Taw Torridge Estuary

Mussel Stock Assessment

2011

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Research Report 201201
April 2012

Contents

Executive Summary

The mussel beds on the Taw Torridge Estuary were previously managed by the Environment Agency, however under the Marine and Coastal Access Act, when all Sea Fisheries Committees were replaced by Inshore Fisheries and Conservation Authorities (IFCAs) on April 1st 2011, they took on the management of fisheries within estuarine waters. Therefore, the Devon and Severn IFCA took over the management of the Taw Torridge mussel beds from the Environment Agency and thus, inherited the byelaws in place to manage the beds. Devon and Severn IFCA therefore felt it necessary to undertake a stock assessment of the mussel beds to help inform a review of the management measures in place. This is the first stock assessment to take place on the Taw Torridge mussels since 2001, when Cefas conducted a stock survey.

There are eight main mussel beds on the Taw Torridge; Coolstone Beds 1, 2 & 3, Lifeboat Slip, Sprat Ridge, Sprat Ridge Far End, Pullys, and Yelland. These beds were each surveyed between August 2011 and January 2012. The total stock on the beds was calculated to be 2,347 tonnes, of which 601 tonnes was of marketable size. The beds that were surveyed in both 2001 and 2011 showed a slight increase in total stock of 4.8% (from 2040 tonnes to 2139 tonnes) but a much larger increase, 54%, of marketable stock (from 320 tonnes to 493 tonnes). However, there was great variation between beds, with only Sprat Ridge showing a significant increase in total stock, while Coolstone was the only bed with a loss of marketable stock. These differences can be put down to the different ways the individual beds are harvested and managed.

This report will form the baseline data on the Taw Torridge mussels for Devon and Severn IFCA, against which all future stock assessments may be compared. It is recommended that the mussel surveys are repeated annually to monitor any changes in the stock composition.

1. Introduction

1.1 Objective

The objective of this project is to carry out a survey of the mussel beds in the Taw Torridge Estuary in North Devon and to define where the mussel beds are and accurately map, using GIS, the overall extent of each of the mussel beds. Devon and Severn Inshore Fisheries and Conservation Authority (IFCA) will undertake a stock assessment on each of the beds and estimate the density of mussels on the beds and the total stock of marketable mussels. This will help inform future management of the mussel beds on the Taw Torridge and development of shellfisheries in this part of the Devon & Severn IFCA district. This survey will also highlight any changes to beds since Cefas conducted a stock survey in 2001 (Walker, 2001).

1.2 *Mytilus edulis*

Mytilus edulis, blue mussels, 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 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).

1.3 Site Description

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 1.1).

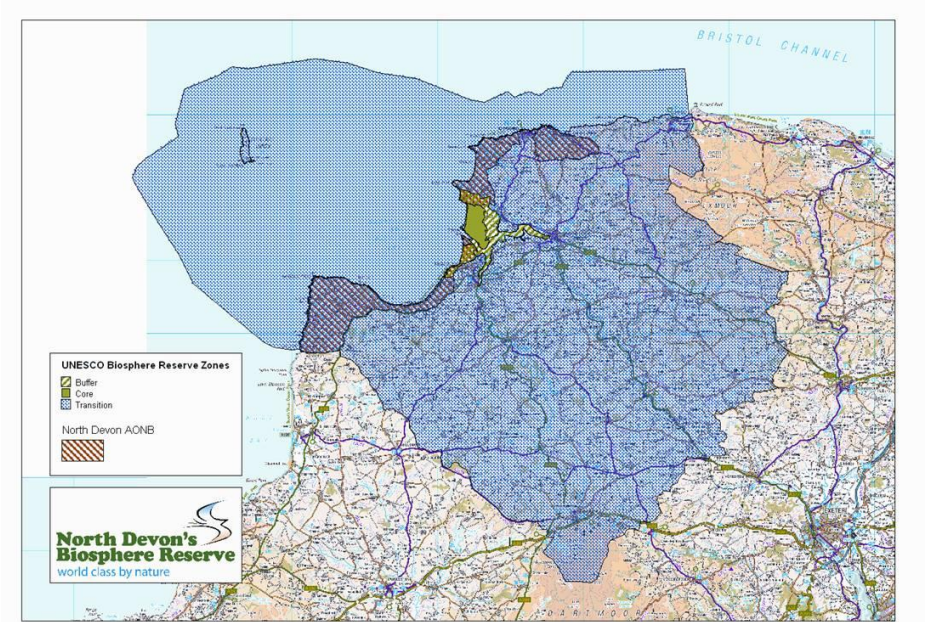


Fig. 1.1 The location of the Taw Torridge Estuary (shown in yellow) within the North Devon Biosphere Reserve and the North Devon Coast AONB. (Taw Torridge Estuary Management Plan, 2010)

The estuary is an important site for wildlife and has been designated a Site of Special Scientific Interest (SSSI) (Figure 1.2) for over-wintering and migratory populations of wading birds, and for the rare plants found on its shores. Parts of the estuary have also been put forward as a recommended Marine Conservation Zone (rMCZ) by Finding Sanctuary (Figure 1.3). It has been recommended for the following habitats; subtidal mud, subtidal sand, coastal marshes & saline reedbeds, intertidal coarse sediment, intertidal sand & muddy sand, and low energy intertidal rock. It has also been recommended for the presence of *Anguilla anguilla* (European eel). The conservation objective for the rMCZ is to "maintain in favourable condition".

Fig. 1.2 Taw-Torridge Estuaries SSSI, shown in yellow. (Natural England)

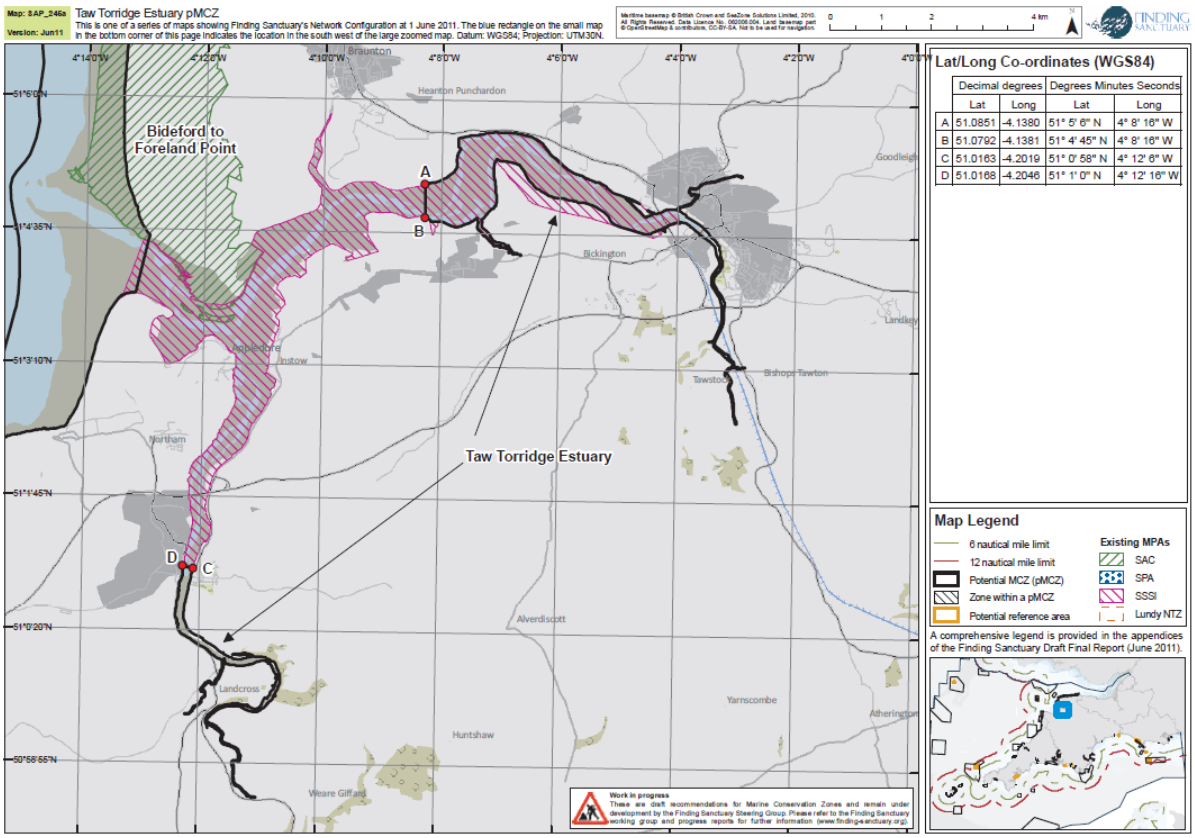


Fig. 1.3 Area of rMCZ, outlined in black. Area of SSSI shown in red hatching, and area of SAC shown by green hatching. (Finding Sanctuary)

The Taw Torridge estuary has both *Mytilus edulis* (blue mussel) and *Crassostrea gigas* (Pacific oyster) harvesting areas classified by Cefas. Shellfish harvesting areas are classified according to the extent of contamination shown by monitoring E. coli in shellfish flesh. The classification categories are:

Class A (≤230 E. coli/100g) – molluscs can be harvested for direct human consumption.

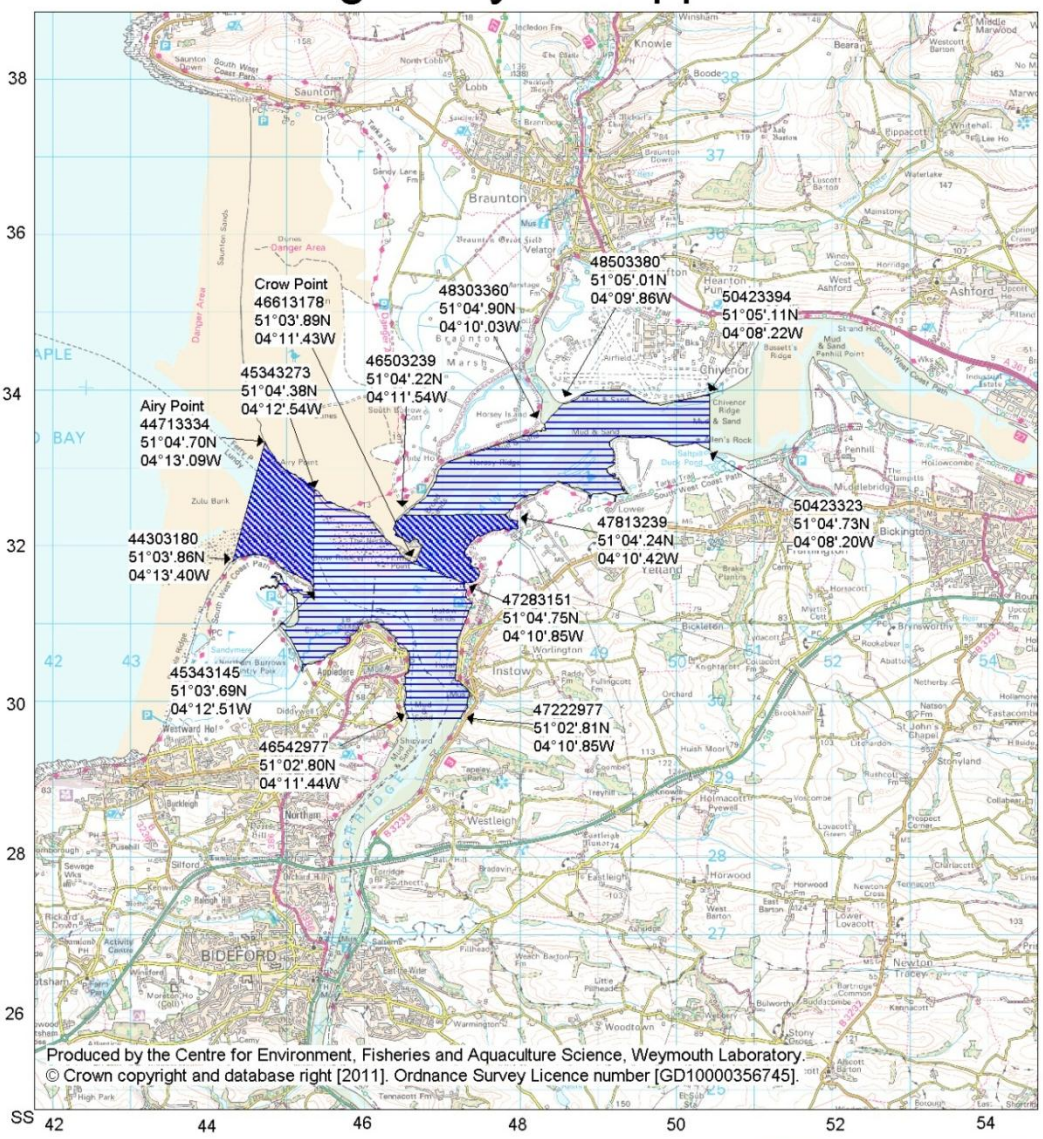
Class B (90% of samples must be ≤4,600 E. coli/100g; all samples must be less than 46,000 E. coli/100g) – molluscs can be sold for human consumption:

- after purification in an approved plant, or
- after re-laying in an approved Class A re-laying area, or
- after an EC-approved heat treatment process.

Class C (≤46,000 E. coli/100g) – molluscs can be sold for human consumption only after re-laying for at least two months in an approved re-laying area followed, where necessary, by treatment in a purification centre, or after an EC-approved heat treatment process.

On the Taw Torridge the *M. edulis* harvesting areas are mostly Long-Term Class B, with two areas of Class C (Figure 1.4), while the *C. gigas* harvesting areas are Long-Term Class B (Figure 1.5).

The Taw Torridge estuary was the first in England to adopt an Estuary Management Plan (EMP). This guides the use of the estuary for commerce, recreation and nature conservation. This includes activities such as hand gathering shellfish, recreational angler bait gathering, and trampling, all of which need managing in such a way as to ensure the sustainability of the estuary's shellfisheries.



Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2011

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
Separate map available for C. gigas at Taw & Torridge

Food Authorities: North Devon District Council (Taw) Torridge District Council (Torridge)

Fig. 1.4 The classification of the *M. edulis* harvesting areas on the Taw Torridge (Cefas)

Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2011

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N.B. Lat/Longs quoted are WGS84
Separate map available for Mytilus spp. at Taw & Torridge

Food Authorities: North Devon District Council (Taw) Torridge District Council (Torridge)

Fig. 1.5 The classification of the *C. gigas* harvesting areas on the Taw Torridge (Cefas)

The mussel beds on the Taw Torridge are public beds which may be fished by anyone, with little current management. However, the shellfisheries on the Taw Torridge are all subject to the following Devon and Severn IFCA byelaws:

- Shellfish – Minimum Sizes: No person shall remove from a fishery:-
    (a) Any oyster that will pass through a gauge having a circular opening of 2½ inches in diameter.
    (b) Any mussel of less than 2 inches in length.
    (c) Any cockle that will pass through a gauge having an aperture of ¾ inch square.
    (d) Any edible crab measuring less than 4½ inches across the broadest part of the back.
    (e) Any lobster or crawfish measuring less than 9 inches from the tip of the beak to the end of the tail when spread as far as possible flat.
- Shellfish – Redeposit of: Any person who by inadvertence takes any shellfish, the removal of which from a fishery is prohibited by any of the Byelaws, or the possession or sale of which is prohibited by or in pursuance of any Act of Parliament, shall forthwith redeposit the same as nearly as possible in the place from which they were taken or under the written authority of the Clerk on other suitable ground, and, in redepositing cockles, in accordance with this Byelaw shall spread them thinly and evenly over the beds.
- Regulation of Shellfish Beds: Where, in the opinion of the Board, in any fishery any bed or part of a bed of shellfish is so severely depleted as to require temporary closure in order to ensure recovery, or any bed or part of a bed contains mainly immature or undersized shellfish which in the interests of the protection and development of the fishery ought not to be disturbed for the time being, or any bed or transplanted shellfish ought not to be fished until it has become established, and where the bed or part thereof has been clearly defined in notices displayed in the vicinity prohibiting the removal or disturbance of the shellfish, or where the display of notices is not possible written notice has been given by one of the Board's Officers, no person shall, while the bed or any part thereof is so defined, take away or otherwise disturb any shellfish without the consent of the Board.

2. Methodology

2.1 Equipment

1 x 4' cane, with 11cm ring attached to one end
1 x 11cm corer
2 x GPS units
2 buckets
Plastic bags
Sieve
Digital scales
Survey forms
Callipers

2.2 Method

The area of the bed is recorded by walking its perimeter and marking points with a handheld GPS, which are then plotted onto MapInfo GIS 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 (Figure 2.1.). 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 a tub, but kept separate from those of other transects.

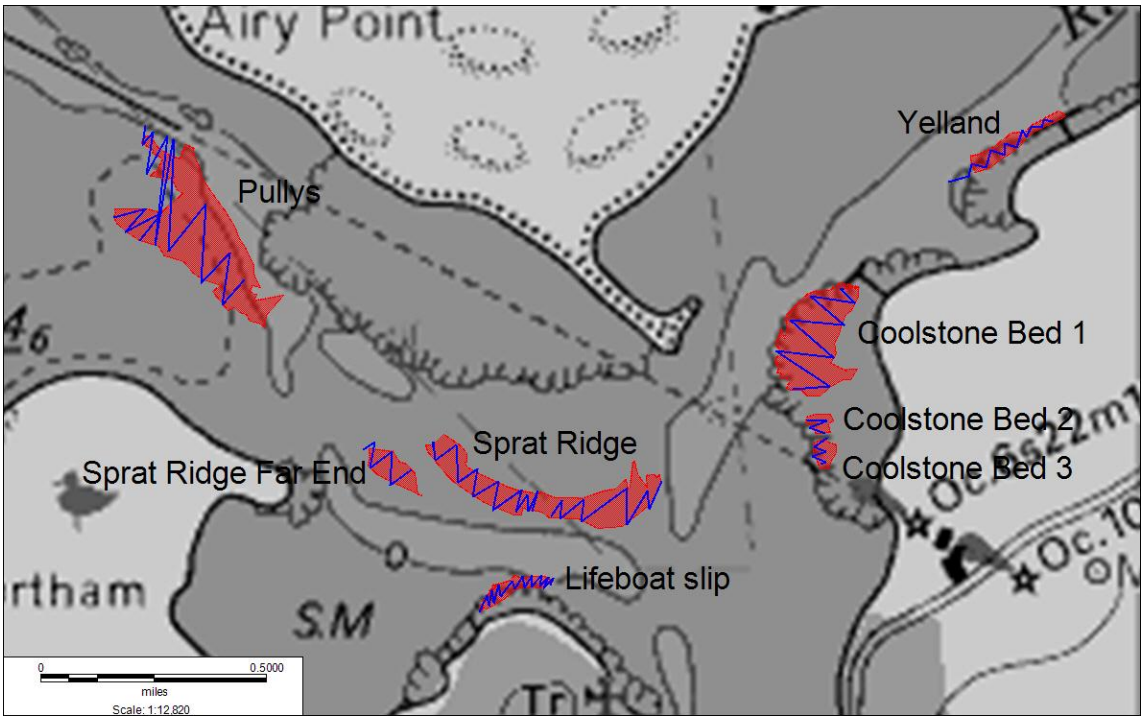

Fig. 2.1 Transects walked (shown in blue) within the perimeter of each bed (shown in red).

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 and then divided into size groups; ≤25mm, 26-49mm, and ≥50mm. These size ranges were chosen because 50mm is the minimum landing size for mussel, so anything above that is marketable, and any mussels under 25mm could be considered seed. 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 2.2), 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.

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

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

Fig. 2.2 Calculations used for mussel coverage on bed, and density of mussels across bed.

The survey method used is a procedure developed by MarinX, Dutch marine consultants. This method was chosen in place of the method used by Cefas in 2001, which uses footfall to determine hits/misses and the throwing of a quadrat to determine coverage, as it is deemed to be more accurate. Using a pre-determined ring size for hits/misses, removes the potential for inaccuracies caused by surveyors having different sized feet. It is also easier to see whether the ring contains live mussel instead of looking at a footprint. The flicking of the ring at the end of the cane provides a random sample which is not subject to human error by trying to select a “representative” quadrat.

3. Results

3.1 Coolstone

There are three distinct beds in the Coolstone area, these were surveyed separately.

Coolstone Bed 1

- Area: 7.4 hectares
- Coverage: 67%
- Mean Density: 4.93 kg/m^2
- Total Stock: 364 tonnes
- Stock ≥50mm: 78 tonnes

Coolstone Bed 1 was surveyed on August 30th 2011. Samples were taken from every fifth "hit", producing 62 samples from nine transects. The stock of marketable sized mussels was estimated to be 78 tonnes out a total 364 tonnes on the bed, i.e. 21%. Figure 3.1 shows the size frequency of mussels taken from samples, while Figure 3.4 shows the size distribution of mussels across the bed.

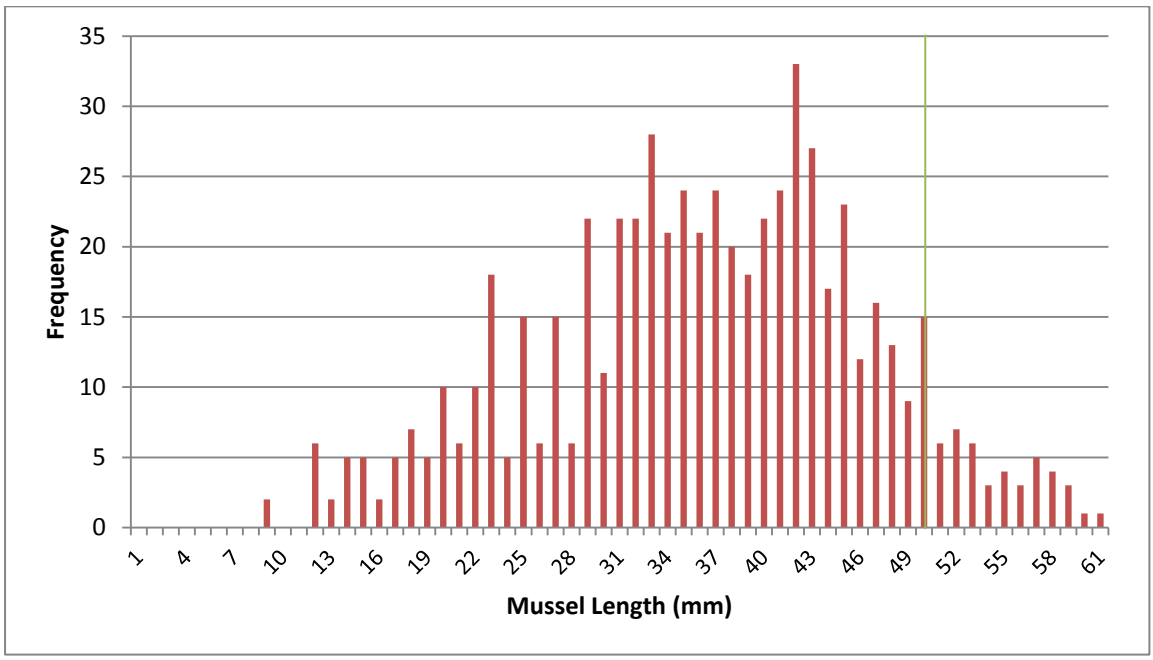

Fig. 3.1 Size frequency of mussels across Coolstone Bed 1. The green line indicates the minimum landing size of 50mm.

Coolstone Bed 2

- Area: 0.5 hectares
- Coverage: 44%
- Mean Density: 5.53 kg/m^2
- Total Stock: 26 tonnes
- Stock ≥50mm: 8 tonnes

Coolstone Bed 2 was surveyed on August 30th 2011. Samples were taken from every fifth "hit", producing four samples from three transects. The stock of marketable sized mussels was estimated to be 8 tonnes out a total 26 tonnes on the bed, i.e. 31%. Figure 3.2 shows the size frequency of mussels taken from samples, while Figure 3.4 shows the size distribution of mussels across the bed.

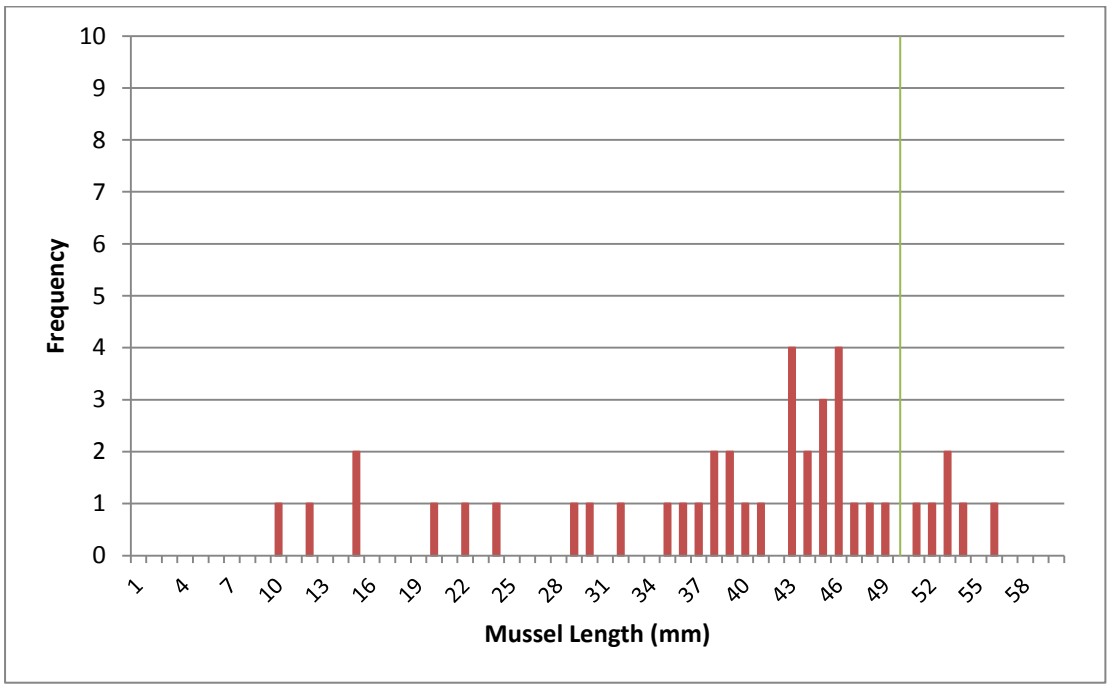

Fig. 3.2 Size frequency of mussels across Coolstone Bed 2. The green line indicates the minimum landing size of 50mm.

Coolstone Bed 3

- Area: 0.6 hectares
- Coverage: 47%
- Mean Density: 2.11 kg/m^2
- Total Stock: 12 tonnes
- Stock ≥50mm: 1 tonne

Coolstone Bed 3 was surveyed on August 30th 2011. Samples were taken from every fifth "hit", producing six samples from five transects. The stock of marketable sized mussels was estimated to be 1 tonne out a total 12 tonnes on the bed, i.e. 8%. Figure 3.3 shows the size frequency of mussels taken from samples, while Figure 3.4 shows the size distribution of mussels across the bed.

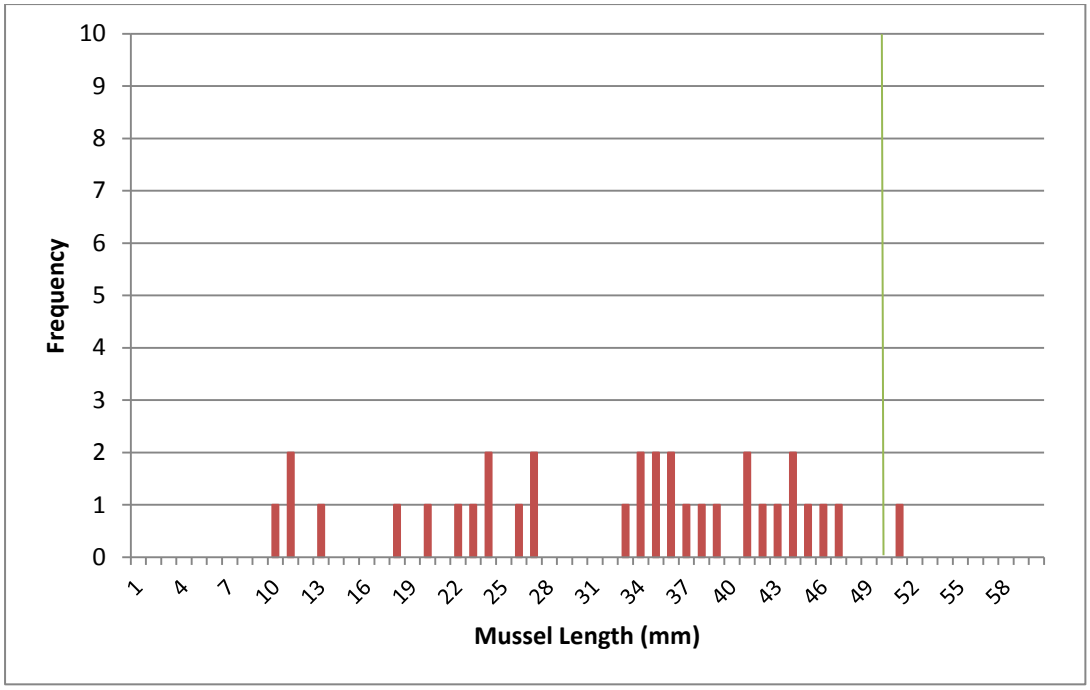

Fig. 3.3 Size frequency of mussels across Coolstone Bed 3. The green line indicates the minimum landing size of 50mm.

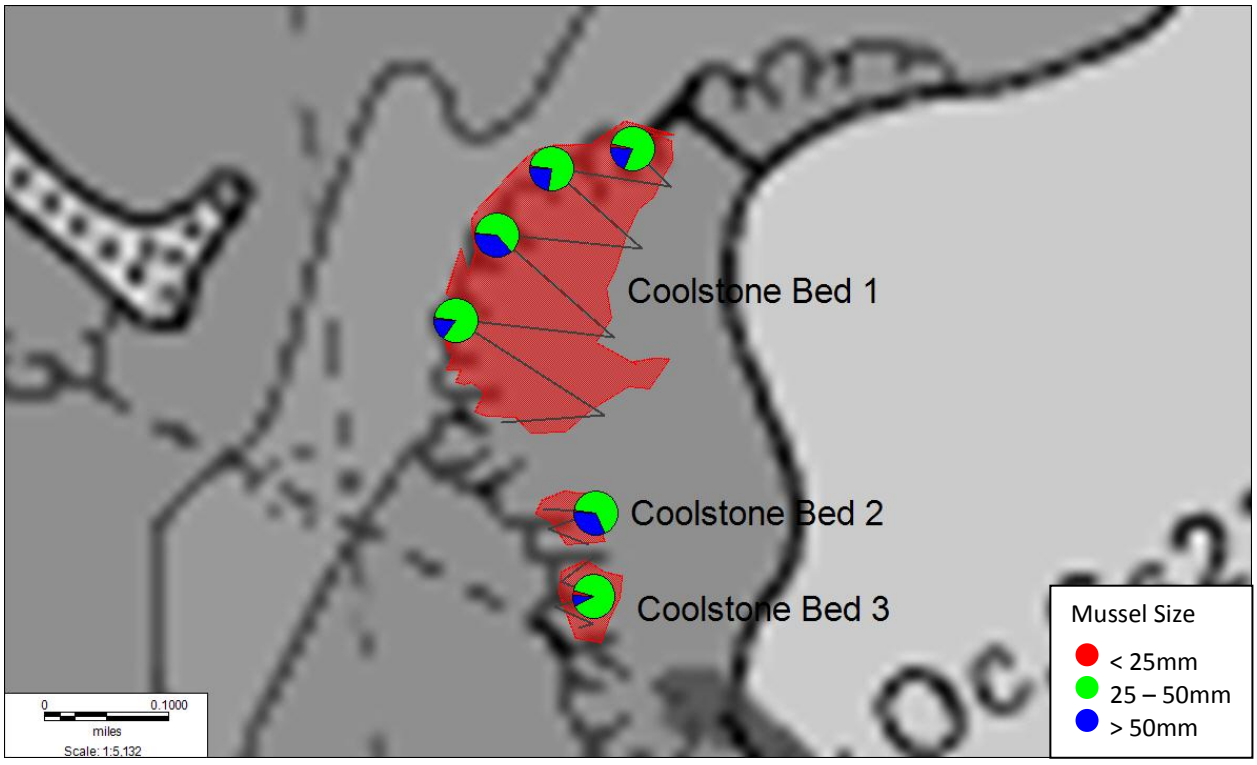

Fig. 3.4 Mussel size ratios, by weight, per transect across the Coolstone Beds

3.2 Lifeboat Slip

- Area: 1.0 hectare
- Coverage: 66%
- Mean Density: 5.15 kg/m^2
- Total Stock: 53 tonnes
- Stock ≥50mm: 7 tonnes

The Lifeboat Slip bed was surveyed on August 31st 2011. Samples were taken from every fifth "hit", producing 36 samples from 18 transects. The stock of marketable sized mussels was estimated to be 7 tonnes out a total 53 tonnes on the bed, i.e. 13%. Figure 3.5 shows the size frequency of mussels taken from samples, while Figure 3.6 shows the size distribution of mussels across the bed. Due to all the samples being pooled, the pie chart in figure 3.6 represents the mussel stock composition for the whole bed, rather than for individual transects.

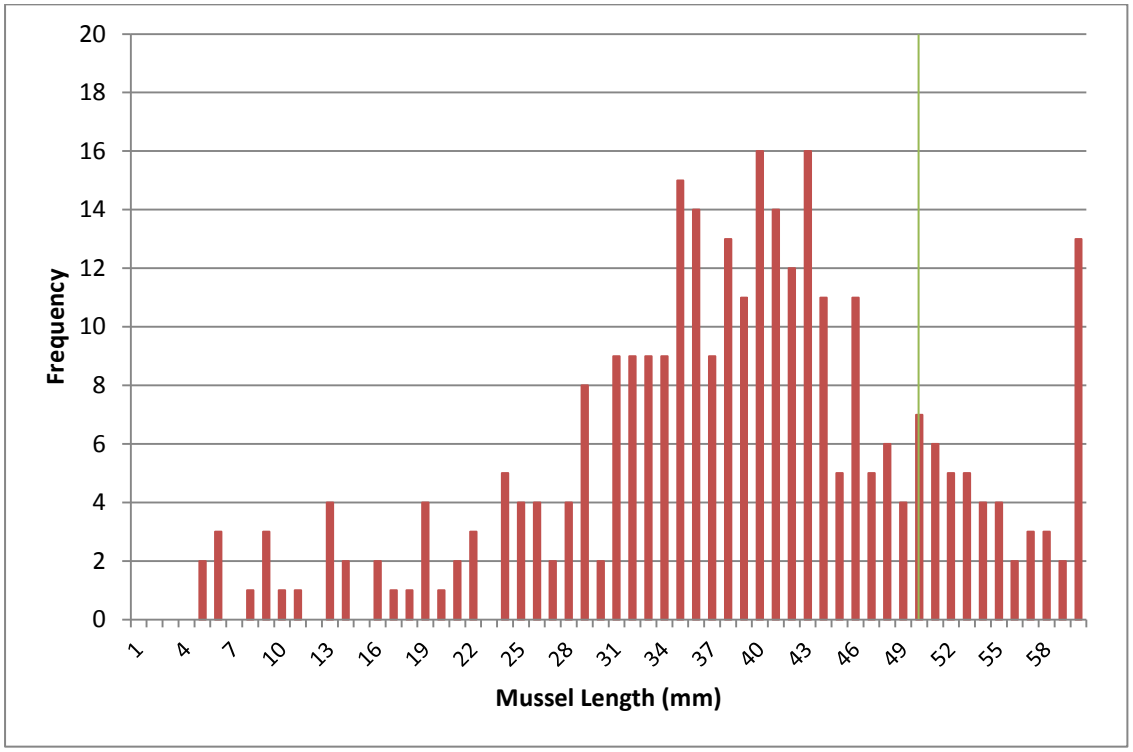

Fig. 3.5 Size frequency of mussels across the Lifeboat Slip bed. The green line indicates the minimum landing size of 50mm. NB. All mussels ≥60mm were recorded together, producing the peak at this length.

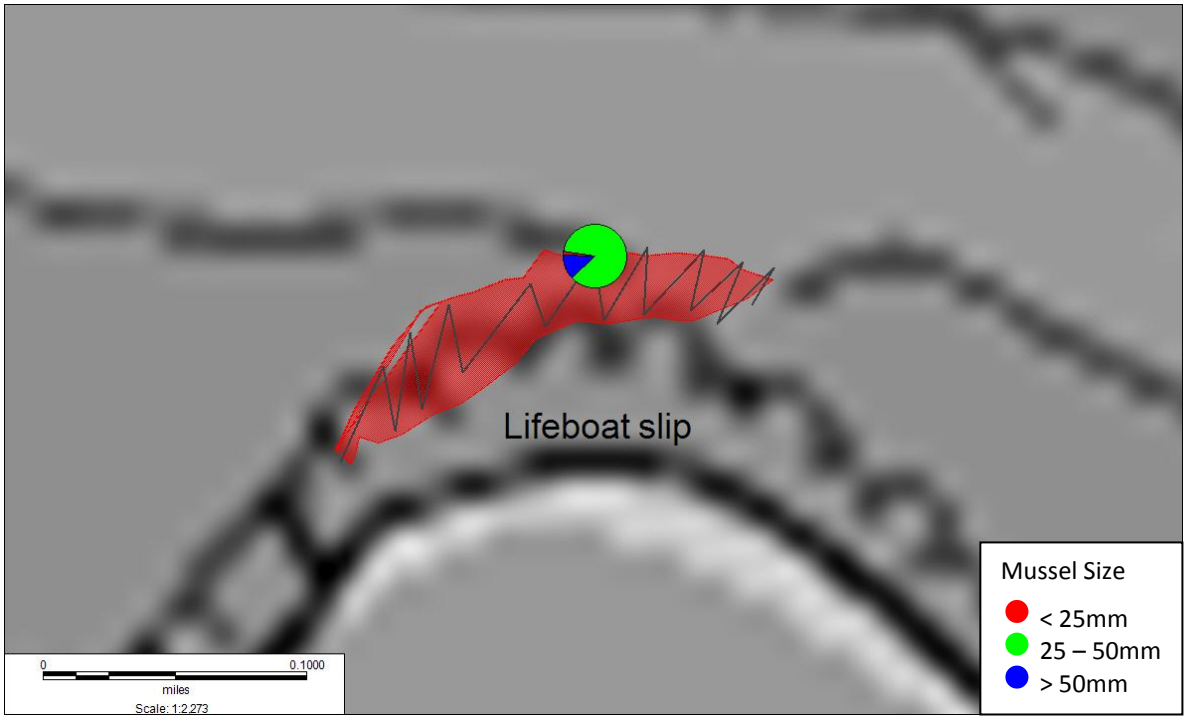

Fig. 3.6 Mussel size ratios, by weight, across Lifeboat Slip

3.3 Sprat Ridge

- Area: 7.4 hectares
- Coverage: 78%
- Mean Density: 10.5 kg/m^2
- Total Stock: 776 tonnes
- Stock ≥50mm: 210 tonnes

The Sprat Ridge bed was surveyed on September 29th 2011. Samples were taken from every fifth "hit", producing 102 samples from 23 transects. The stock of marketable sized mussels was estimated to be 210 tonnes out a total 776 tonnes on the bed, i.e. 27%. Figure 3.7 shows the size frequency of mussels taken from samples, while Figure 3.8 shows the size distribution of mussels across the bed.

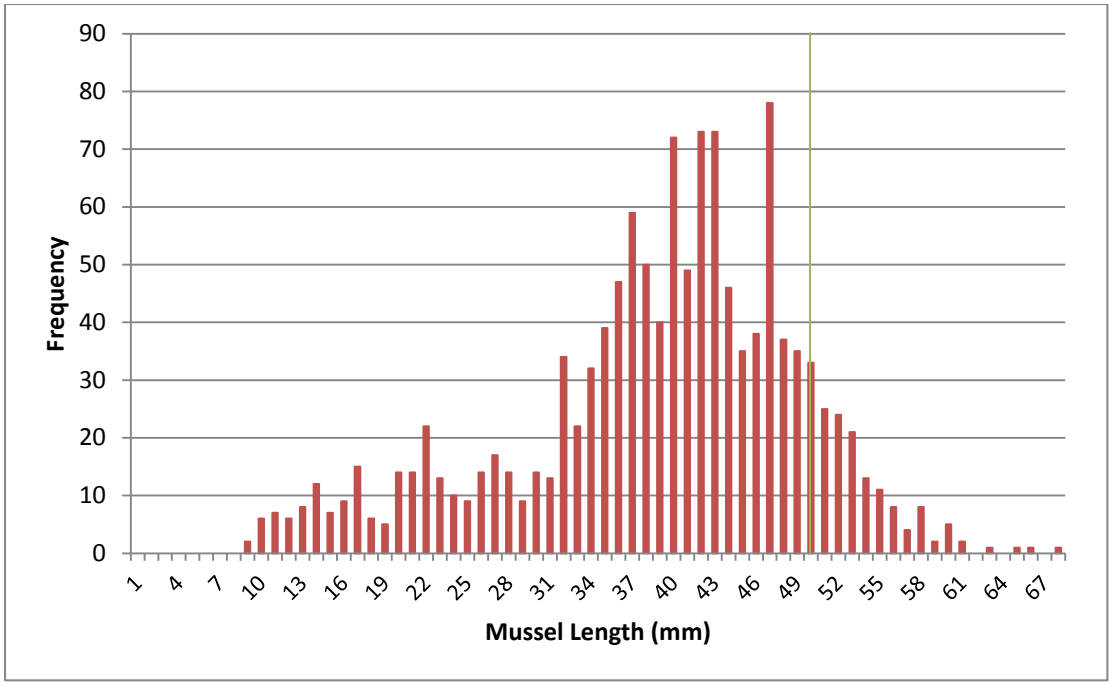

Fig. 3.7 Size frequency of mussels across the Sprat Ridge bed. The green line indicates the minimum landing size of 50mm.

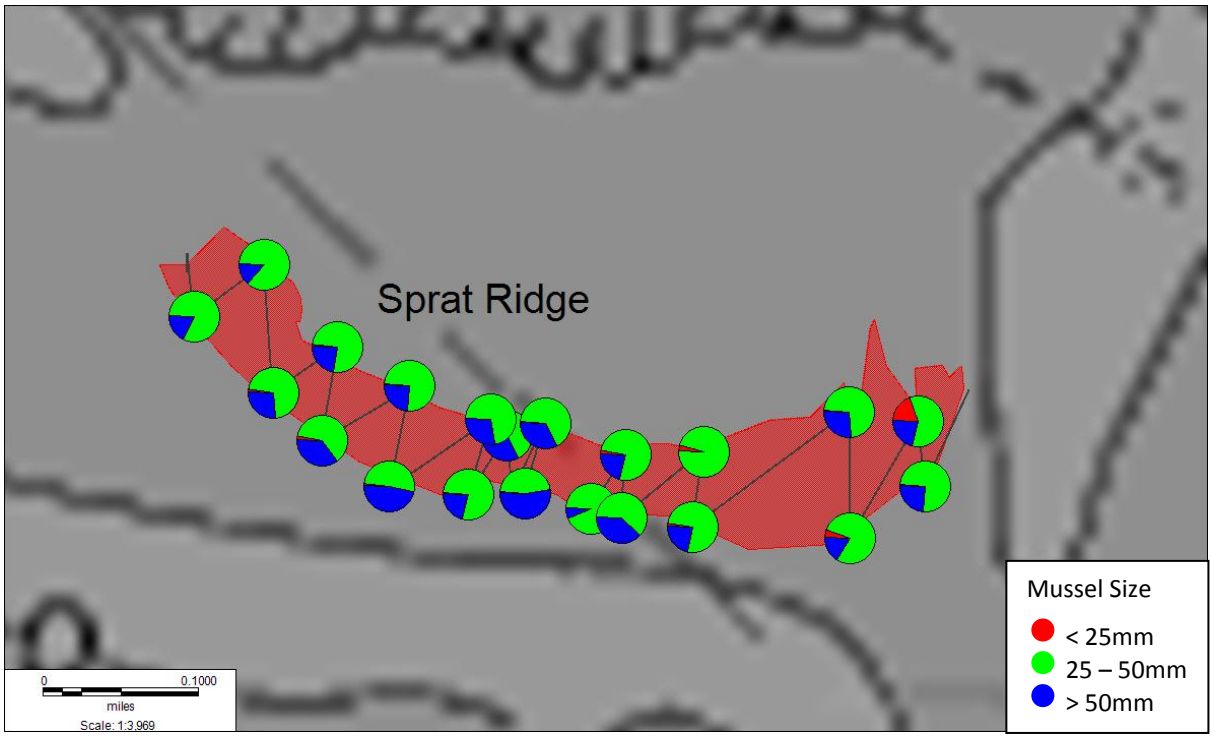

Fig. 3.8 Mussel size ratios, by weight, per transect across Sprat Ridge

3.4 Sprat Ridge Far End

- Area: 1.5 hectares
- Coverage: 61%
- Mean Density: 8.03 kg/m^2
- Total Stock: 117 tonnes
- Stock ≥50mm: 92 tonnes

Sprat Ridge Far End was surveyed on September 29th 2011. Samples were taken from every fifth "hit", producing 15 samples from six transects. The stock of marketable sized mussels was estimated to be 92 tonnes out a total 117 tonnes on the bed, i.e. 79%. Figure 3.9 shows the size frequency of mussels taken from samples, while Figure 3.10 shows the size distribution of mussels across the bed.

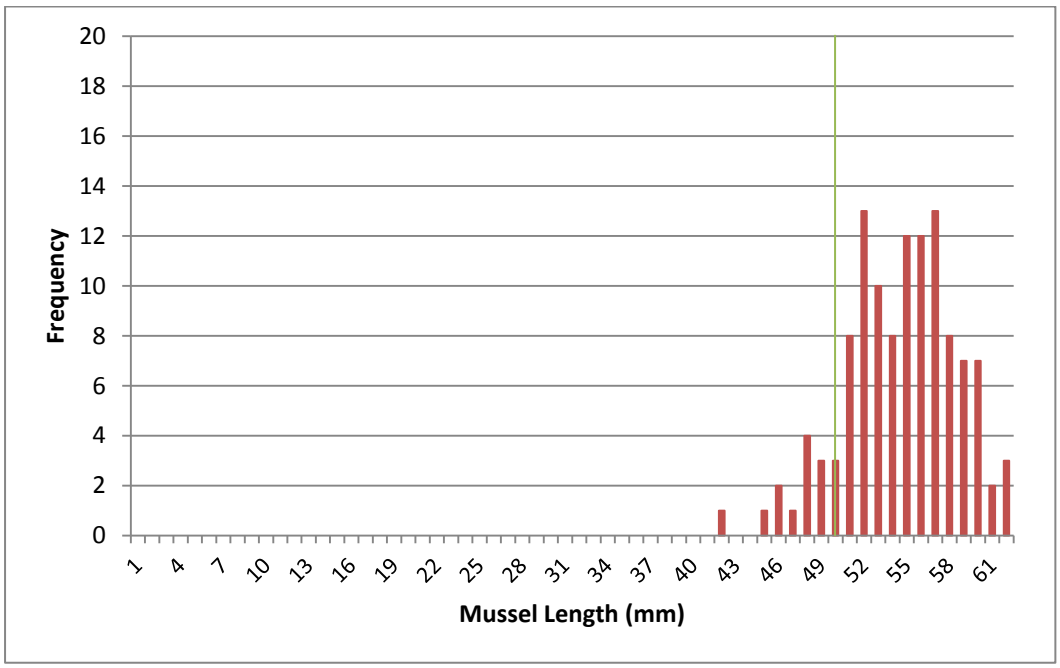

Fig. 3.9 Size frequency of mussels across the Sprat Ridge Far End bed. The green line indicates the minimum landing size of 50mm.

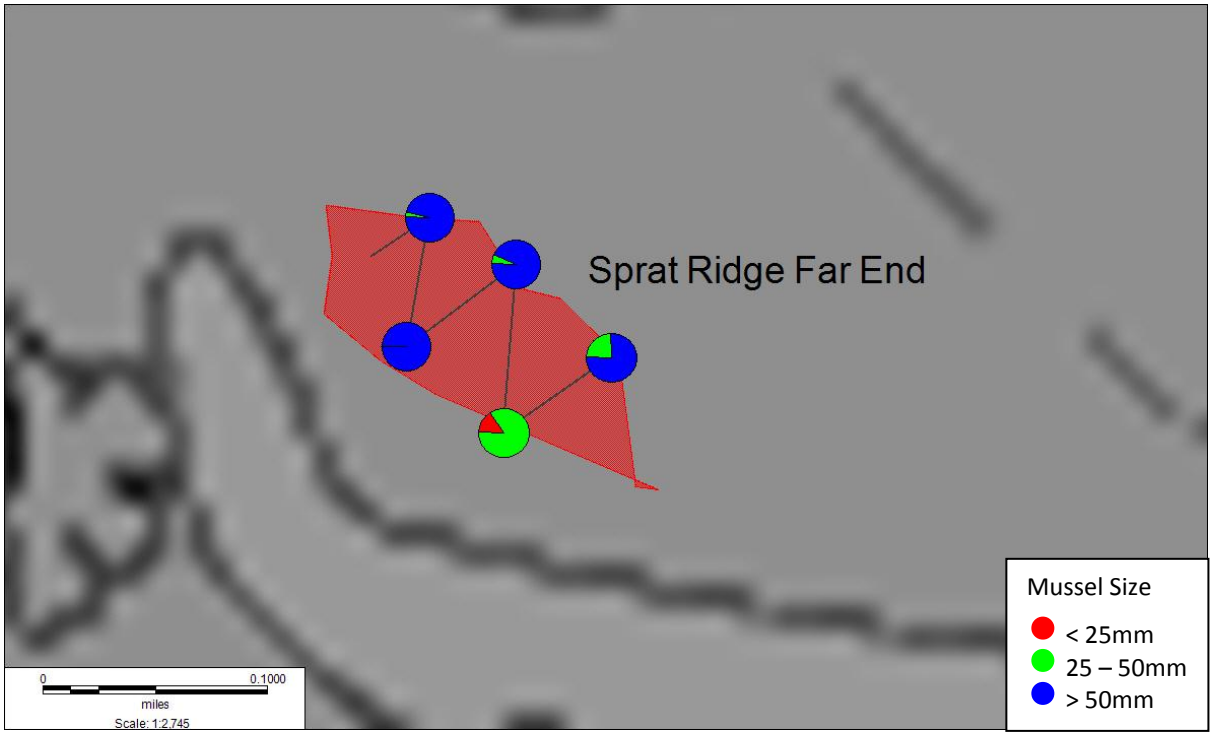

Fig. 3.10 Mussel size ratios, by weight, per transect across Sprat Ridge Far End

3.5 Pullys

- Area: 13 hectares
- Coverage: 70%
- Mean Density: 7.23 kg/m^2
- Total Stock: 936 tonnes
- Stock ≥50mm: 159 tonnes

The Pullys bed was surveyed on October 26th 2011. Samples were taken from every fifth "hit", producing 104 samples from 16 transects. The stock of marketable sized mussels was estimated to be 159 tonnes out a total 936 tonnes on the bed, i.e. 17%. Figure 3.11 shows the size frequency of mussels taken from samples, while Figure 3.12 shows the size distribution of mussels across the bed.

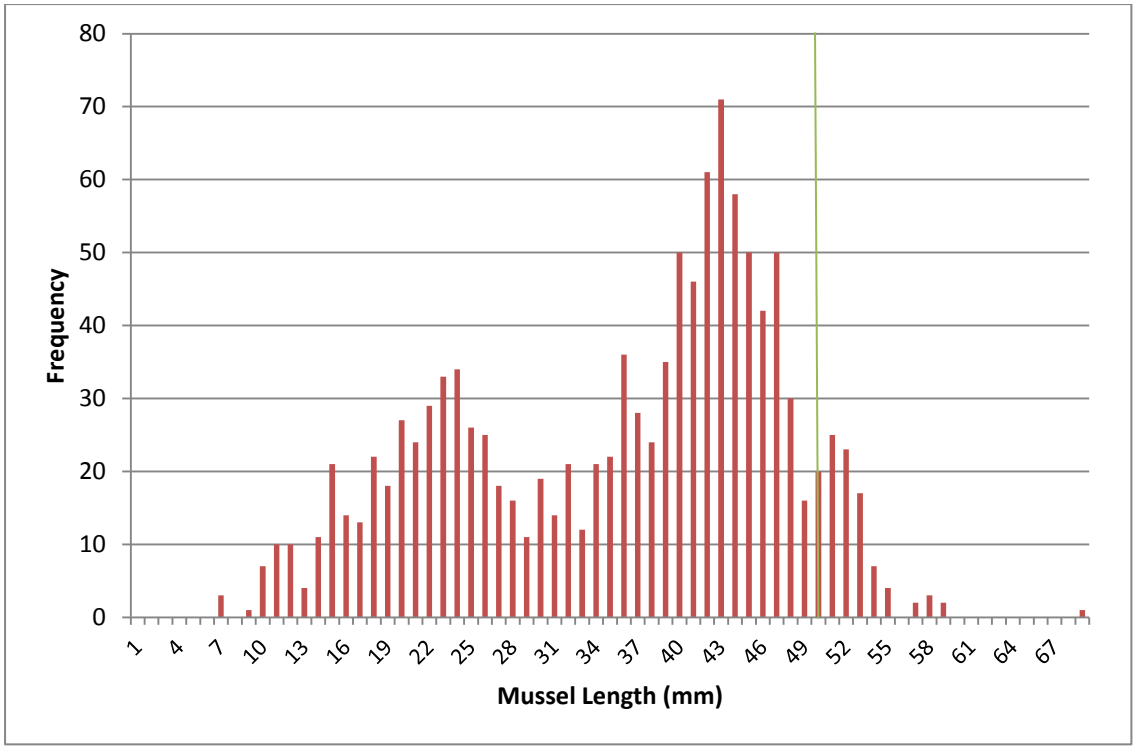

Fig. 3.11 Size frequency of mussels across the Pullys bed. The green line indicates the minimum landing size of 50mm.

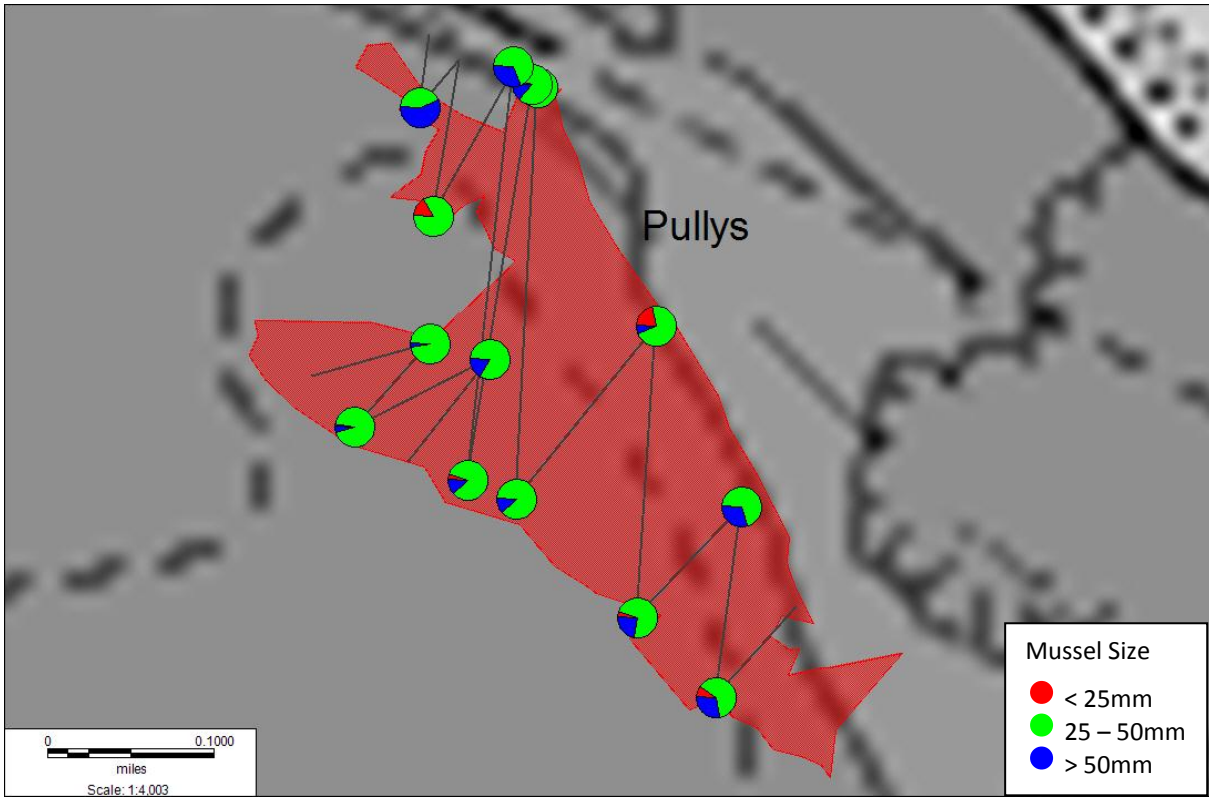

Fig. 3.12 Mussel size ratios, by weight, per transect across Pullys

3.6 Yelland

- Area: 1.5 hectares
- Coverage: 44%
- Mean Density: 4.21 kg/m^2
- Total Stock: 63 tonnes
- Stock ≥50mm: 46 tonnes

The Yelland bed was surveyed on January 23rd 2012. Samples were taken from every fifth "hit", producing 14 samples from 16 transects. The stock of marketable sized mussels was estimated to be 46 tonnes out a total 63 tonnes on the bed, i.e. 73%. Figure 3.13 shows the size frequency of mussels taken from samples, while Figure 3.14 shows the size distribution of mussels across the bed.

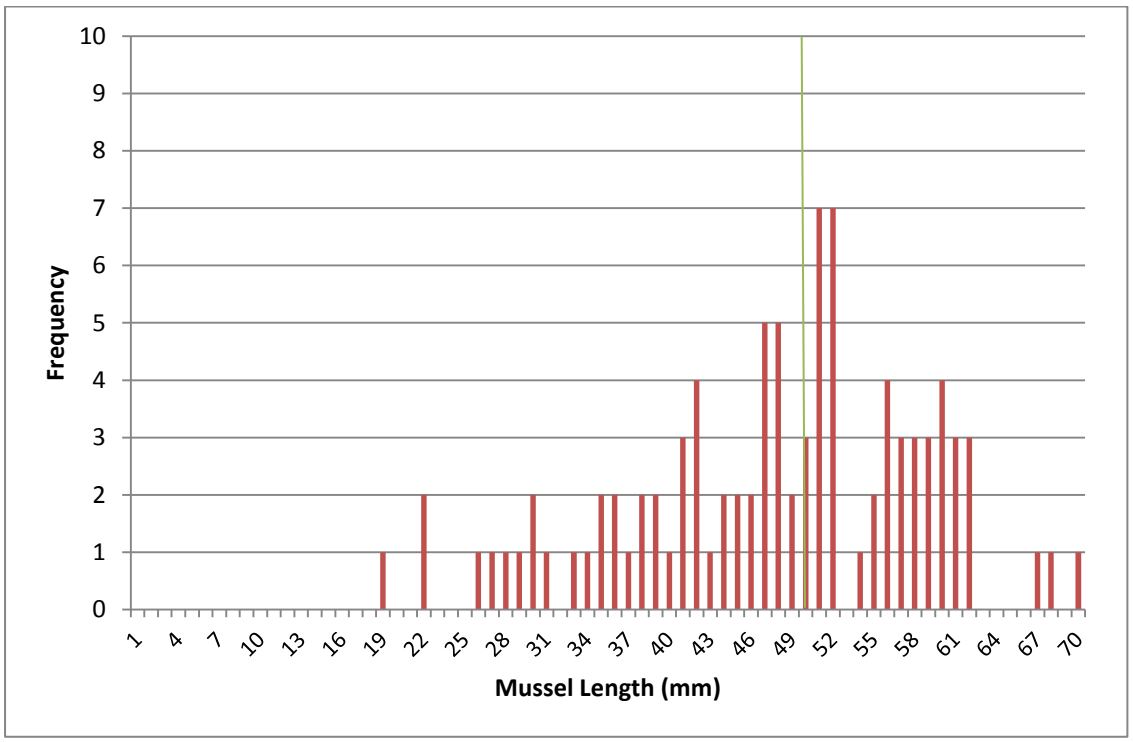

Fig. 3.13 Size frequency of mussels across the Yelland bed. The green line indicates the minimum landing size of 50mm.

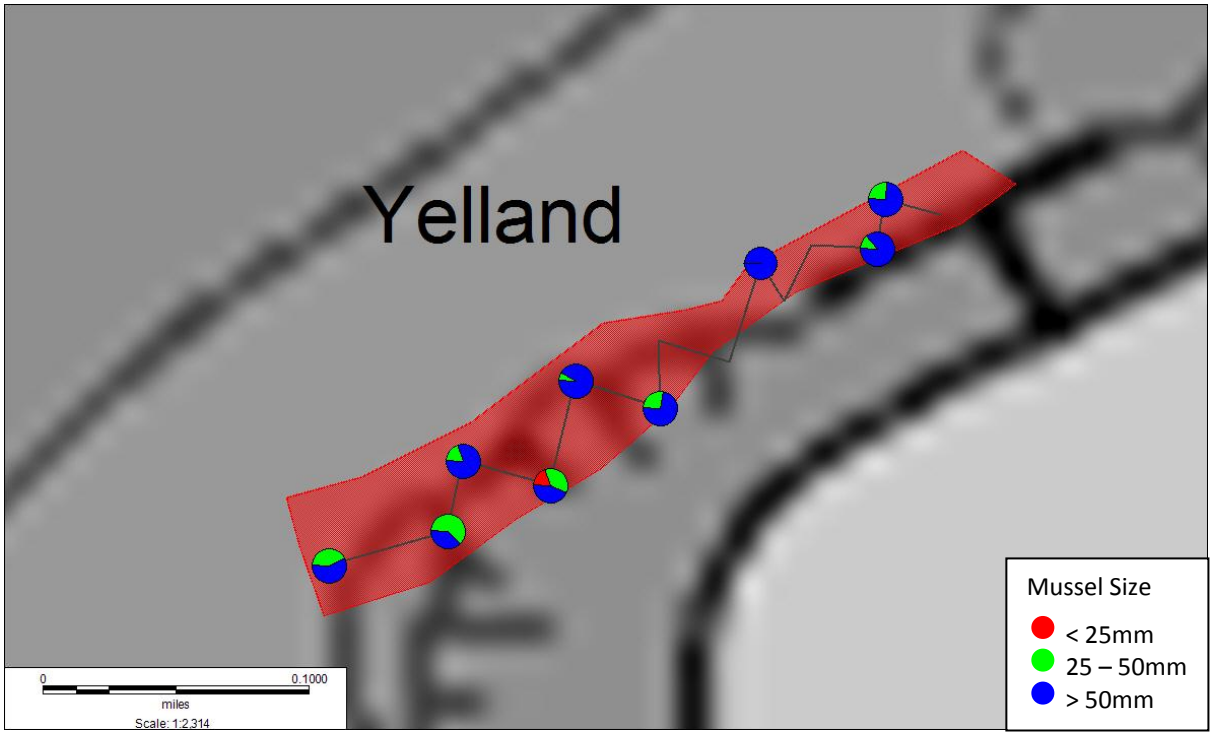

Fig. 3.14 Mussel size ratios, by weight, per transect across Yelland

Table 3.1 Summary of Intertidal Stocks

Bed	Area (hectares)	Total Stock (tonnes)	Stock ≥50mm (tonnes)
Coolstone Bed 1	7.4	364	78
Coolstone Bed 2	0.5	26	8
Coolstone Bed 3	0.6	12	1
Lifeboat Slip	1.0	53	7
Sprat Ridge	7.4	776	210
Sprat Ridge Far End	1.5	117	92
Pullys	13.0	936	159
Yelland	1.5	63	46
Total	**32.9**	**2347**	**601**

4. Discussion of Results

Whilst there is an estimated total of 2347 tonnes of mussel on the beds surveyed, this is not distributed evenly across the beds and there is great variation in mussel density and size distribution between beds (Table 3.1). Similarly, for the four beds surveyed in both 2001 and 2011 (Pullys, Coolstone, Sprat Ridge, and Yelland) there was an overall increase in marketable stock from 320 tonnes to 493 tonnes, but again there was great variation between beds (Table 4.1). All four beds showed an increase in area, with Pullys and Yelland both growing by around 40%, and Coolstone growing by approximately 20% (as well as the addition of Coolstone Beds 2 and 3). Sprat Ridge showed the greatest increase in area, growing from 1.8ha to 7.4ha, as well as the development of the Sprat Ridge Far End bed. Pullys and Coolstone both showed a decrease of around 30% of their total stock, but while Coolstone's marketable stock decreased by 63%, Pullys' marketable stock increased from 40 tonnes to 159 tonnes. Sprat Ridge showed an increase in stock of approximately 500%, with the marketable stock increasing by just over 400% (Table 4.1). While Yelland's stock grew by just 5%, but with a 50% increase in marketable stock. Sprat Ridge was the only bed where mussel density remained the same; all others showed a significant decrease. There was little variation in coverage on the beds, except on Yelland which fell from 73% to 44%.

Table 4.1 Differences in bed composition between 2001 and 2011

	Coolstone		Sprat Ridge		Pullys		Yelland	
Year	2001	2011	2001	2011	2001	2011	2001	2011
Area (hectares)	6.1	7.4	1.8	7.4	9.4	13	1.1	1.5
Coverage (%)	69	67	71	78	73	70	73	44
Density (Kg/m^2)	12.6	4.93	10.5	10.5	16.1	7.23	7.0	4.21
Total stock (tonnes)	530	364	130	776	1320	936	60	63
Marketable stock (tonnes)	210	78	40	210	40	159	30	46

Some of the variation in the amount of change on the beds between 2001 and 2011 may be explained by the way mussels are harvested from each bed. For example, the decrease in marketable stock on Coolstone may be due to the fact there is more harvesting on this bed than on Sprat Ridge and Pullys, and the harvesting is carried out by several different fishermen. Therefore, the bed is not likely to be sustainably managed. Although the Yelland bed is known to be well harvested, the stock levels did not change much. This could be because it is only worked by one fisherman who manages the bed so as to maintain stock for his markets.

It was noted by the surveyors that there are large areas of seed mussel, particularly on the Pullys and Sprat Ridge beds. However, this is not reflected in the survey results. This could be due to the methodology of only taking samples on every fifth hit, meaning that the seed areas did not necessarily get sampled. It is therefore recommended that a separate survey is conducted to map the seed mussel areas, and to monitor their development over the next few years.

Several of the beds show bimodal distribution of the mussel sizes; this is particularly evident on Pullys (Figure 3.11). This could be due to birds eating the mussels of a medium size (ranging from 25 to 38mm), which would support the theory that birds choose mussels of a size that is a compromise between minimizing shell ingestion and maximizing the energy gain from their food (e.g. Hamilton et al., 1999 and Nagarajan et al., 2002).

Throughout some of the earlier surveys there were discrepancies in the recording of the data. This meant that for some of the beds (Coolstone Bed 2, Coolstone Bed 3, and Lifeboat Slip) all the samples were pooled into one large sample. This meant that for these beds we were unable to accurately calculate the size distribution of mussels across the bed. To rectify this problem standard data recording sheets were developed and used on all the following surveys. This will also ensure that data is accurately recorded on any future surveys.

This survey creates a baseline of data for the Taw Torridge mussel stocks, and it is recommended that the survey is repeated annually to monitor any changes in the stock. It is also recommended that surveys be undertaken of the subtidal beds, using Acoustic Ground Discrimination Systems (AGDS) and grab samples to gain an idea of level of subtidal mussel stock. This would be especially useful in the Yelland area where it is known that a fisherman harvests the subtidal mussels.

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