Taw-Torridge
Mussel Stock Assessment 2019

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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).

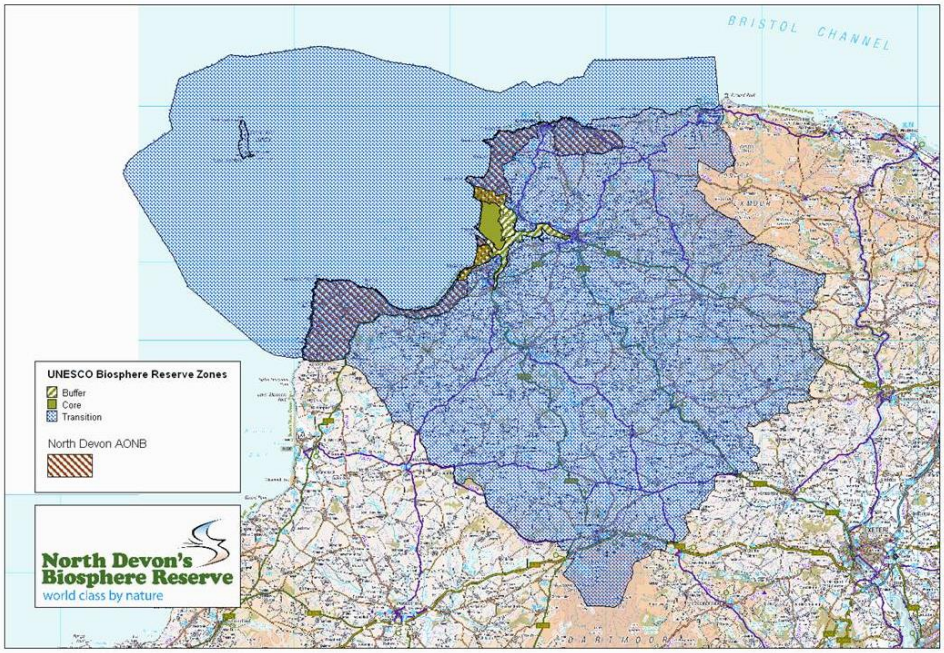


Figure 1 The location of the Taw Torridge Estuary (shown in yellow) within the North Devon Biosphere Reserve and the North Devon Coast AONB. (Taw Torridge Estuary Management Plan, 2010)

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.

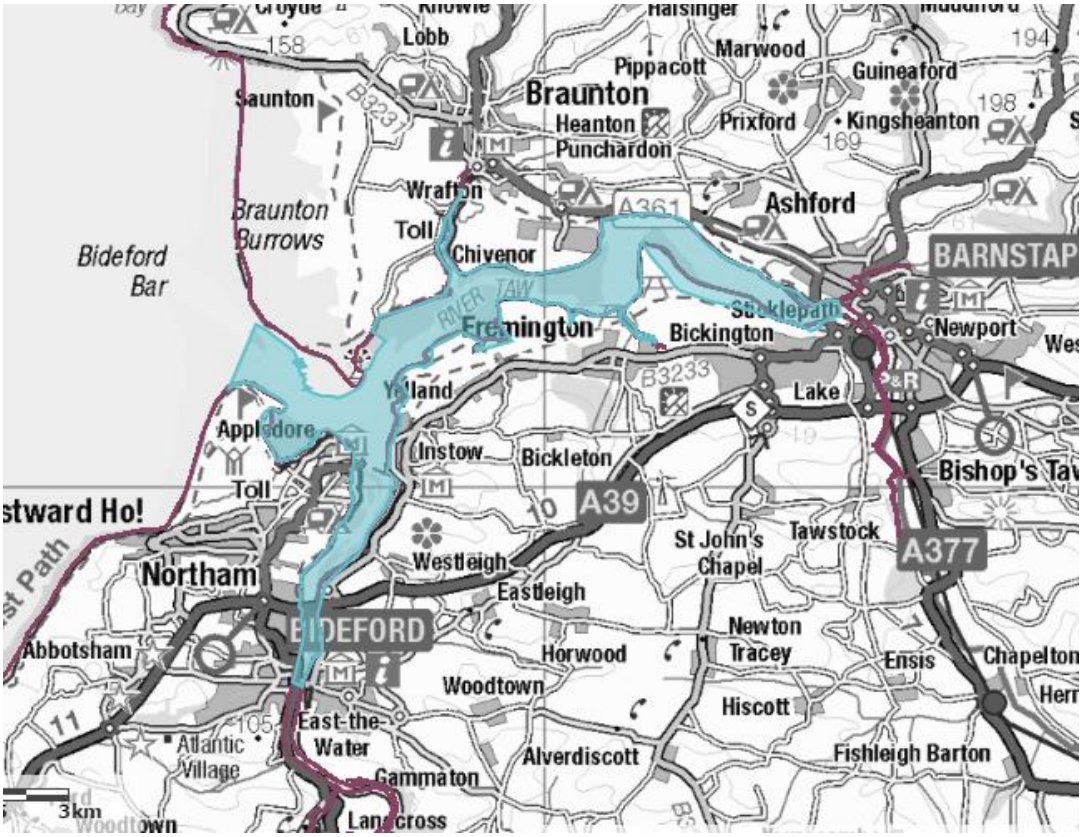


Figure 2 Taw-Torridge Estuary SSSI, shown in blue (Defra, 2016)

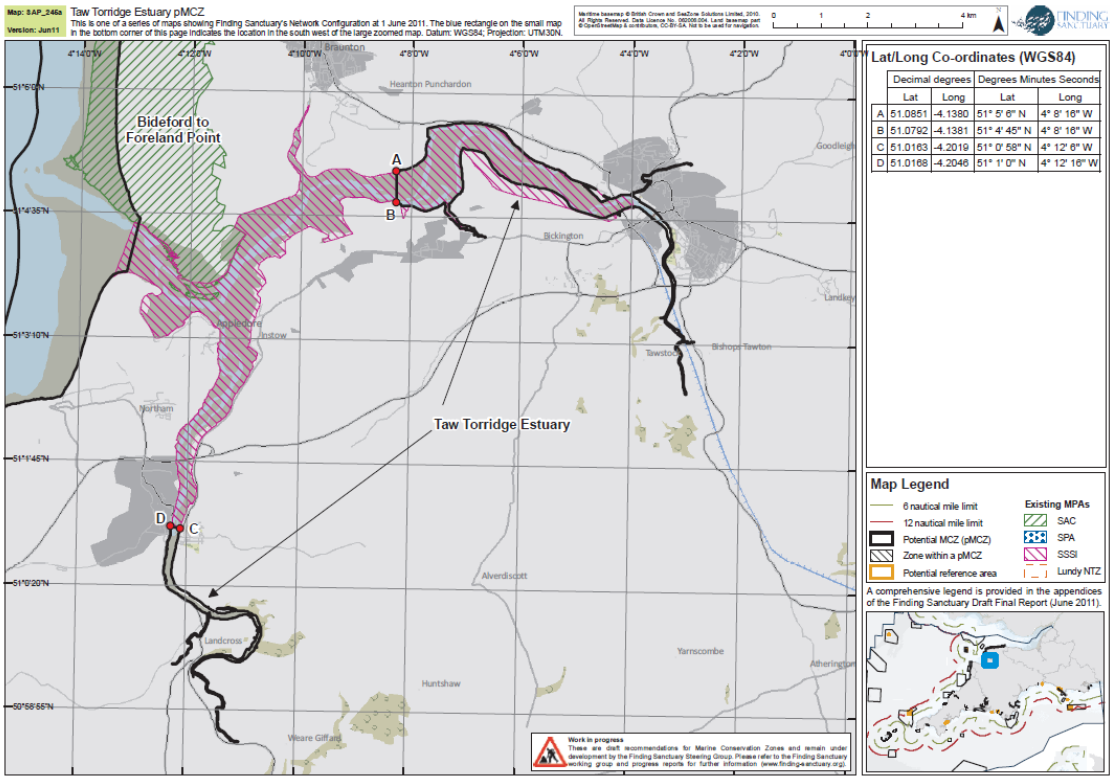


Figure 3 Area of rMCZ, outlined in black. Area of SSSI shown in red hatching, and area of SAC shown by green hatching. (Finding Sanctuary, 2011)

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 role in the healthy functioning of marine ecosystems; having a role in coastal sediment dynamics, acting as a food source to wading birds, and providing an enhanced area of biodiversity in an otherwise sediment-dominated environment (Maddock, 2008). Mussel beds support their own diverse communities as the mussel matrix, composed of interconnected mussels and accumulated sediments and debris, provides numerous microhabitats and an organically enriched environment (Andrews et al., 2011, Seed & Suchanek, 1992). Blue mussels are filter feeders, feeding primarily on micro-algae, suspended debris and zooplankton, and play a vital role in estuaries by removing bacteria and toxins.

The reproductive strategy of *M. edulis* is to deploy a large number of gametes, 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, 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, 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 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 pattern across the survey area, right up to the perimeter, providing optimum coverage across the transect. The start and end coordinates of each transect were recorded using a handheld GPS (Figure 4). 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 along each transect the cane was flicked out to one side and it was recorded whether it was a "hit" if the ring contains live mussels, or a "miss" if the ring did not contain live mussels. 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.

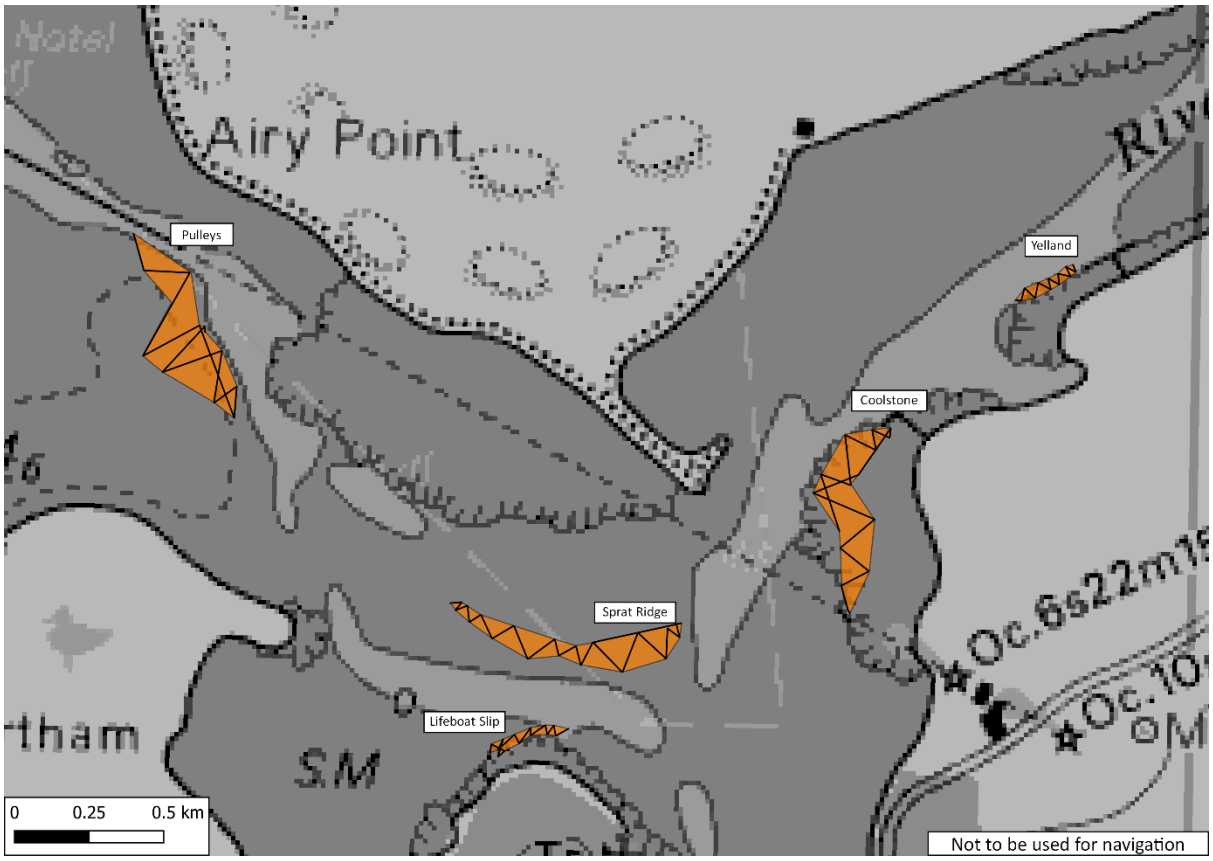


Figure 4 Transects walked (black) and area of each mussel bed (orange).

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 data is once

pooled, was to calculate the percentage cover of live mussels over the survey area. The hit data was 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 All sites within the estuary were sampled between the 17th[th] of May and the 4[th] of June 2019 with a compiled 152 samples collected from a total of 70 transects. Since 2018 the tonnage of mussel total stock across the estuary increased by 3.8% (

Figure **6**). The combined survey area containing live mussels increased in spatial coverage by 13%. Total mean mussel density within the surveyed sites increased 28.8% whilst mean patch density increased by 9.3% (Figure 7). The stock of marketable sized mussels (>41mm) was estimated to be 551 tonnes out a total 1110.5 tonnes for all sites, i.e. 50%.

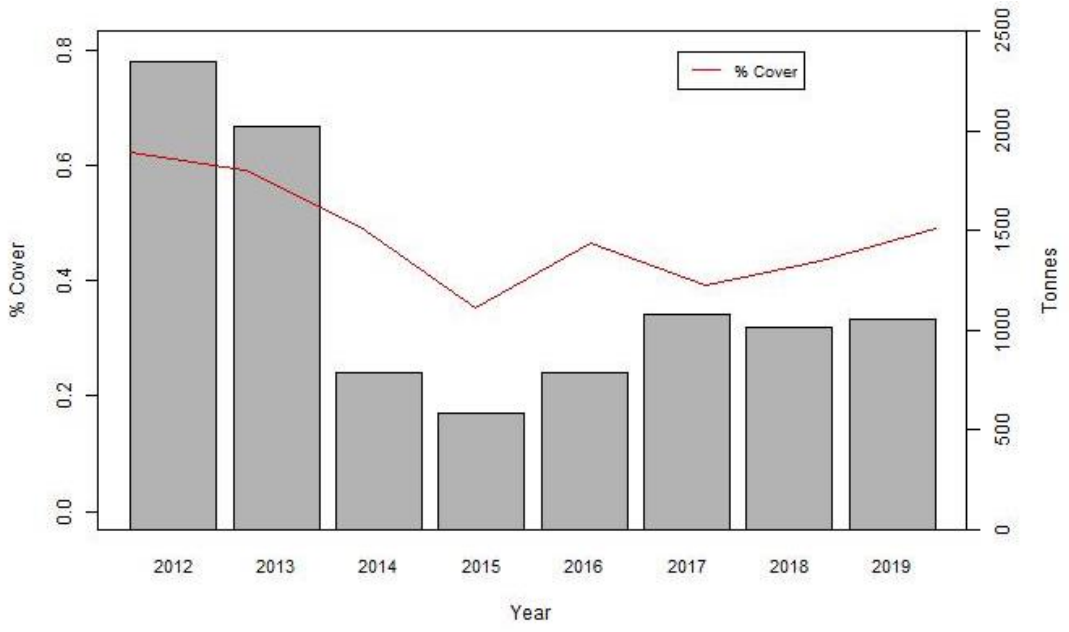


Figure 6 Mean percentage cover of live mussels plotted over tonnage of total stock within all survey areas 2012-2019.

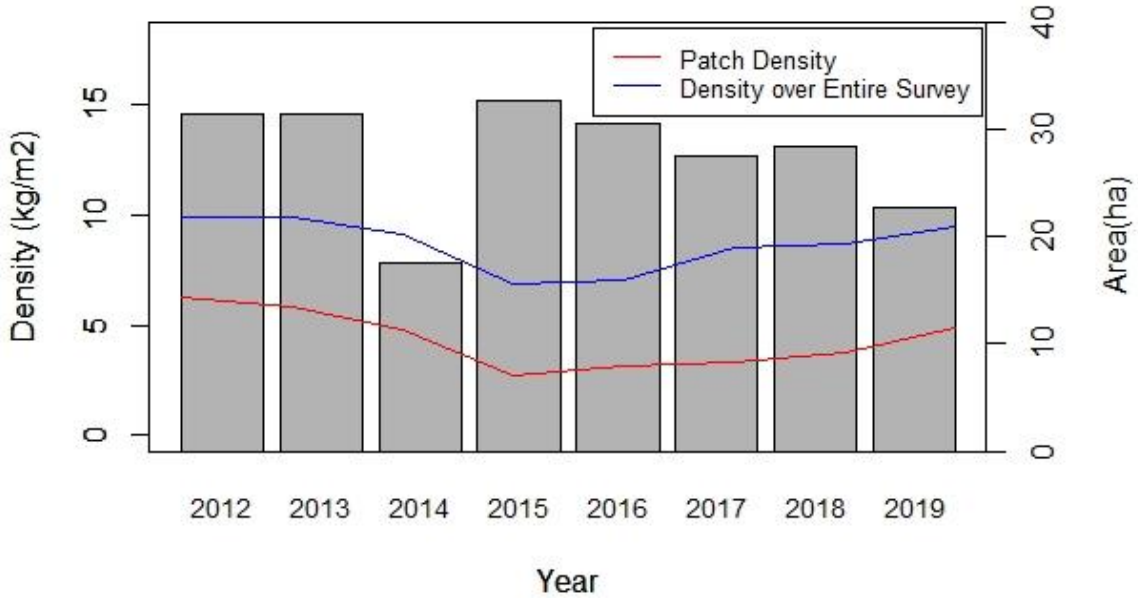


Figure 7 Mean mussel density data for patches and total area plotted over total area surveyed for all sites 2012-2019.

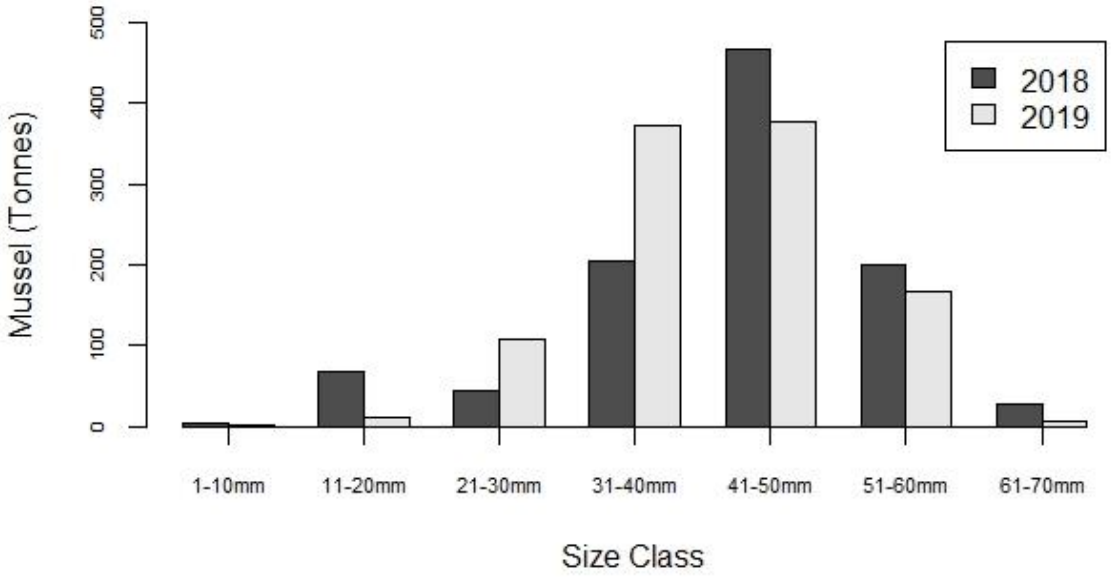


Figure 8 Total Combined 10mm size class for 2018-2019 stock.

3.2 Coolstone

Coolstone was surveyed on 20th May 2019 with 26 samples collected from 14 transects. Since 2018 the tonnage total stock decreased by 23% and the survey area containing live mussels increased in spatial coverage by 43% (Figure 9, Figure 10). Total mussel density within the survey area increased by 22.9% whilst patch density decreased by 11.3% (Figure 10). The stock of marketable sized mussels (>41mm) was estimated to be 90 tonnes out a total 128 tonnes on the bed, i.e. 70 % (Figure 11). Data are averaged for 2012-14 when the Coolstone beds were separate prior to merging into one continuous bed in 2015.

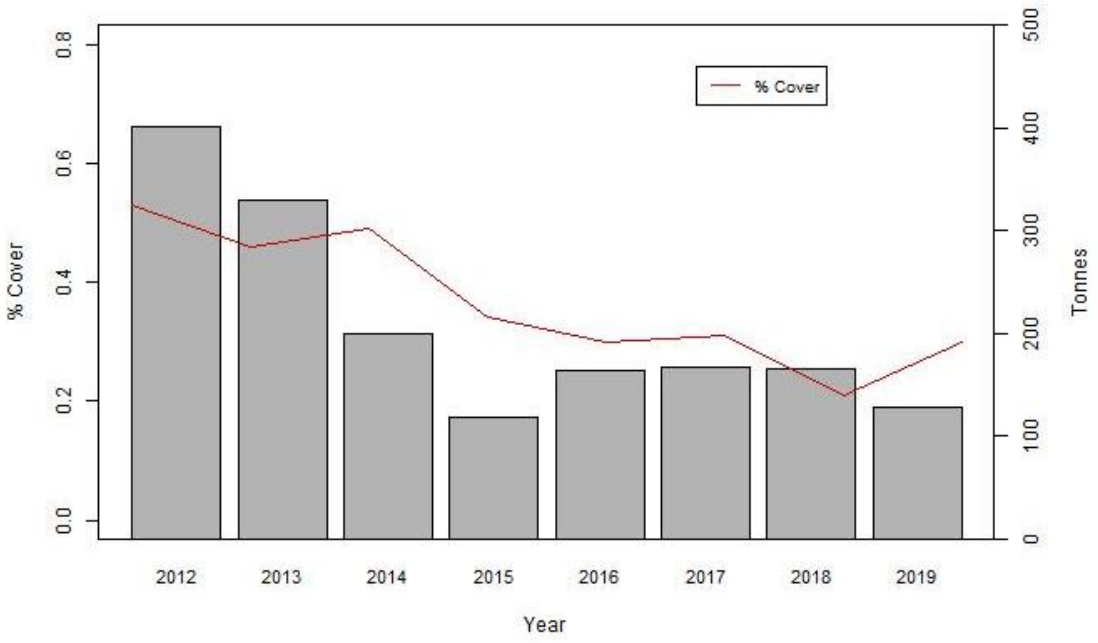


Figure 9 Percentage cover of live mussels plotted over total stock within the Coolstone survey area 2012-2019.

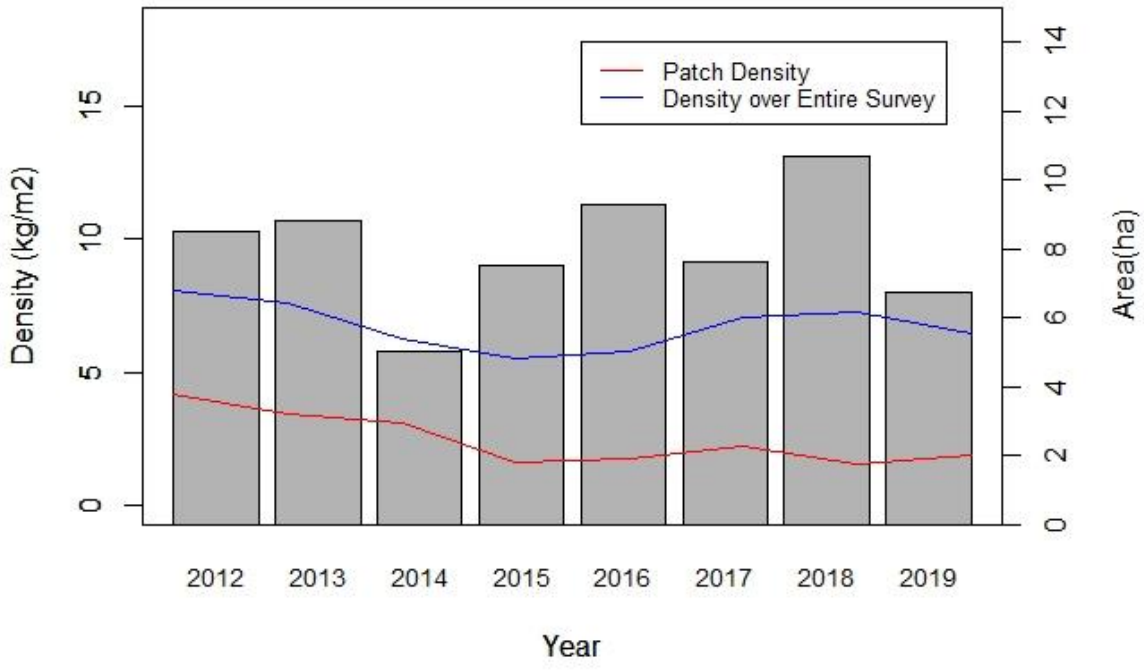


Figure 10 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Coolstone 2012-2019.

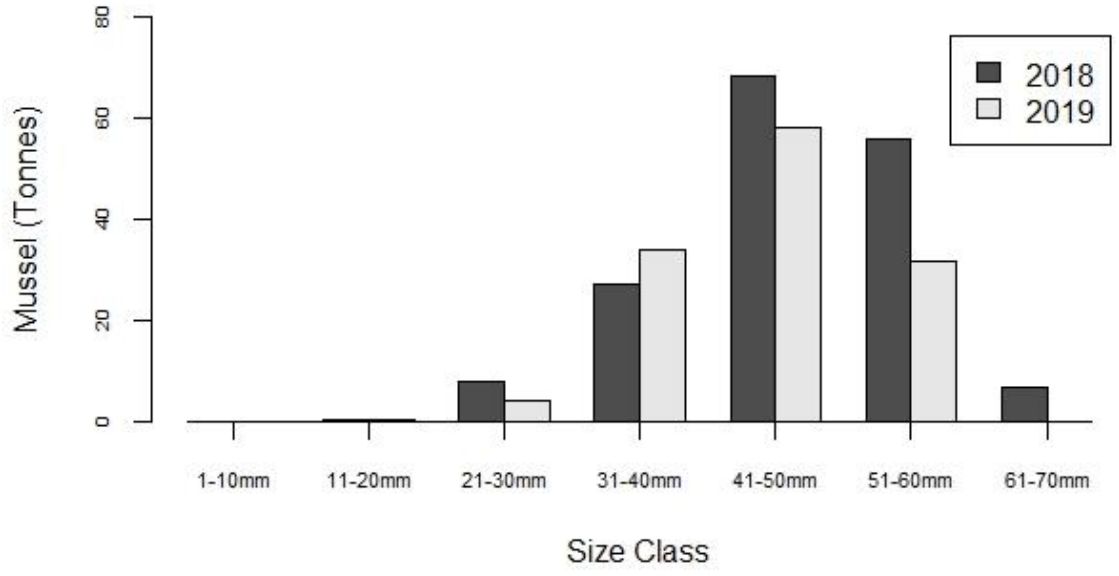
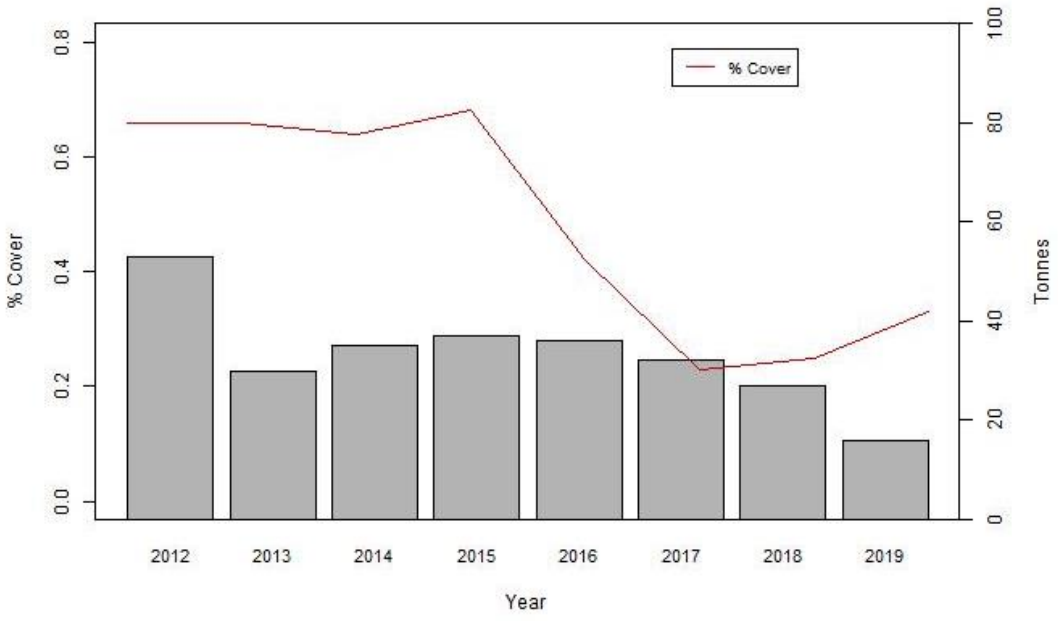


Figure 11 Coolstone 10mm size class for 2018-2019 stock.

3.3 Lifeboat Slip

Lifeboat Slip was surveyed on 21st[th] May 2019. Eight samples were collected from 14 transects. Since 2018 the tonnage total stock decreased by 41% and the survey area containing live mussels increased in spatial coverage by 32% (

Figure **12**). Total density within the survey area fell by 21% whilst patch density also decreased by 41% (Figure 13). The stock of marketable sized mussels (>41mm) was



estimated to be 10 tonnes out a total 16 tonnes on the bed, i.e. 60 % (Figure 14).

Figure 12 Percentage cover of live mussels plotted over total stock within the Lifeboat Slip survey area 2012-2019.

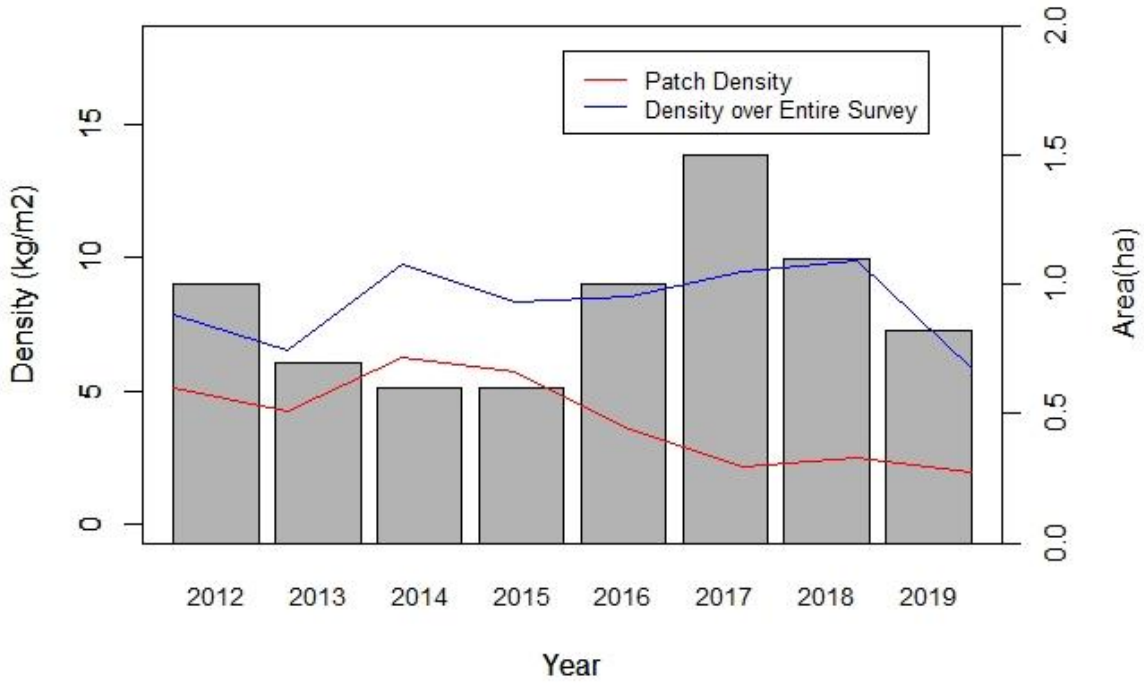


Figure 13 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Lifeboat Slip 2012-2019.

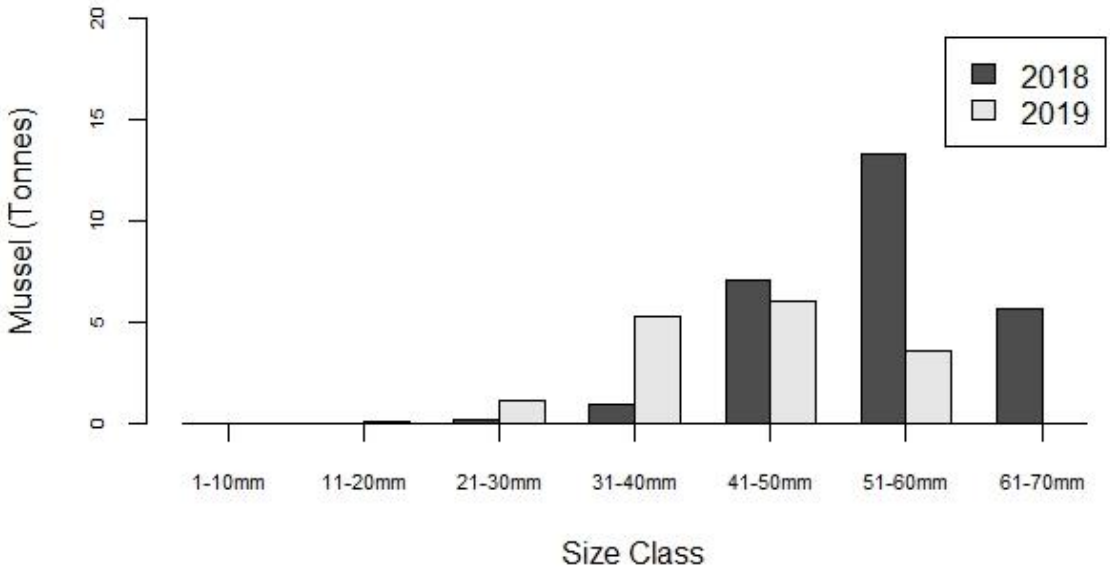


Figure 14 Lifeboat Slip 10mm size class for 2018-2019 stock.

3.4 Sprat Ridge

Spat Ridge was surveyed on 4th May 2018. Forty-nine samples were collected from 20 transects. Since 2018 the tonnage of total stock increased by 37% and the survey area containing live mussels decreased in spatial coverage by 3.2% (Figure 15, Figure 16). Total density within the survey area rose by 35% whilst patch density increased by 40% (Figure 16).

The stock of marketable sized mussels (>41mm) was estimated to be 384 tonnes out a total 503 tonnes on the bed, i.e. 76 % (Figure 18).

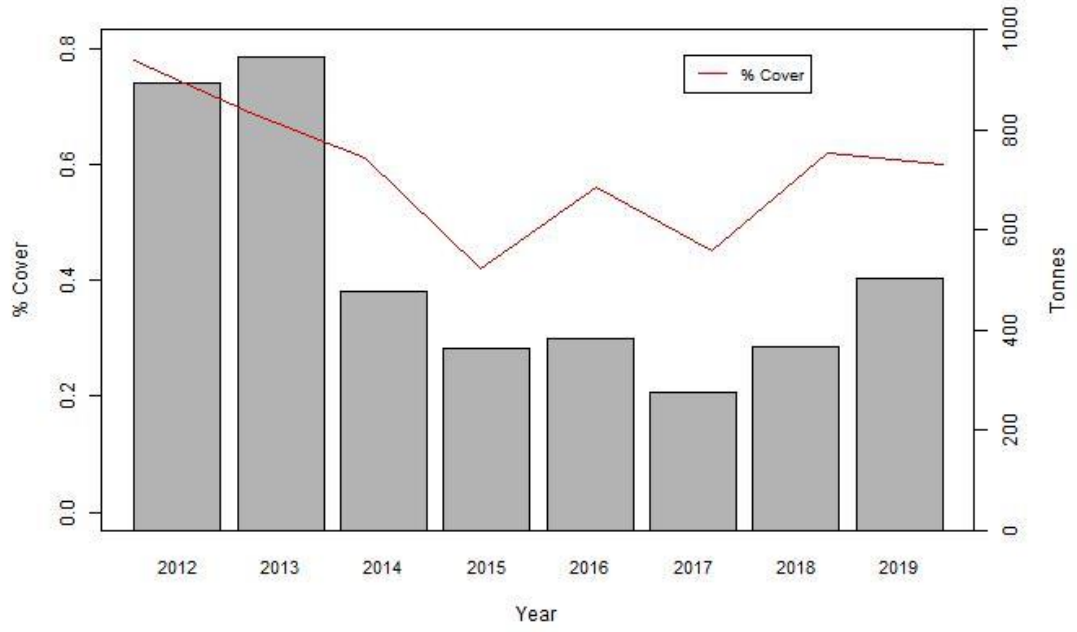


Figure 15 Percentage cover of live mussels plotted over total stock within the Sprat Ridge survey area 2012-2019.

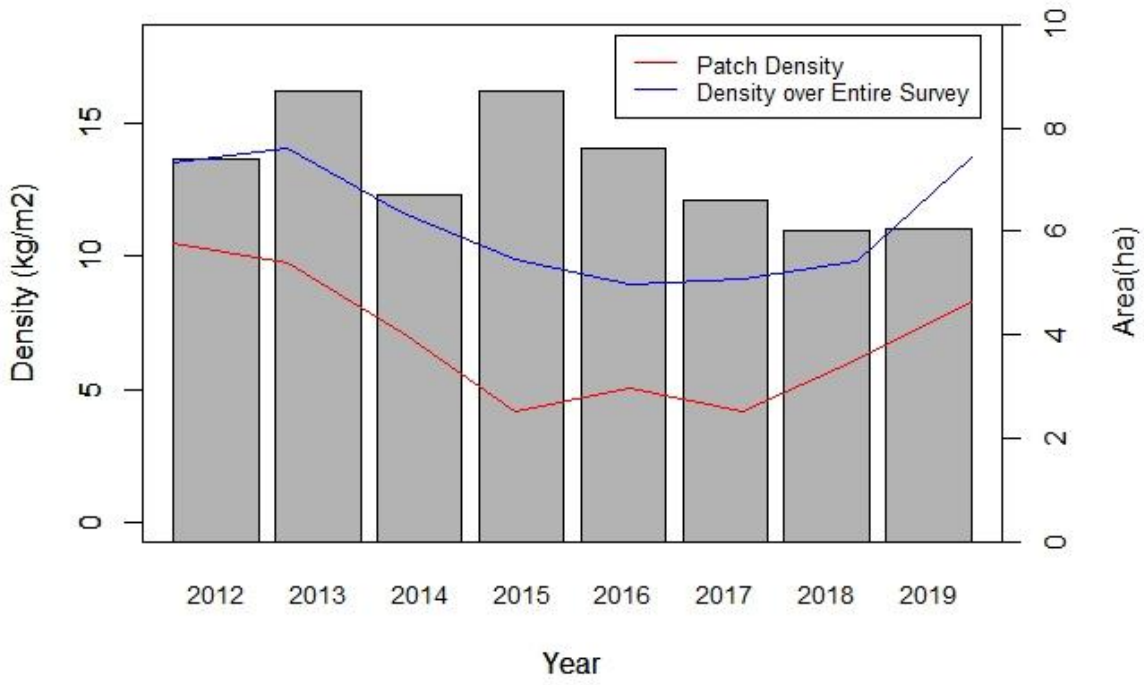


Figure 16 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Sprat Ridge 2012-2019.

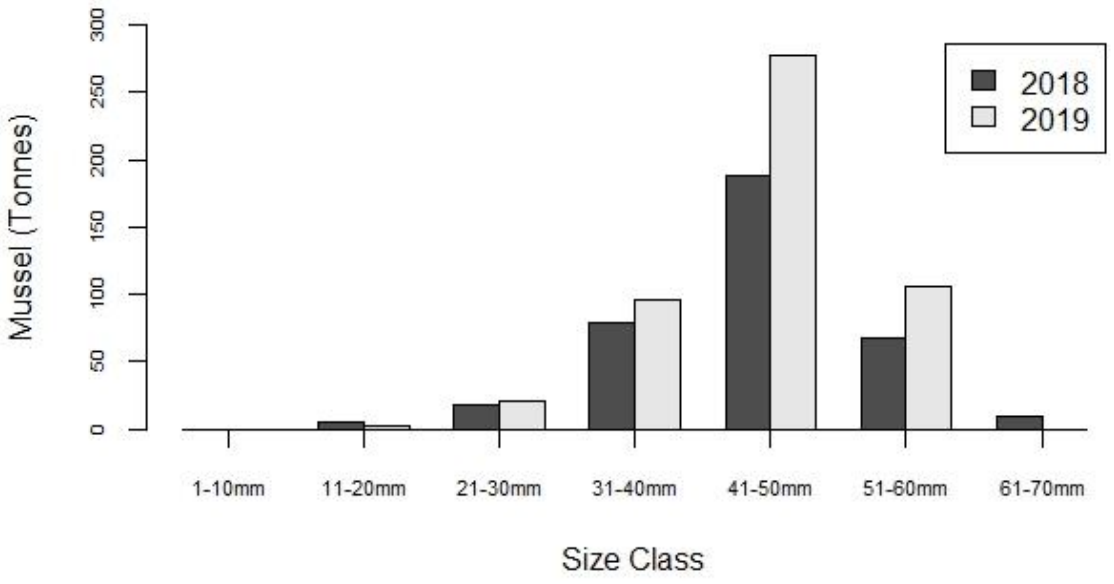


Figure 17 Sprat Ridge 10mm size class for 2018-2019 stock.

3.5 Pulleys

Pulleys was surveyed on 19th May 2018. Fifty-nine samples were collected from 10 transects. Since 2018 the tonnage total stock decreased by 17% and the survey area containing live mussels increased in spatial coverage by 16% (Figure 18,
Figure **19**). Total density within the survey area increased by 16% whilst patch density decreased by only 0.1% (
Figure **19**). The stock of marketable sized mussels (>41mm) was estimated to be 27 tonnes out a total 407 tonnes on the bed, i.e. 7 % (Figure 20).

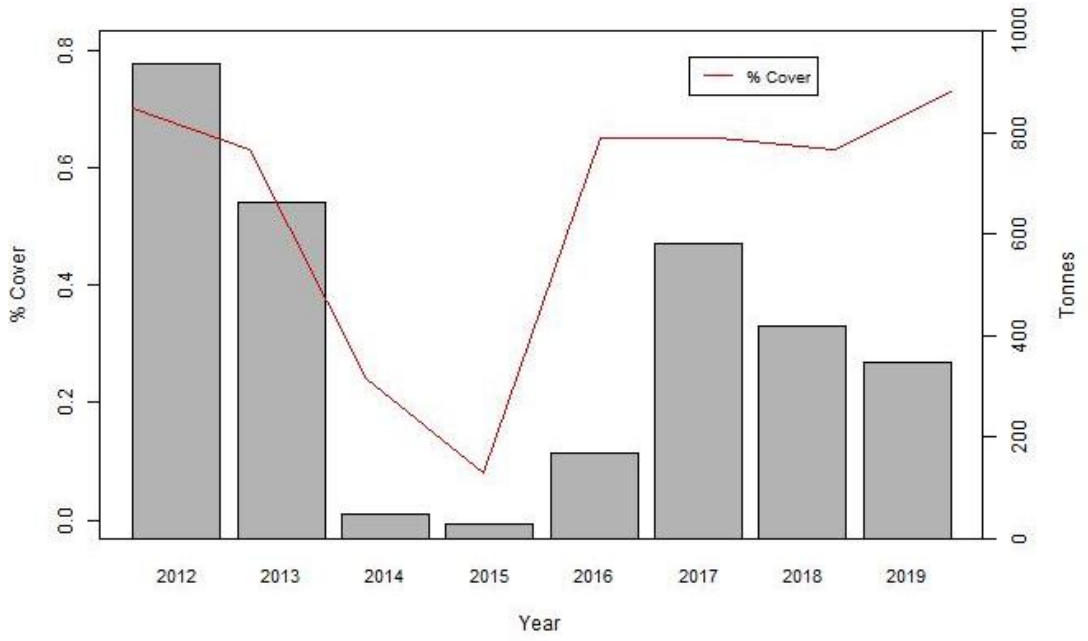


Figure 18 Percentage cover of live mussels plotted over total stock within the Pulleys survey area 2012-2019.

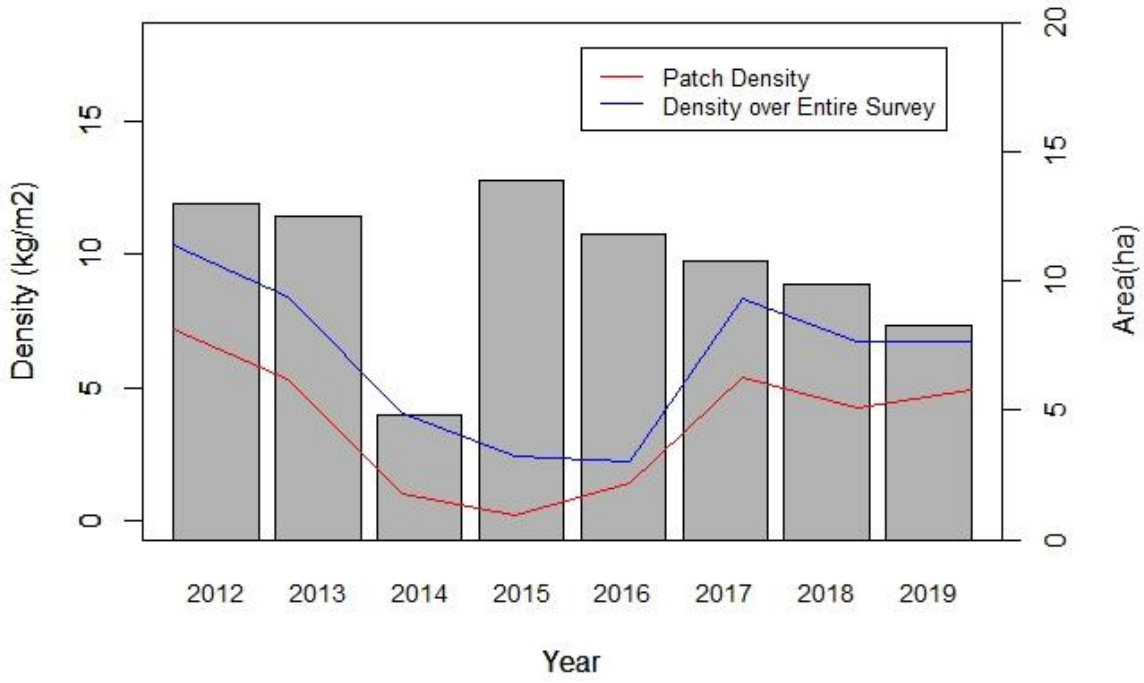


Figure 19 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Pulleys 2012-2019.

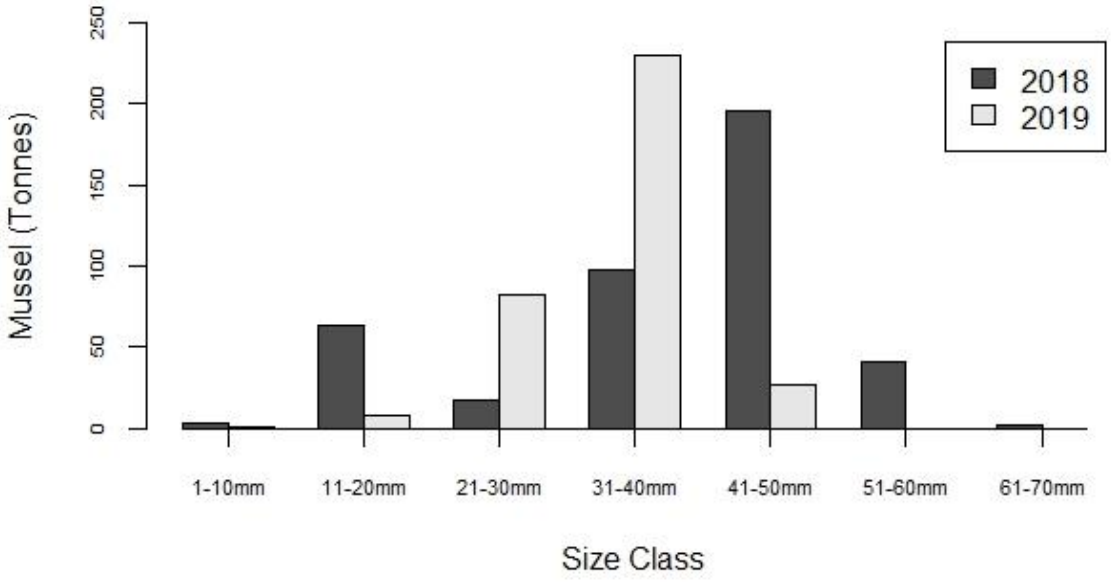


Figure 20 Pulleys 10mm size class for 2018-2019 stock.

3.5 Yelland

Yelland was surveyed on 17th May 2019. Ten samples were collected from 12 transects. Since 2018 the tonnage total stock increased by 67% and the survey area containing live mussels increased in spatial coverage by 6.5%

Figure 21, Figure 22). Total density within the survey area rose by 63% whilst patch density increased by 51% (Figure 22). The stock of marketable sized mussels (>41mm) was estimated to be 41 tonnes out a total 57 tonnes on the bed, i.e. 72 % (Figure 23).

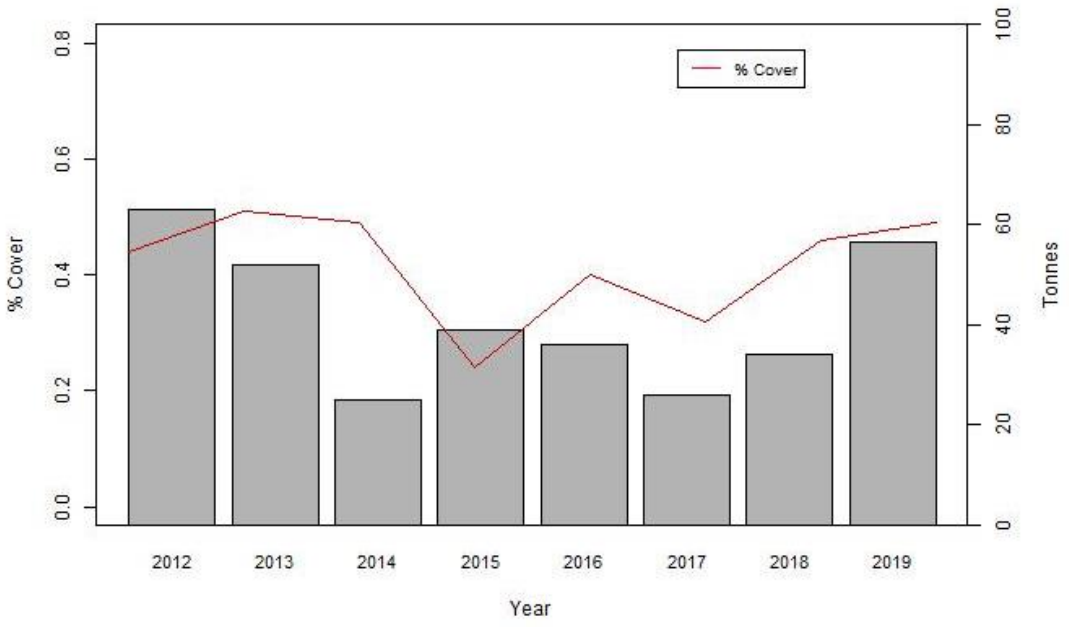


Figure 21 Percentage cover of live mussels plotted over total stock within the Yelland survey area 2012-2019.

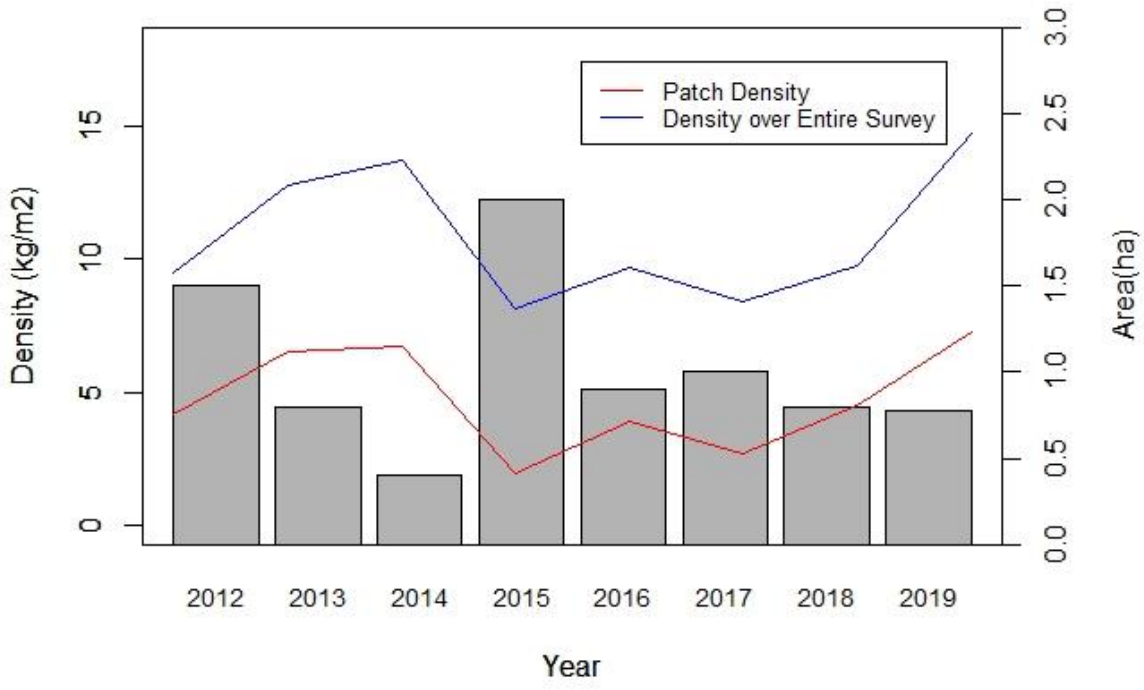


Figure 22 Mean mussel density data for patches and mean density across whole survey area. This is plotted over total area surveyed at Yelland 2012-2019.

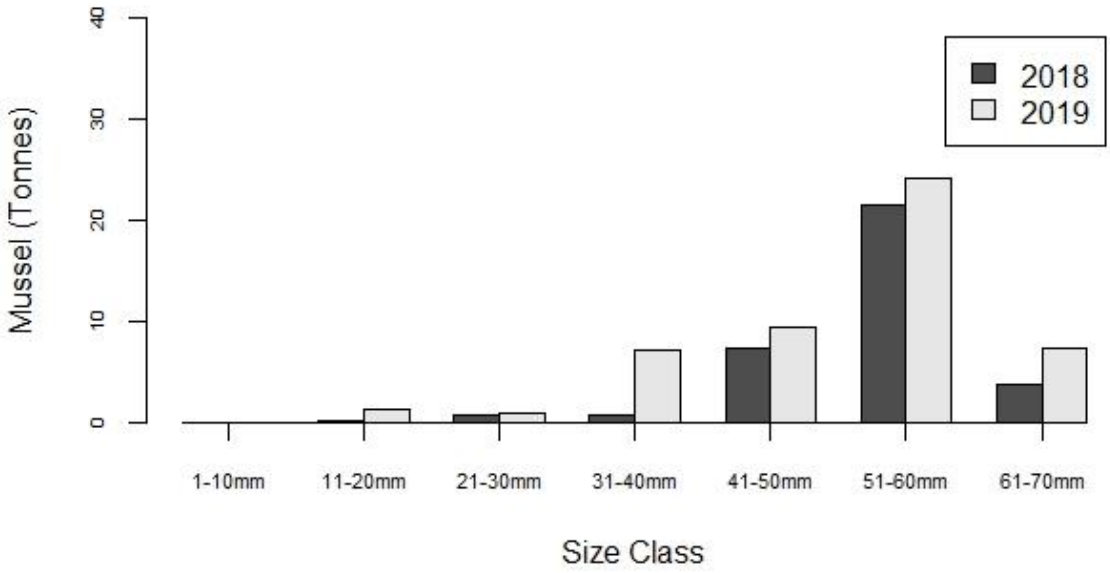


Figure 23 Yelland 10mm size class for 2018-2019 stock.

4. Discussion

4.1 Combined analysis of all survey sites.

Overall the total tonnage of mussel stock in the surveyed beds within the estuary has stayed stable, remaining at a similar level to the past two years (

Figure **6**). Positive increases were seen in the percentage coverage of live mussels and mussel density across the survey area. These increases may be attributed to increased recruitment and growth, however, total area surveyed also decreased by ~4ha (Figure 7). Recruitment across the estuary was also relatively low and whilst there was an increase in the amount of mussels 21-40mm since 2018 there were declines in total tonnage for all other size classes (Figure 8). When these data are viewed in combination with the knowledge that during year's survey increased focus was also placed on conducting smaller surveys in areas with visible mussels rather than prospectively surveying a larger area for the presence of. These increases in density and live coverage seem more likely due to change in survey technique instead of the aforementioned factors. This is not to say that they are entirely due to this methodological change.

Patch density is calculated based on random samples taken from areas of increased mussel abundance, it is a good indicator of the state of denser populations or beds within the survey area (regardless of survey area size). Patch density has been steadily increasing across the estuary since 2015 suggesting that established populations of mussels are on average becoming denser over time. Denser more homogenous mussel beds are typically more resilient to ecosystem change than patchier or loose mussels, so increased patch density could indicate that the beds are both stable and successfully recruiting (Seed & Suchanek, 1992). This has positive implications for continued delivery of the ecosystem services provided by the mussels within the estuary.

4.2 Analysis of individual beds

<u>Coolstone</u>

Tonnage of mussels within the Coolstone survey area had remained relatively stable since 2016. The 2019 survey, however, shows a marked decrease in tonnage to a level similar to 2015 at around ~120 total tonnes (Figure 9). The area surveyed was greatly reduced this year by around 4ha. With this increased resolution, mussel density across the survey area could be expected to rise, however it has actually decreased. Percent cover of live mussels, although remaining relative low, has increased to 2017 levels of around 37% (Figure 10, Figure 11). This suggests that the mussel population across the survey area is still patchy, and thinly distributed. Mussel density in patches has remained low but also stable with similar density's recorded in 2019 to those found in 2015.

Recruitment of mussel spat <30mm was minimal in 2019 and there where was considerable mortality of mussels >51mm (~35 tonnes) since 2018. Over the next year mussel growth of the current cohorts may increase the tonnage of the total stock marginally however mortality of mussels due to age or predation will potentially nullify any significant gains. It could

therefore be expected that total tonnage of mussel stock across the survey area will remain low/ in decline without significant levels of increased recruitment over the next year.

Lifeboat

The mussel population within Lifeboat survey area displays some similarities with the population found within the Coolstone site. A notable drop in mussel tonnage, increased coverage of live mussels and reduced density across the whole survey area. Patch density remains relatively low and stable from 2017-19. This survey area likewise is also patchy, thinly populated by mussels and displaying low homogeneity (

Figure **12**, Figure 13).

There was significant mortality between 2018-19 of the >41mm size classes of mussels, with the tonnage of mussels decreasing by ~50%. Recruitment of small spat was very low, however mussels in the 21-40mm size classes increased noticeably (Figure 14). This is noteworthy as recruitment was low in the previous year so such an increase due to growth alone seems unlikely considering that *Mytilus edulis* growth, though variable based on location, ranges in of the south coast of the UK an average around 10mm per annuum (Bayne & Worrall, 1980, Handå at al., 2011). It could be suggested that the current survey technique may not be adequately detecting the presence of smaller mussels <20mm, or alternately depending on spawning times the survey may be missing annual periods of heightened spat settlement (Bayne & Worrall 1980). If this is true for either of these scenarios, then current estimations on levels of spat recruitment for all survey sites within this report based would be subject to increased levels of variability. This is something that will need reviewing before next year's survey.

Sprat Ridge

Sprat Ridge has seen positive increases in total tonnage of mussels, and mussel density, with mussel populations becoming denser across the whole survey area and in more concentrated patches (Figure 15, Figure 16). Sprat Ridge like Pulleys is dense and homogenous enough (over 60% 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 area though decreasing annually since 2015 has stabilized remaining a similar size to last 2018. There have been positive gains in all size classes with particularly strong growth in the 31-60mm size classes. Recruitment of spat <30mm within the bed remains relatively high at >25 tonnes (Figure 17).

Overall the bed seems to be flourishing, getting deeper with increased mussel deposition and denser with live mussels, if the strong recruitment seen 2018-19 continues similar positive increases as outlined previously may be seen next year. Such a recovery approximately 5 years after a major disturbance would according to the literature be expected (Seed & Suchanek, 1992).

Pulleys

Pulleys, unlike Sprat Ridge, has seen a decrease in total mussels from 2018-19, with a total loss of over 200 tonnes since 2017 (Figure 18). The bed has shrunk by two hectares. Despite these potential indicators of bed decline, the density both across the bed and in patches ,however, remains stable since last year (Figure 19). Percent coverage of live mussels has increased after plateauing for three years, which suggests that despite decreasing mussel biomass the bed is becoming overall more homogenous. There were significant increases in mussels in the 21-40mm size class 2018-19, this may be due to growth of the 2018 spat <30mm. There have also been substantial declines in mussels >50mm in the same time span with <50 tonnes of >50mm mussels in 2019 compared to >250 tonnes the previous year (Figure 20).

Whilst the declines seen in this bed over the past couple of years are substantial, 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 2019, may continue in the coming months. This estimate of low recruitment will be subject to similar reliability issues as those alluded to for the Lifeboat site.

Yelland

The area surveyed at Yelland has seen recovery of mussel biomass over 2018-2019 to levels greater than pre the 2014 storm event. Percent cover and density over both survey area and in patches have all seen large positive increases whilst the survey area has stayed broadly similar (

Figure 21, Figure 22). The mussel population at Yelland is more homogeneous than Coolstone or Lifeboat and its limits more clearly defined. This suggests that the observed increases are mainly biological, due to both growth and successful spat recruitment. Evidence for this growth is observable across the size classes as biomass of mussels in every size class sampled in 2019 exceeded those of 2018 levels (Figure 23). If these positive trends continue it is possible that with increased recruitment the area cover of Yelland may increase, as the bed is relatively small it may be expected that alone this expansion will be relatively slow, the presence of larger healthy adjacent beds like Sprat Ridge may accelerate this growth with increased recruitment across the estuary.

4.3 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 mussels removed (including location) together with copies of movement documents are submitted to Natural England and the IFCA within 14 days of harvesting.

4.4 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 and particularly to detect any signs of recovery. 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 allowing Natural England to ensure the mussel harvesting limit remains suitable to provide enough bird food availability.

In addition to this the use of a fine 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 funding and time constraints the latter option is most likely not feasible.

References

Andrews, J.W., Brand, A.R., and Maar, M. (2011) *MSC Assessment Report for Isefjord and East Jutland Danish Blue Shell Mussel Fishery* [online: msc.org] Moody Marine Ltd. Derby UK

Bayne, B. L., and Worrall, C. M. (1980) Growth and production of *Mytilus edulis* from two populations. *Marine Ecology – Progress Series* **1**: 317-328

Cefas (2016) Shellfish harvesting classification zone maps www.cefas.co.uk/cefas-data-hub/food-safety/classification-and-microbiological-monitoring/england-and-wales-classification-and-monitoring/classification-zone-maps/

Defra (2016) MagicMap http://magic.defra.gov.uk/MagicMap.aspx

Finding Sanctuary (2011) Final Report and Recommendations. September 2011

Gardner, J.P.A. (1996) The *Mytilus edulis* species complex in southwest England: effects of hybridization and introgression upon interlocus associations and morphometric variation. *Marine Biology* **125**: 385-399

Handå, A., Alver, M., Edvardsen, V. C., Halstensen, S., Olsen, A. J., Øie, G., Reitan, K. I., Olsen, Y., Reinertsen, H. (2011) Growth of farmed blue mussels (*Mytilus edulis* L.) in a Norwegian coastal area; comparison of food proxies by DEB modelling. Journal of Sea Research, 66(4), 297-307.

Maddock, A. (2008) *UK Biodiversity Action Plan; Priority Habitat Descriptions*. BRIG.

McGrorty, S., Clarke, R. T., Reading, C. J., & Goss-Custard, J. D. (1990) Population dynamics of the mussel *Mytilus edulis*: density changes and regulation of the population in the Exe estuary, Devon. Marine ecology progress series. Oldendorf, 6(2), 157-169.

Seed, R. Suchanek, T.H. (1992) Population and community ecology of Mytilus. In The mussel Mytilus: ecology, physiology, genetics and culture (ed. Gosling, E.M.), Amsterdam: Elsevier Science Publ. Developments in Aquaculture and Fisheries Science, 25, 87-169.