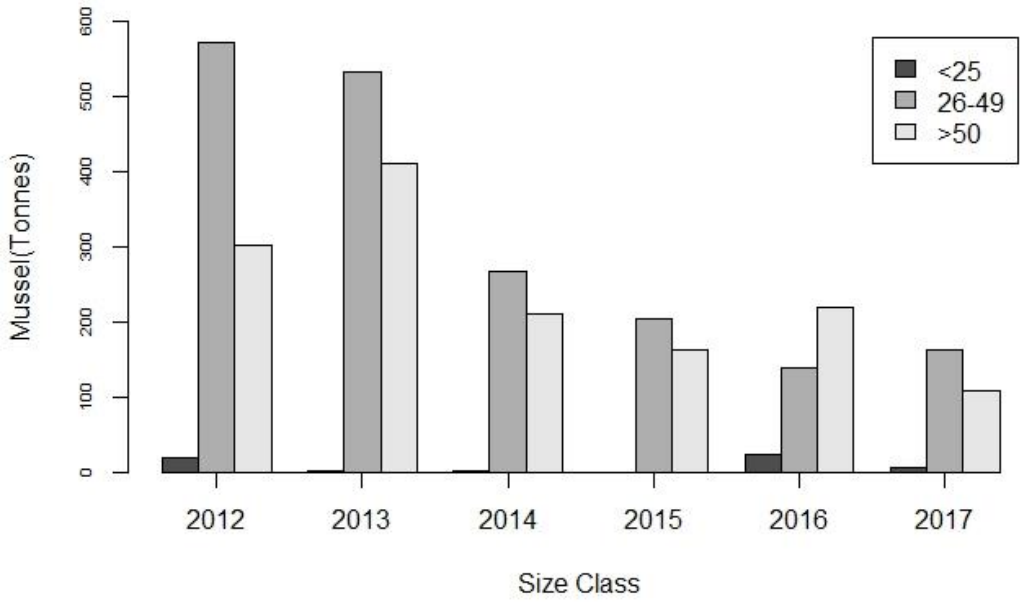

Figure 18 Sprat ridge size class comparison of stock 2012-2017.

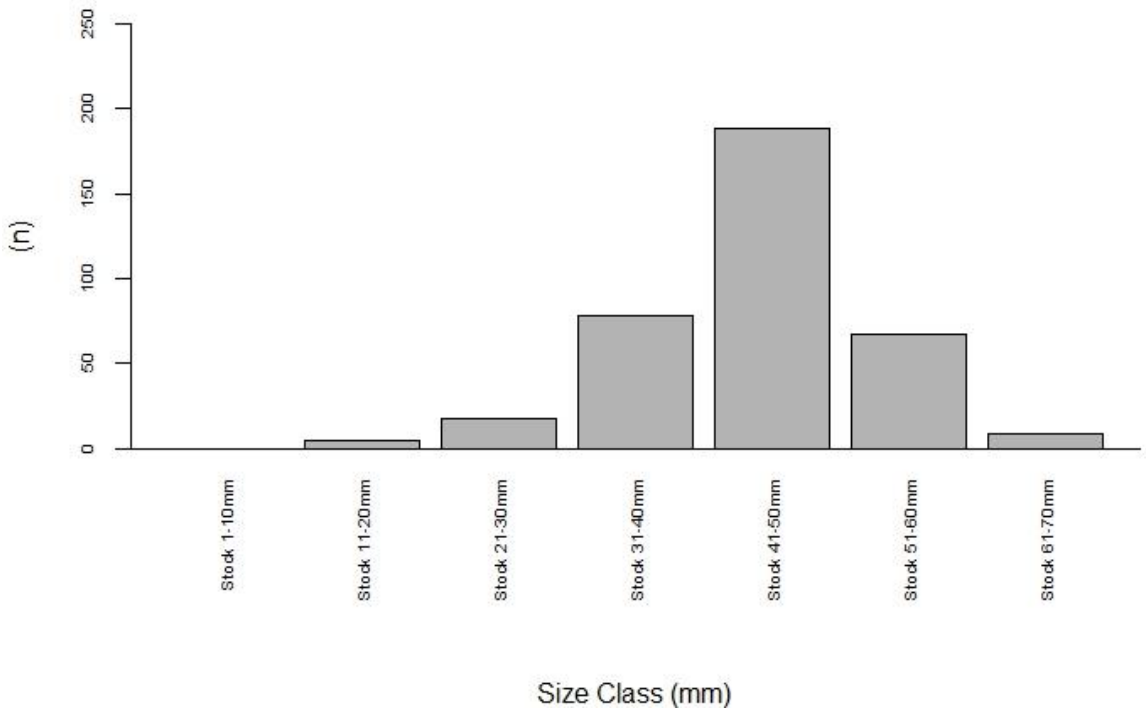

Figure 19 Sprat Ridge 10mm size class for 2018 stock.

3.5 Pulleys

Pulleys was surveyed on 17th May 2018. Sixty-nine samples were collected from 11 transects. Since 2017 the tonnage total stock decreased by 28% and the survey area containing live mussels decreased in spatial coverage by 8% (Figure 20, Figure 21). Total density within the survey area decreased by 22% whilst patch density decreased by 19% (Figure **21**). The stock of marketable sized mussels (>41mm) was estimated to be 239 tonnes out a total 420 tonnes on the bed, i.e. 57 % (Figure 23).

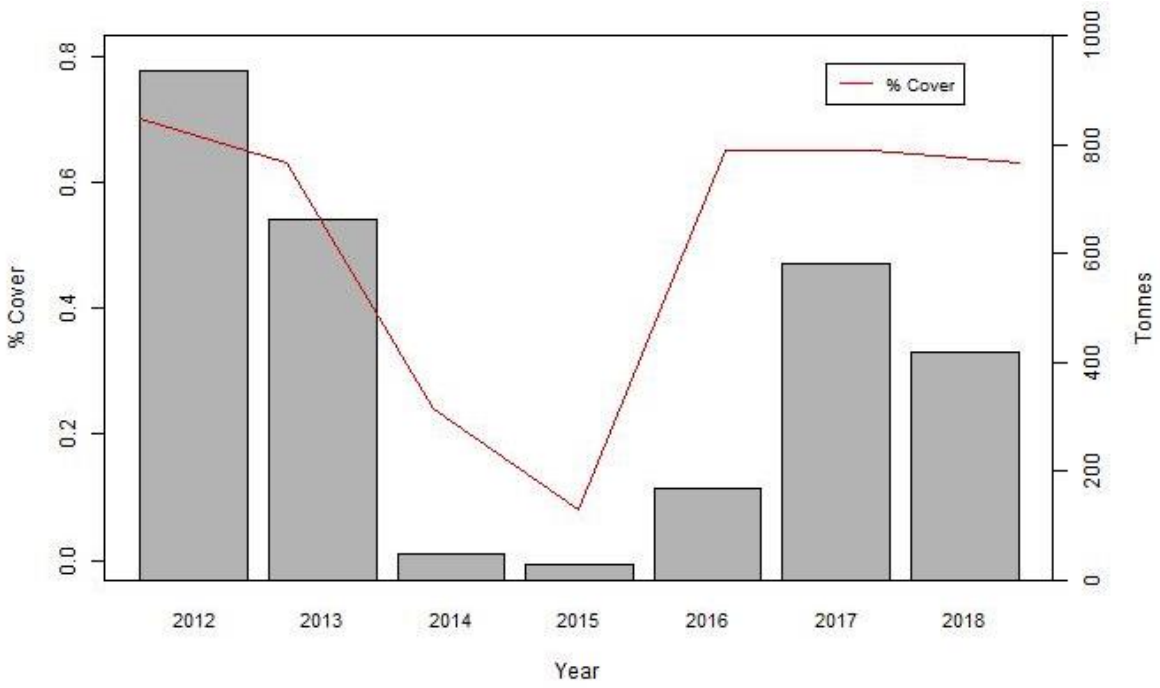

Figure 20 Percentage cover of live mussels plotted over total stock within the Pulleys survey area 2012-2018.

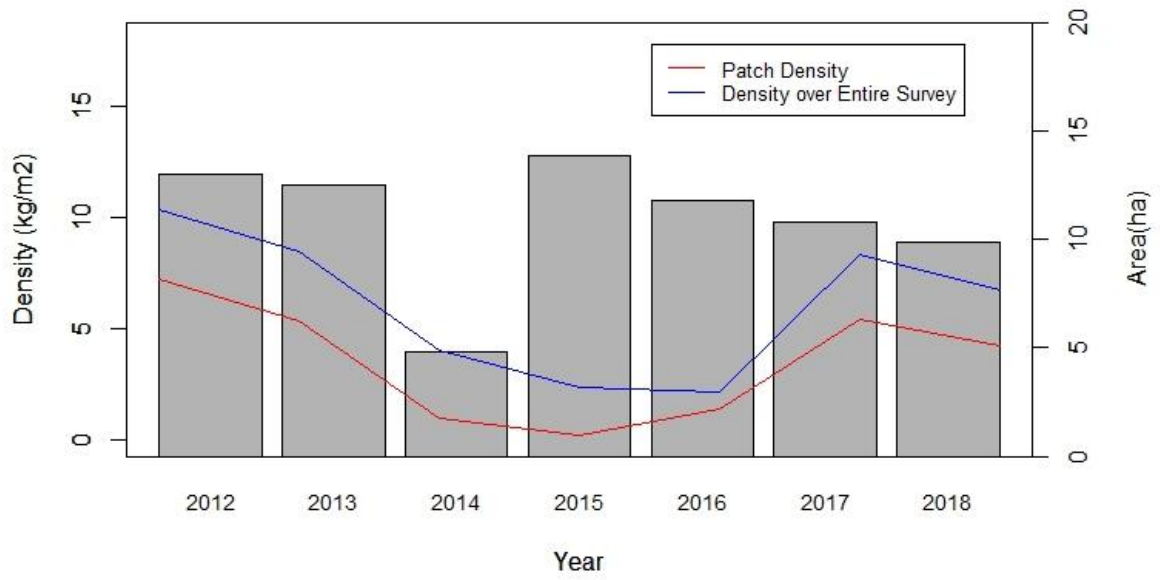

Figure 21 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Pulleys 2012-2018.

Figure 22 Pulleys size class comparison of stock 2012-2017.

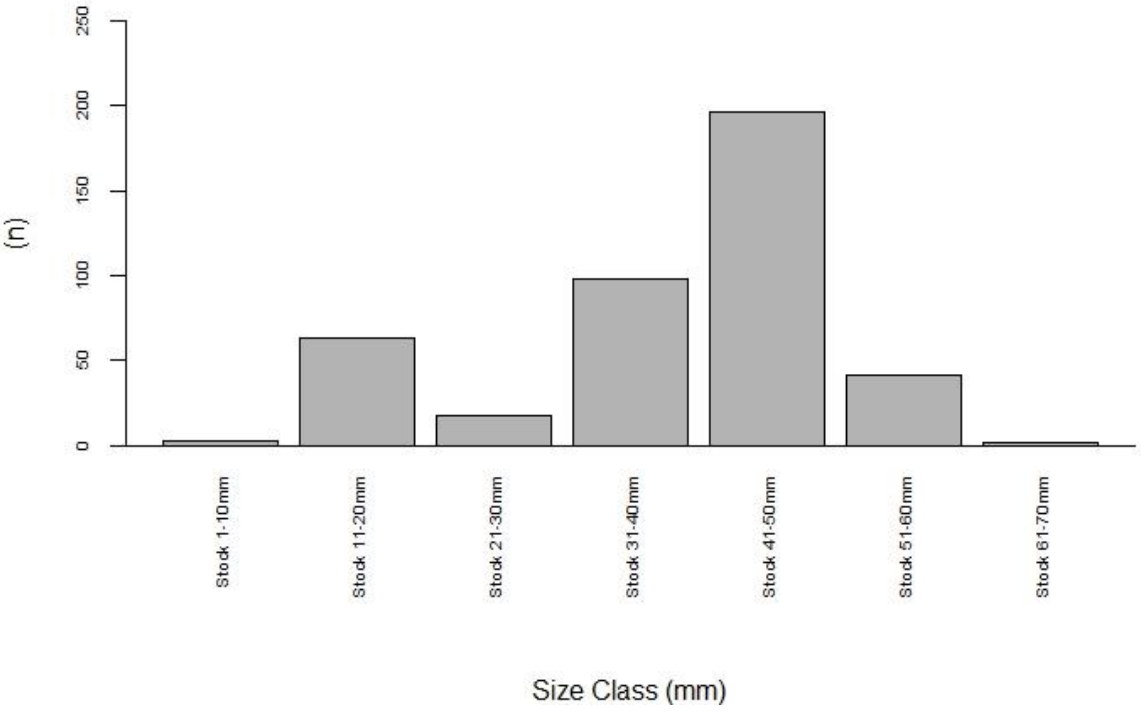

Figure 23 Pulleys 10mm size class for 2018 stock.

3.5 Yelland

Yelland was surveyed on 31st May 2018. Fourteen samples were collected from 12 transects. Since 2017 the tonnage total stock increased by 31% and the survey area containing live mussels decreased in spatial coverage by 41% (Figure 24, Figure 25). Total density within the survey area rose by 68% whilst patch density increased by 16% (Figure 25). The stock of marketable sized mussels (>41mm) was estimated to be 33 tonnes out a total 34 tonnes on the bed, i.e. 96 % (Figure 27).

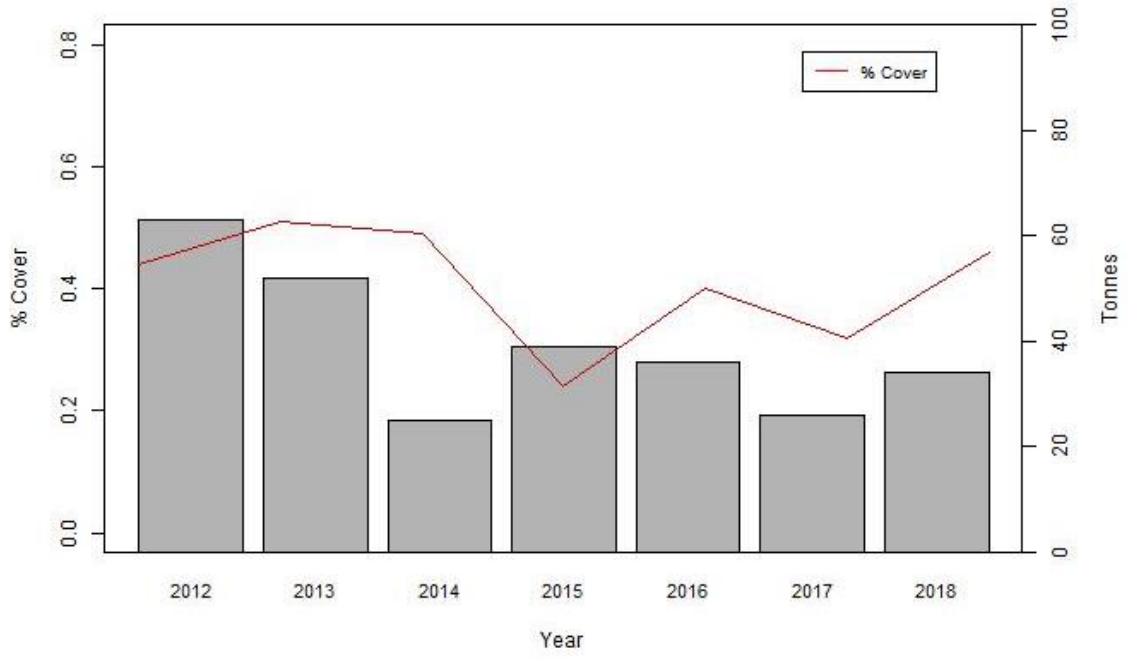

Figure 24 Percentage cover of live mussels plotted over total stock within the Yelland survey area 2012-2018

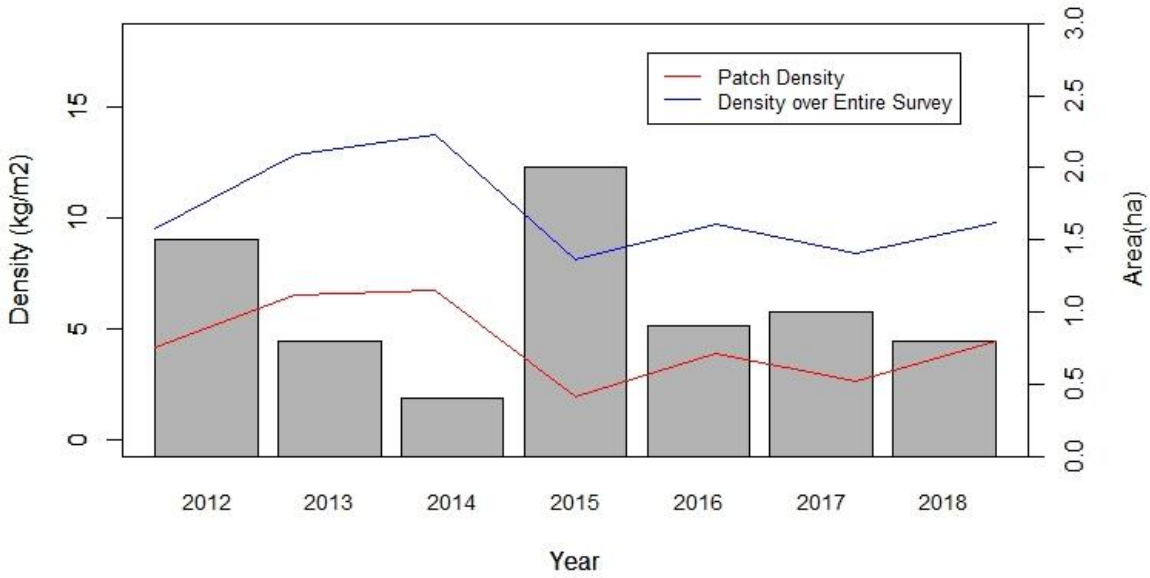

Figure 25 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Yelland 2012-2018.

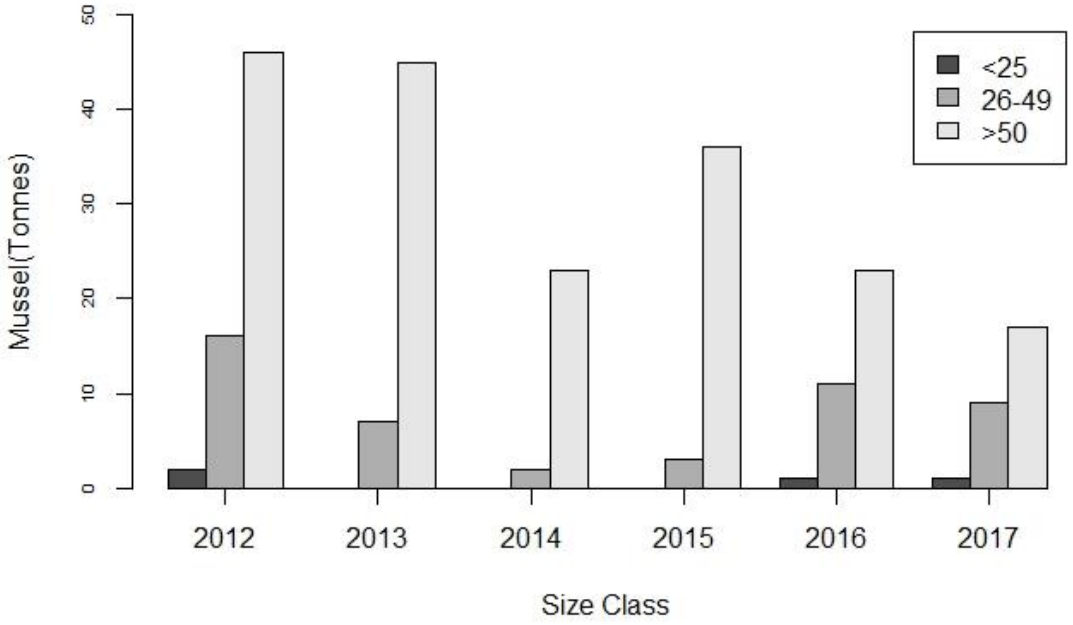

Figure 26 Yelland size class comparison of stock 2012-2017.

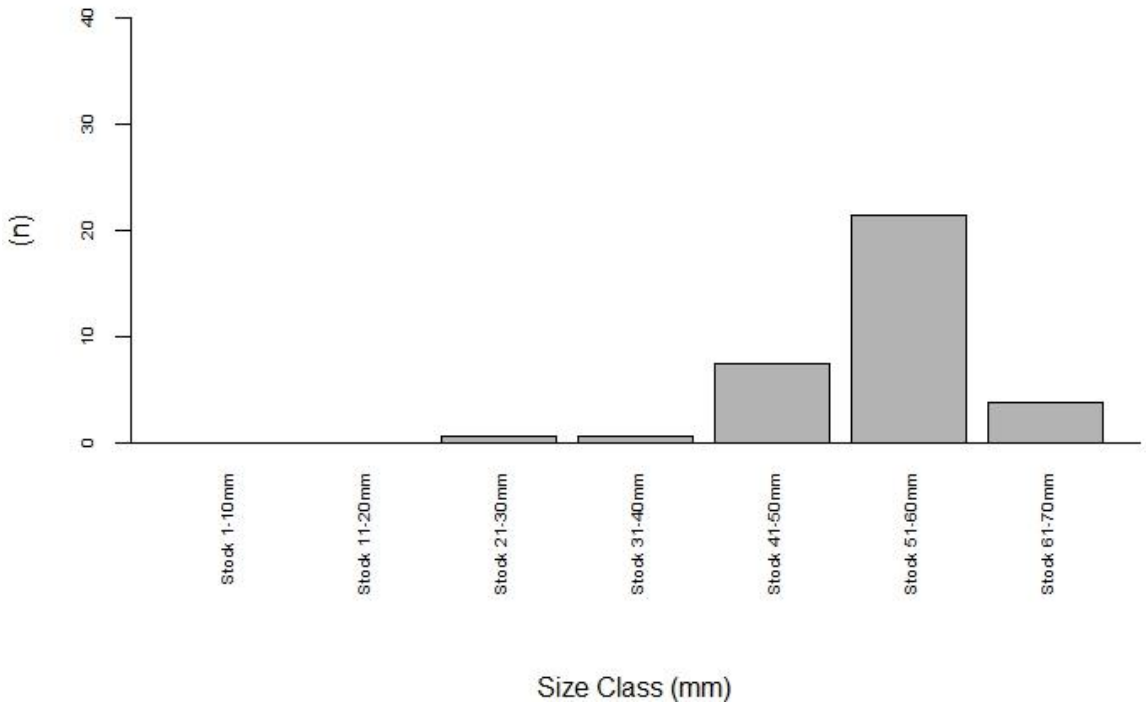

Figure 27 Yelland 10mm size class for 2018 stock.

4. Discussion

4.1 Combined analysis of all the survey beds.

Overall the total tonnage of mussel stock of the surveyed beds within the estuary has stayed broadly the same since 2017 (Figure 6). Whist this is certainly a positive outcome it is important to note that this is still half the weight of the stock in 2012-2013 prior to the 2013-2014 winter storms which scoured all the surveyed beds. Mean percentage cover of live mussels across the surveyed areas has increased marginally since 2015 but this is still ~20% less than 2012-13 levels. Both mean patch density and mean mussel density for the combined survey area is increasing marginally since 2015, including 2017 (Figure 7). This slow increase in density may be due to mussel growth of existing stock. Low spat settlement could however be limiting expansion of the beds and leading to loss of homogeneity in previously denser patches of mussels across the estuary. A fact more apparent when the total area surveyed estimated to contain live mussels has stayed approximately the same size since 2012-13 despite significant changes to the size and composition of all the surveyed mussel ‘beds’ within the estuary.

4.2 Analysis of individual beds 2017-18

<u>Coolstone</u>

The Coolstone beds have remained at a similar stock levels to previous years, however area coverage of live mussels has decreased as well as density of mussel over the survey area

(Figure 8,Figure 9). This could be due to increasing settlement of live mussels, however low abundances of mussel spat <31mm do not support this hypothesis (

Figure ***11***), most of the mussel was >31mm so increase in survey area might well be due to discrepancy's in annual survey methodology rather than fresh mussel spat settlement expanding the bed. Patch density remained relatively stable, increasing since 2016. This suggests that despite perceived decreases in coverage and density across the bed as a whole and a loss of homogeneity, the concentrated mussel patches are still relatively dense and productive and homogenous. The low recruitment of spat within these patches could however lead to decreased patch density in the forthcoming year.

Lifeboat

The tonnage of mussels within the survey area at lifeboat has decreased annually since 2015 with the 2018 levels are the lowest since 2012 (Figure 12). Percentage of live mussel cover is relatively low compared to 2015 where a percentage of live mussels within the survey area sharply decreased. 2018 sees an end to this decline and there is a low increase in percentage live mussel cover since 2017. Mean density similarly sees a positive increase, both in patches of mussels and across the entire survey area, suggesting a higher homogeneity of the mussel community found within the survey area (

Figure ***13***). This is likely attributed to mussel growth within existing patches and a decrease in survey area rather than recruitment as the presence of spat <31mm was negligible (Figure 15).

Pulleys

Unlike lifeboat and Coolstone, Pulleys has seen some spat recruitment in 2018 with >50 tonnes of mussels in the <31mm category (Figure 23). This could be due to its advantageous position towards the mouth of the estuary which would be subject to increased waterflow and therefore increasing the chance for juvenile settlement (Figure 4). High mortality of the older cohort could therefore be displaced over the next year as the new spat begins to develop. Pulleys unlike some of the patchier areas of mussel surveyed could be considered as a true mussel 'bed', The percentage cover of live mussels is nearly 70% of the whole bed and both the patch density and density across the survey area are relatively high (in comparison to the other survey areas) (Figure 20,

Figure **21**). This matches with the ground truthing at the site in which the whole area containing mussels was easy to discern due to its high homogeneity. If the density continues to increase coupled with similarly increased levels of spat recruitment pulleys could, according to the literature (Bayne & Worrall 1980, Seed & Suchanek, 1992), see recovery to pre-2013 levels within a few years.

Sprat Ridge

Similarly to Pulleys Sprat ridge also saw increased recruitment of the <31mm mussels (Figure 19). The amount was a substantially lower amount than pulleys but still a significantly higher amount than the other sites. This recruitment is likely due to the beneficial effects of the local hydrology, with the bed positioned in a central part of the estuary allowing for

increased waterflow and therefore increased chances for successful spat settlement. Actual tonnage of mussels on the bed has remained moderately stable since 2015, and there have been positive increases since 2017 (Figure 16). Percentage cover of live mussels remains high, and the mussels within the survey area could be considered a 'true' bed due to the high density's and homogeneity of mussel cover. The rapid increase of mussel growth from 2016-17 seen by an increase in both patch and overall density of the bed saw a slight reduction on the previous year (Figure 17). This is likely due to the mortality of the older mussel cohort within the bed (Figure 18). Increased sprat recruitment could increase the density over time should the environmental conditions remain stable.

Yelland

Yelland's stock has remained relatively stable since 2014 with total tonnage of mussels ranging within 10 tons over a 5 year period (Figure 24). Percentage cover since 2014 has also began to recover and both patch and overall density have seen slow but positive increases (Figure 25). the survey area containing live mussels remains relatively small, but if these positive increases continue then the bed could be expected to increase in homogeneity and density over time to the point where it can again be considered as a true bed. However of note the bed has seen markedly low levels of spat recruitment since 2016 (Figure 26, Figure 27). This could be the only factor that limits continued recovery of the bed to 2012 levels, if this is of course now possible as the storm events of 2014 may well have affected and changed the local hydrology to a point where the bed simply cannot reach recover to this level.

4.3 Conclusions and Recommendations

Following the loss of mussels between 2013 and 2014 Natural England, as the regulatory body for SSSIs, 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 Devon & Severn 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 mussels removed (including location) are submitted to Natural England and the IFCA within 14 days of harvesting.

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 and development of a possible Hand Working Byelaw, as well as allowing Natural England to ensure the mussel harvesting limit remains suitable to provide enough bird food availability.

References

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