Tamar Estuaries Marine Conservation Zone blue mussel bed survey 2016

Final report for the 2017 Tamar Estuaries MCZ blue mussel bed survey (20160619_CIFCA_MCZ_TAM_MBS)

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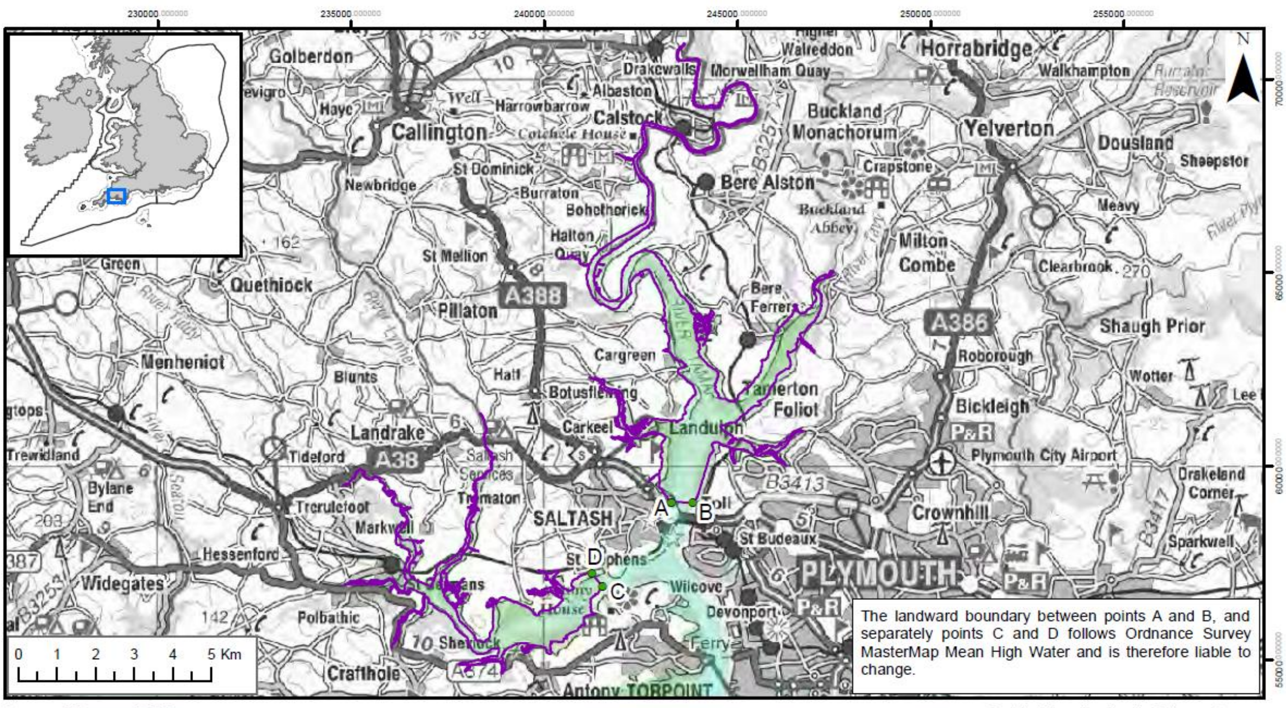
1 Introduction

The Tamar Estuary Sites Marine Conservation Zone (MCZ) was designated in tranche one of the MCZ designation process in 2013 (Defra, 2013). The site is split into two spatially separate areas (Figure 1); the Lynher estuary and the upper reaches of the Tamar, and is designated to protect the following features:

- Intertidal biogenic reefs
- Intertidal coarse sediment
- Blue mussel (*Mytlius edulis*) beds
- Native oyster (*Ostrea edulis*)
- Smelt (*Osmerus eperlanus*)

Biogenic reefs and blue mussel beds provide ecologically important refuge areas for a diverse array of species. Native oyster (*Ostrea edulis*) numbers significantly declined during the 20th century but this species is found in the MCZ. The estuary is also an important area for breeding smelt (*Osmerus eperlanus*), a shoaling estuarine fish. The Tamar Estuary Sites MCZ covers an area of approximately 15km^2.



Point	Lat	Long
A	50°24' 38.027" N	4°12' 25.189" W
B	50°24' 38.242" N	4°11' 56.585" W
C	50°23' 25.328" N	4°13' 51.340" W
D	50°23' 36.335" N	4°14' 6.272" W

Reference: Theme ID: 1477649
Map Projection: British National Grid

Figure 1: The boundary of the Tamar Estuary Marine Conservation Zone.

In 2014 and 2015 Cornwall Inshore and Fisheries Conservation Authority (IFCA) undertook scoping surveys to map the extent of the intertidal biogenic reef (shown in Figure 2) and asses its value as a mussel fishery resource (Cornwall IFCA, 2015). The results of these surveys indicated that the bed is of very low quality from a fishery point of view due to the single year class structure and high percentage of shell. The extent was similar to that identified by the 2010 Ecospan surveys (Curtis, 2010) with the bed extending further down the shore than expected. It was recommended that the survey be repeated annually to assess any changes to the extent of the bed and structure of populations over time.

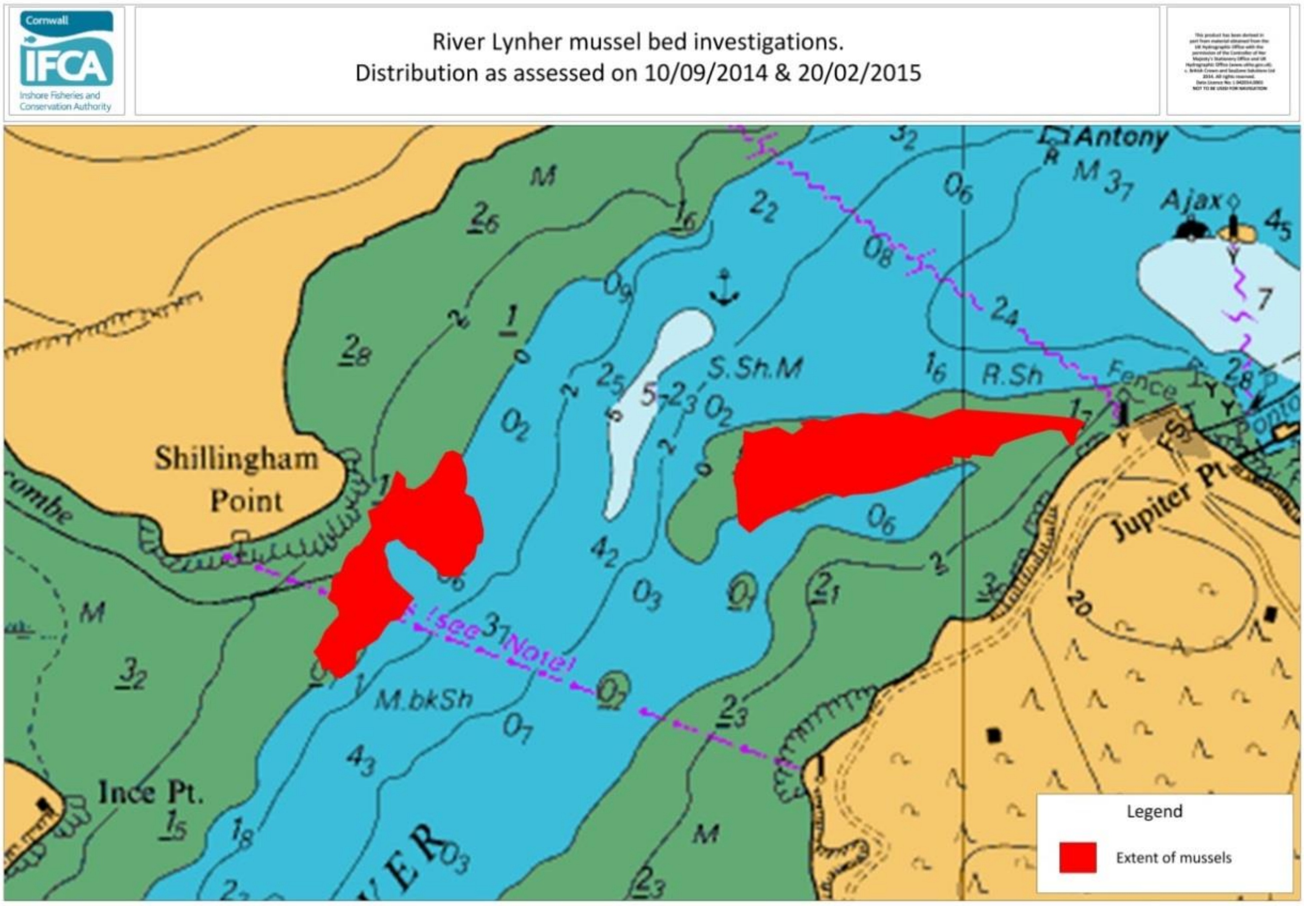


Figure 2: Mapped polygons of the Shillingham Point and Jupiter Point mussel beds. Mussel bed perimeters were walked with handheld GPS units and the resulting tracks were used to determine the extent of the intertidal beds.

1.1 Aims and objectives

1.1.1 Aims

- Monitor extent of the intertidal mussel beds in the River Lynher part of the Tamar Estuaries MCZ.
- Mussel stock assessment of mussels on the beds; density and size structure.

1.1.2 Objectives

- Repeat transects and collect samples to enable a fishery stock assessment of the mussels.
- Verify the extent of the mussel beds from stills images collected with a drone.

2 Methodology

2.1 Mussel bed extent

A drone was used to collect images to map the extent of the mussel bed. This was operated by Duncan Hine of Vertical Horizons Media. The survey areas were provided to Duncan who plotted flight paths for broad scale to cover the entire survey area and fine scale to cover Shillingham and Jupiter Points separately (Figure 3). The resultant survey flight path with planned image locations for the broad scale resolution and fine scale resolution are shown in Figure 4 and Figure 5 respectively.

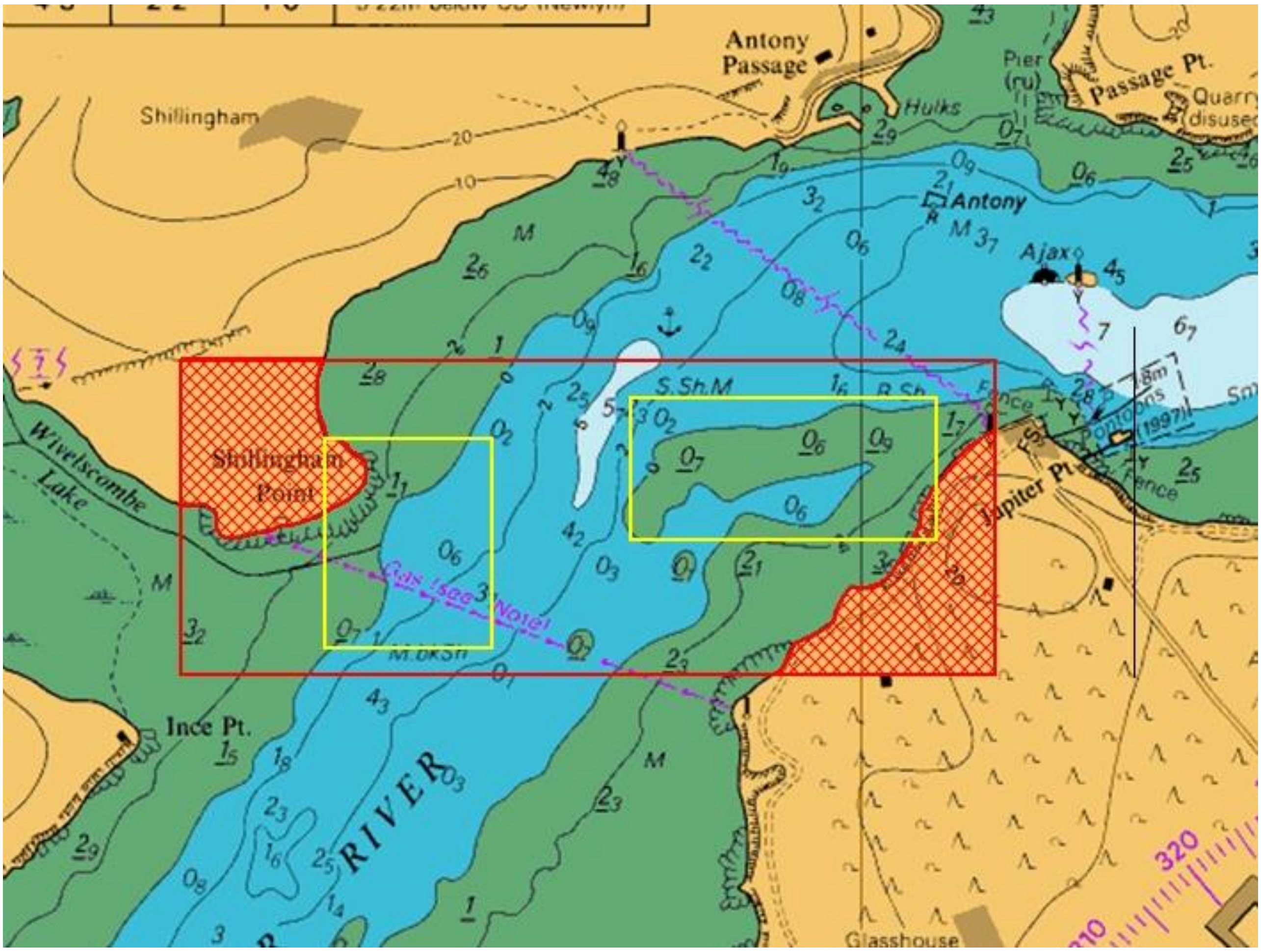


Figure 3: The two survey areas, Shillingham Point in the West and Jupiter Point (yellow) and broad scale survey area (red)

Figure 4: The pre-determined flight path showing individual camera locations for the broad scale flight by Vertical Horizons Media on 19th September 2016

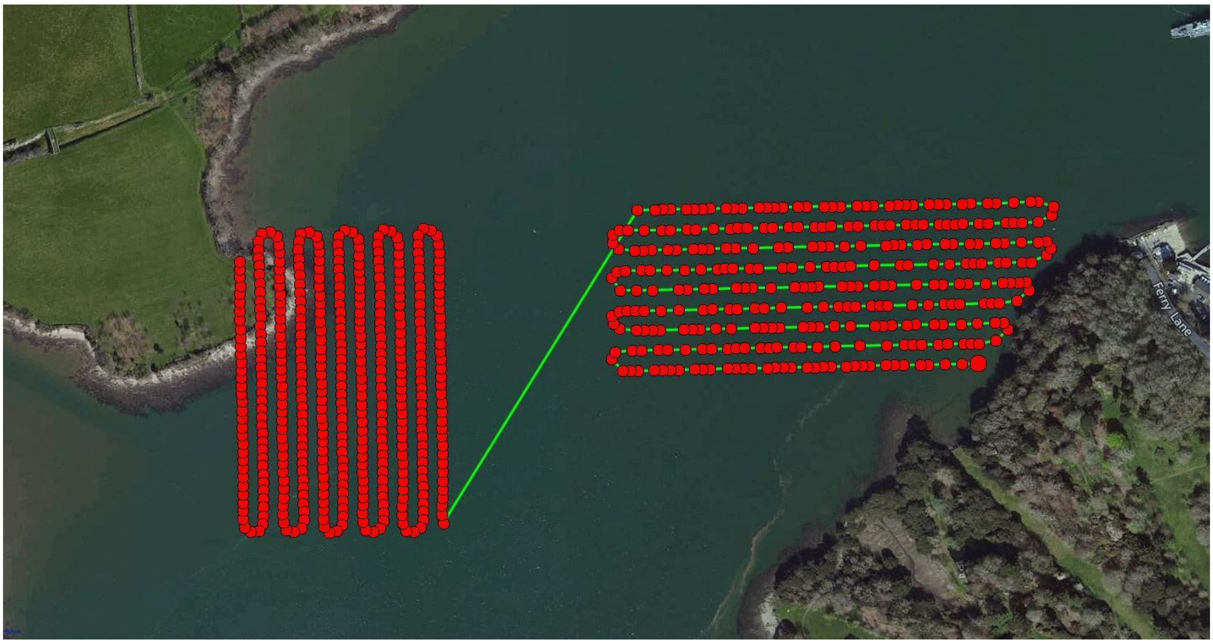


Figure 5: The pre-determined flight path showing individual camera locations for the fine scale flight by Vertical Horizons Media on 19th September 2016

The broad scale flight commenced 30 minutes before low tide and fine scale flights at low tide and 15 minutes after low tide.

2.2 Mussel bed fishery assessment

The intertidal mussel survey was conducted during daytime periods of low spring tide. This allows the lower beds to become fully exposed.

Officers used the same 'Dutch wand' methodology as employed in the 2015 survey, and followed the same transect lines to achieve optimum coverage of the beds and time series data. Handheld Global Positioning System

(GPS) were used to locate the same transects that had been previously surveyed. All positions used the WGS84 projection.

The method involved using a bamboo cane with a 110mm ring attached to one end in such a way that it rests flat on the sediment when the cane is held at approximately 45^{o}. Facing along the transect, place the ring on the mussel bed at approximately 90^{o} (out to the side). Walk forward until the ring is approximately 45^{o} behind. Lift the cane and move it to approximately 45^{o} in front of you; this point becomes your sample point. Walk forwards again until the cane points 45^{o} behind and repeat. At every sample point a second surveyor records whether it was a 'hit' (live mussel present) or a 'miss' (live mussel absent).This method was taken from Dutch marine consultants, MarinX, and previously used at Eastern Inshore Fisheries and Conservation Authority (Jessop *et al*., 2013).

Samples were collected every 3rd hit which was determined as the best sampling regime for this bed from previous surveys. Samples were collected using a 100mm ø, 150mm long corer twisted into the mussel bed. The samples were labelled and stored temporarily.

To process the samples, each sample was individually washed on a riddle (Figure 6). The live mussel was separated, individually measured and collectively weighted. The remaining shell (including any slipper limpets) was weighted. The method employed to assess the mussel stock is fully described in Annex 1.

Figure 6: Photo of Cornwall ICFA officer Kimara Street and work experience student (Bryony Jones) measuring the weight of live mussel and shell at Shillingham Point

Data was recorded in waterproof notebooks. It was then uploaded back in the office into a Microsoft Excel spreadsheet for analysis. GPS tracks were uploaded into MapInfo (Version 15.2) where they were overlaid onto charts to verify previous transects were accurately followed.

2.3 Native oyster stock

The presence of native oysters (*Ostrea edulis*) was noted but a detailed survey was not carried out.

3 Results

The foot surveys were carried out on the 19th September 2016 by two teams; the Jupiter Point beds were surveyed by IFCA Officers Colin Trundle, Hilary Naylor and Annie Jenkin, and the Shillingham beds were surveyed by IFCA Officer Kimara Street and Natural England Lead Adviser Angie Gall with assistance from a work experience student (Bryony Jones). Simultaneously the drone survey was conducted on the whole site, operated by Duncan Hine of Veritcal Horizons Media.

The low water for Jupiter Point was predicted to be 0.43m at 14:32 (UTC). Given the tidal prediction it can be considered that all intertidal mussels were visible and that any remaining mussel in the area is sub-tidal. As noted in other surveys it was apparent that the mussel bed does continue into the sub-tidal, although the extent of this is unknown.

3.1 Mussel bed extent

The drone flights were successful in obtaining aerial imagery of the mussel beds at both resolutions (Figure 7, Figure 8 and Figure 9).

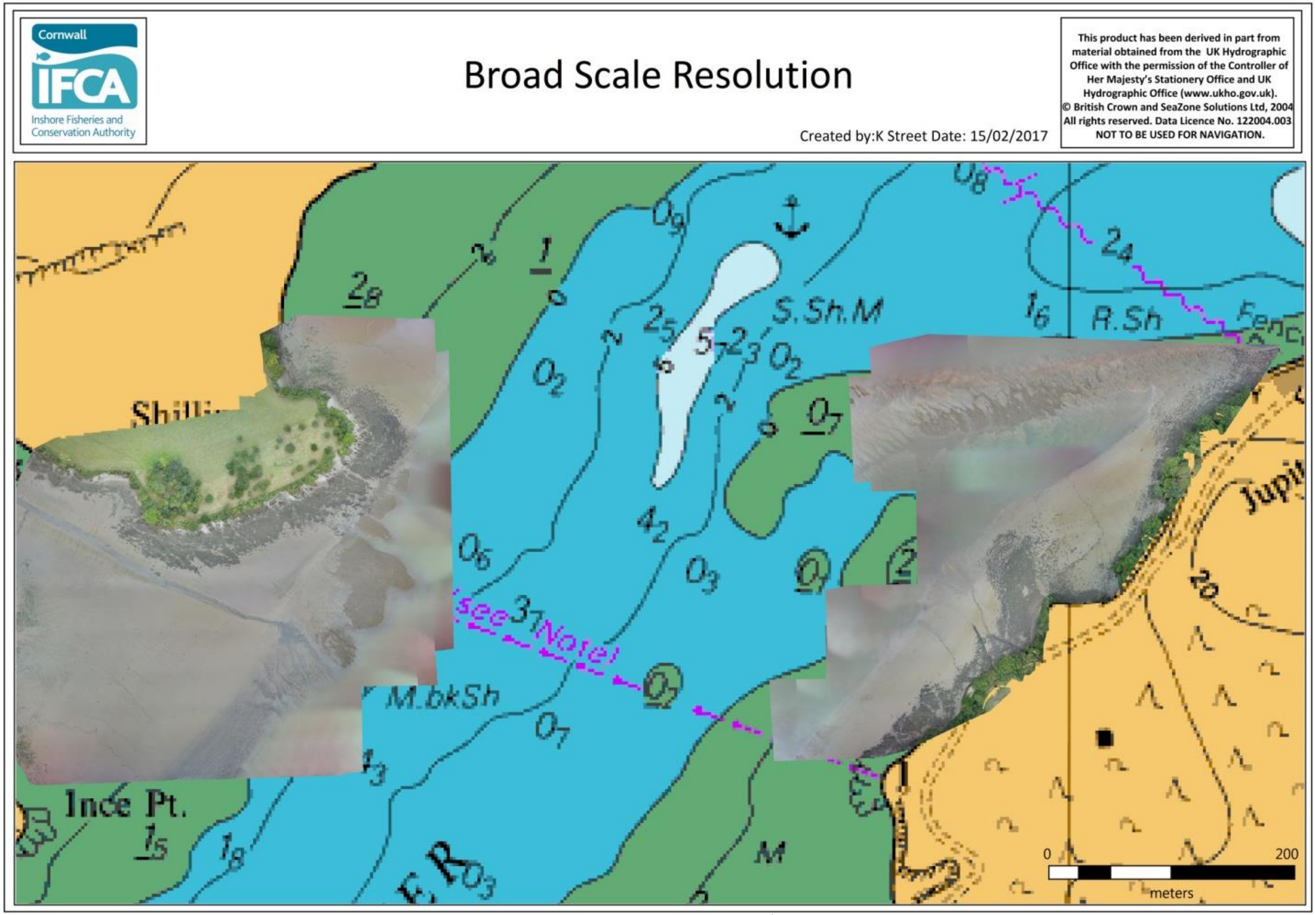


Figure 7: Results of the broad scale drone flight over the Shillingham Point Jupiter Point mussel bed on 19th September 2016.

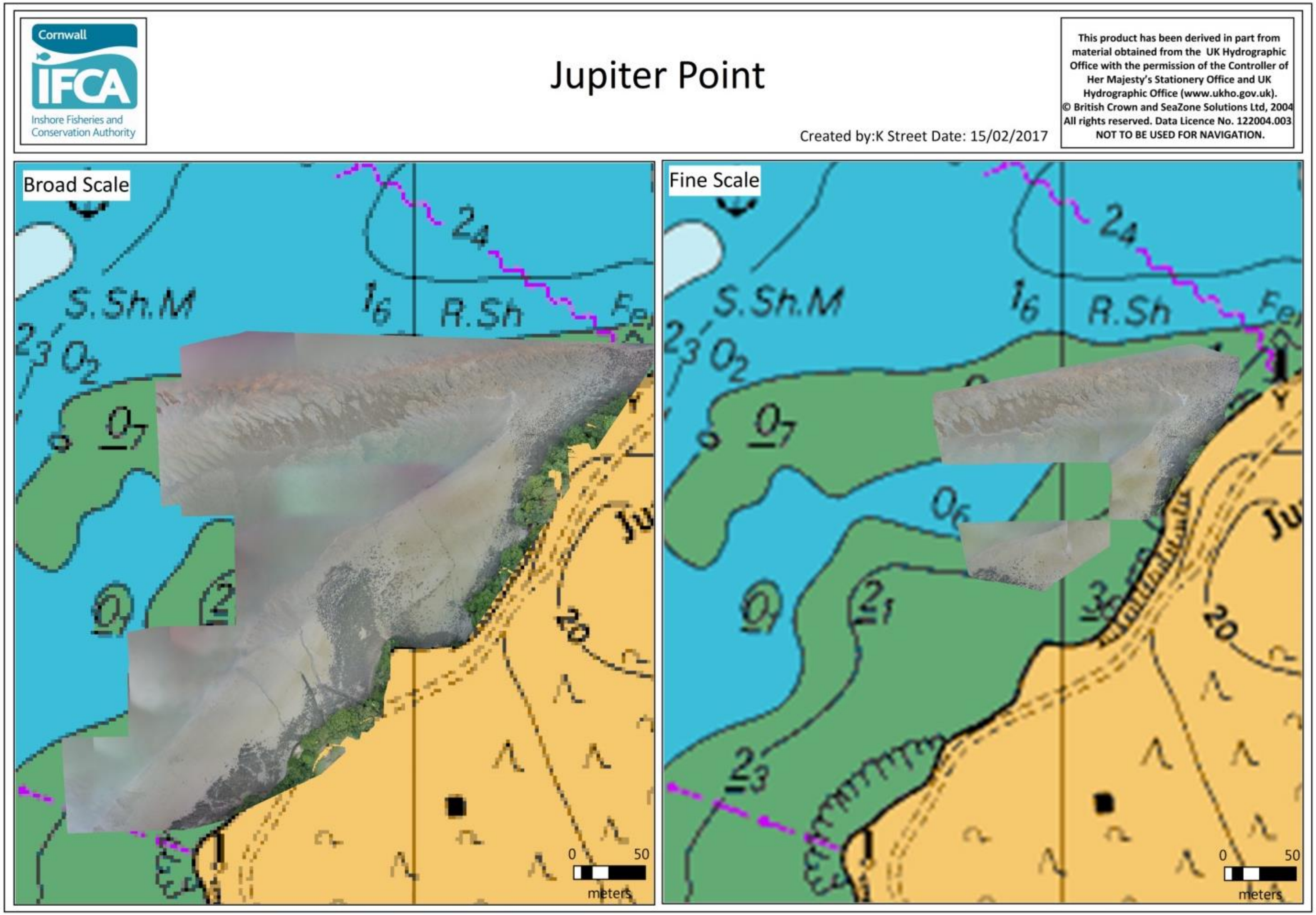


Figure 8: Results of the fine scale drone flight over the Jupiter Point mussel bed on 19th September 2016. The flight was conducted when the tide had turned and the bed was being submerged.

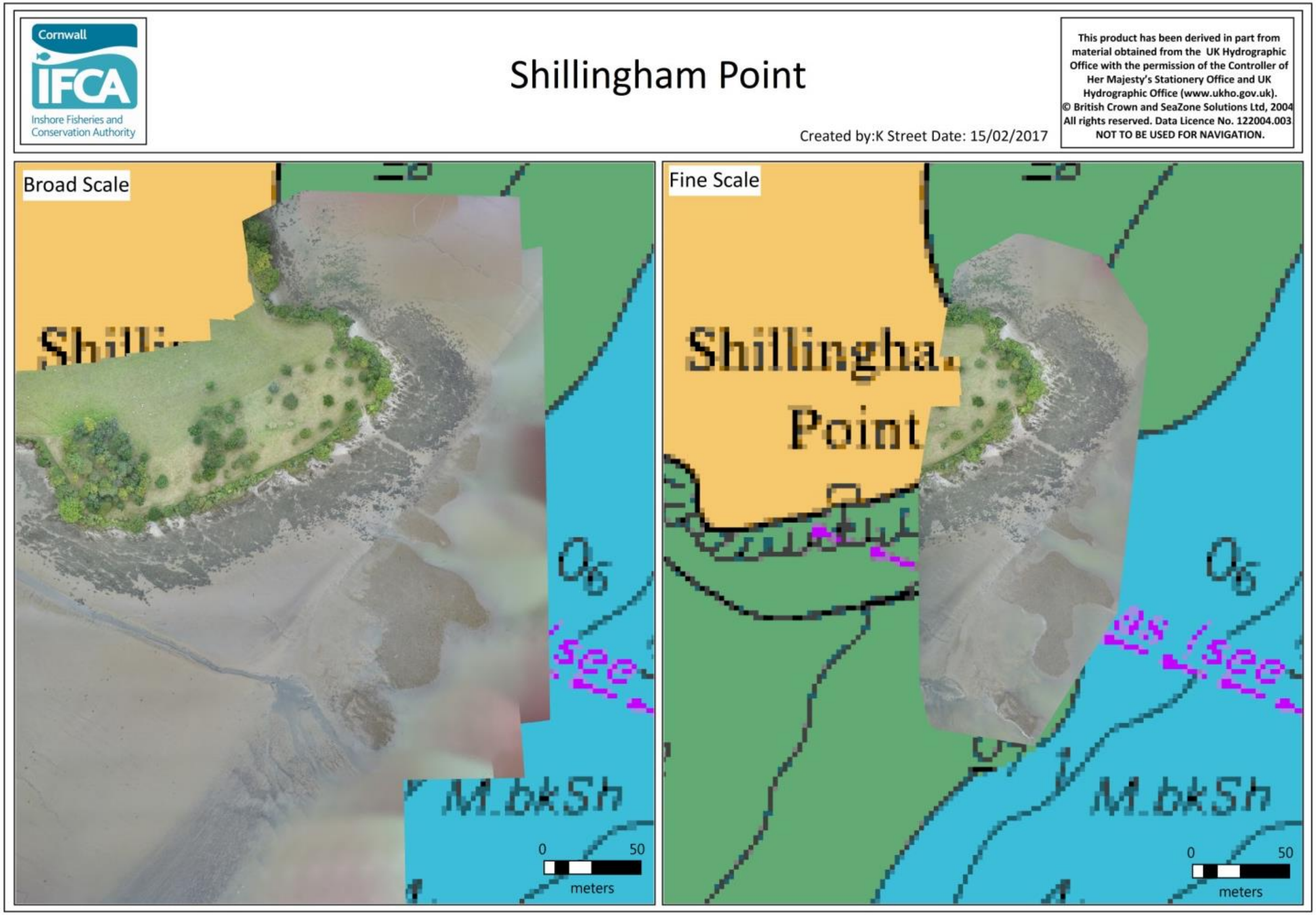


Figure 9: Results of the fine scale drone flight over the Shillingham Point mussel bed on 19th September 2016. The flight was conducted when the tide had turned and the bed was being submerged.

The broad scale images were of sufficient quality to identify the extent of the Shillingham Point bed and were captured when the tide was lower and therefore gave a better representation of the bed exposed on the day, therefore these images have been used to plot the extent (Figure 10).

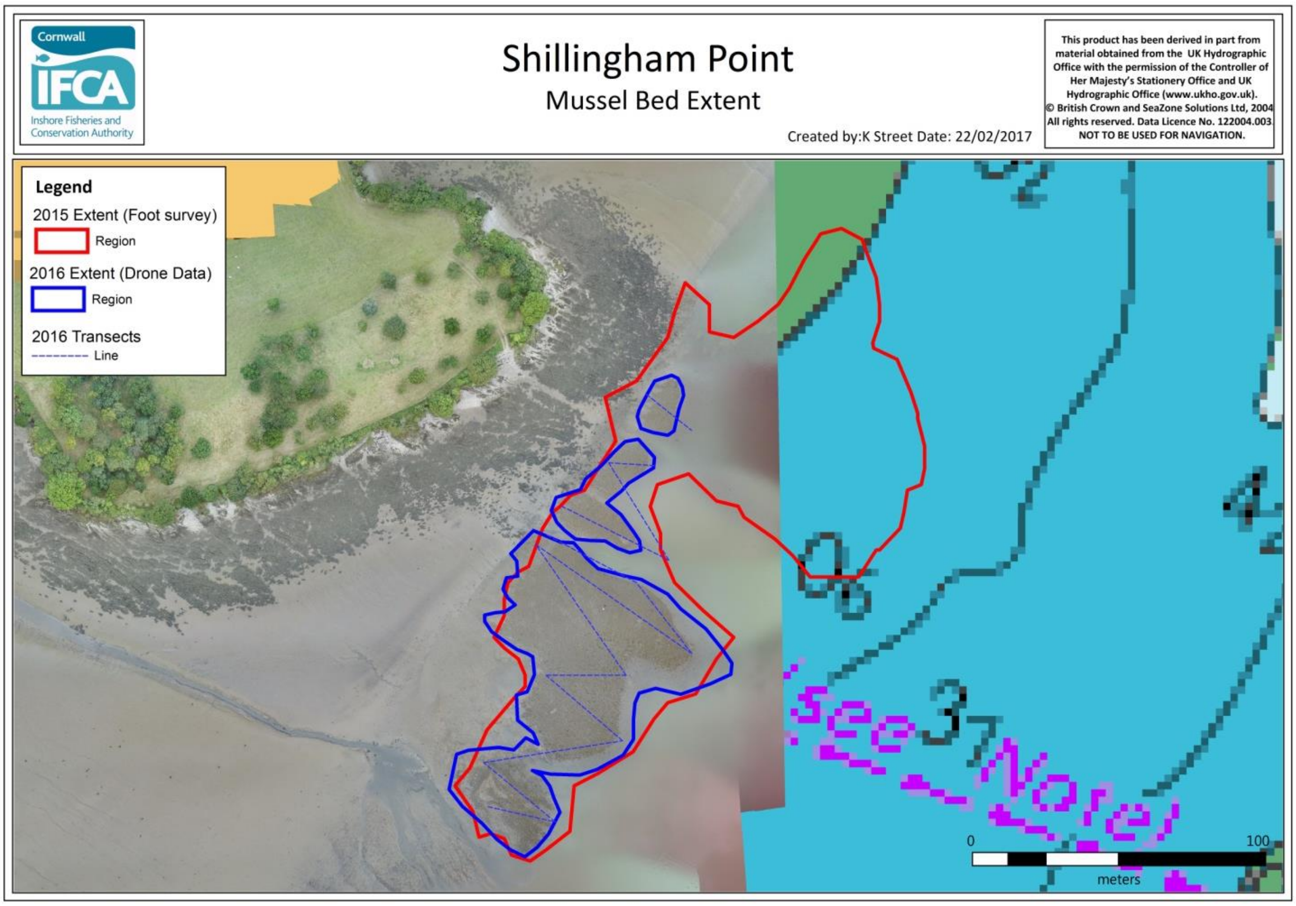


Figure 10: Extent of the Shillingham Point mussel bed. The extent is shown for 2015 (red) from a survey on foot and 2016 (blue) from a drone survey.

Due to the patchy nature of the Jupiter Point bed, a perimeter could not be depicted from the aerial imagery.

3.2 Mussel stock assessment

Initial observations were that the beds were largely similar to those observed in 2015 with a single year class structure and a high percentage of dead shell (Figure 11).

Figure 11: Example of the mussel bed at Shillingham Point which contained a large volume of dead shells and single size-class, large mussels (Photo: Bryony Jones/ Work experience student).

Based on 2016 transects, 13 transects were carried out at Shillingham Point and 11 at Jupiter Point (Figure 12).

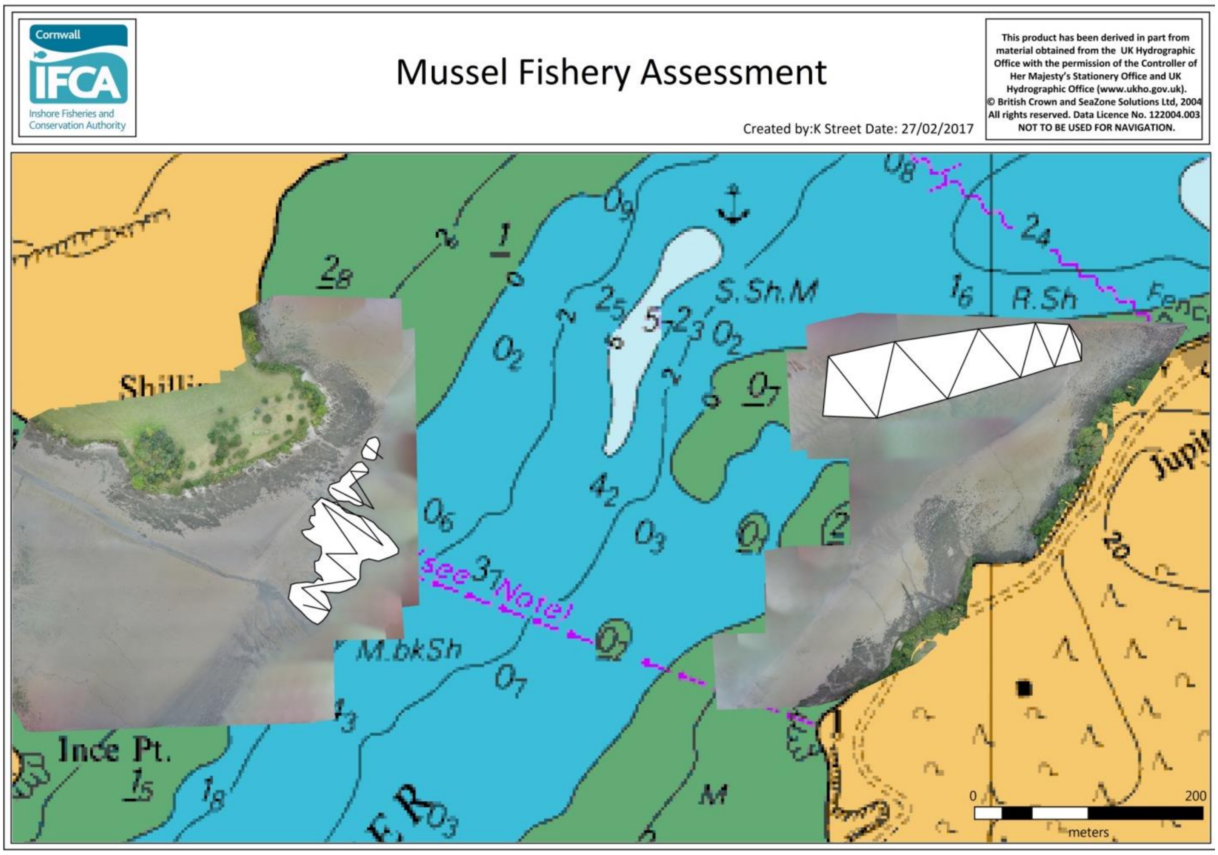


Figure 12: Mussel fishery assessment, showing the area used for the fishery assessment in white (defined by the aerial imagery at Shillingham Point, and by the edge of the surveyed area for Jupiter Point), and the survey transect lines.

The area of the Jupiter Point mussel bed is slightly larger than the Shillingham Point bed, 1.2ha and 0.55ha respectively (Table 1). However the stock availability on the smaller Shillingham Point bed is much larger, 19 tonnes, compared with 10 tonnes on the Jupiter Point bed due, in part, to higher mussel cover on the Shillingham Point bed, 44%, compared with only 10% on the Jupiter Point bed.

Table 1: Detailed information including area surveyed, percentage mussel cover (%), density in patches (m^2), density over whole bed (m^2) and total stock (tonnes) from a detailed survey carried out by Cornwall IFCA on 19th September 2016 at Shillingham Point and Jupiter Point.

	Shillingham Point	Jupiter Point
Area Surveyed	0.55 ha	1.2 ha[1]
Mussel cover	44% (52 hit, 65 miss)	10% (16 hit, 146 miss)
Density in patches	7.86 kg/m^2	8.34 kg/m^2
Density over whole bed	3.49 kg/m^2	0.82 kg/m^2
Total stock	**19 tonnes**	**10 tonnes**

3.3 Shell cover

At both sites, cumulatively the samples contained 33% live mussel, however they varied per transect at both sites; 10% to 47% at Shillingham Point (Figure 13) and 17% to 52% at Jupiter Point (Figure 14).

[1] Based on the area surveyed, not entire area of bed, see Figure 12

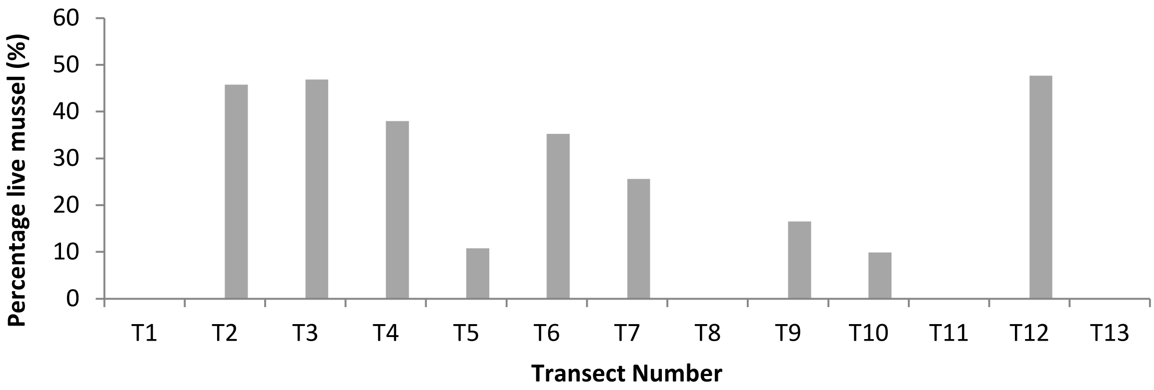


Figure 13: Percentage live mussel (%) in samples recorded at Shillingham Point during a survey on 19th September 2016

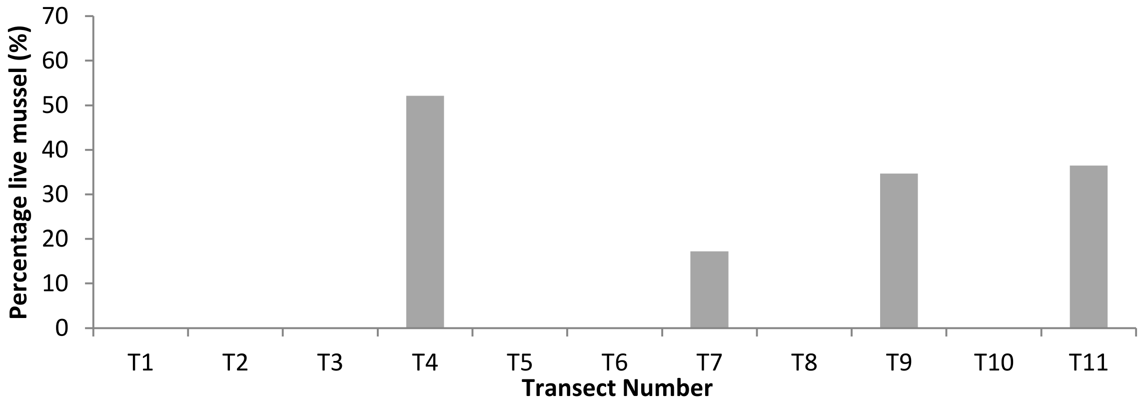


Figure 14: Percentage live mussel (%) in samples recorded at Jupiter Point during a survey on 19th September 2016

3.4 Mussel size and size/frequency distribution

At the Shillingham Point mussel bed a total of 36 mussels were collected in the samples, weighing 1.20kg. At the Jupiter Point mussel bed 10 mussels were collected, weighing 0.36kg. Given the low sample numbers the outputs should be treated with caution.

The average mussel length on the Shillingham Point mussel bed was 60.4mm (standard deviation 5.7) and Jupiter Point was 59.9mm (standard deviation 7.18) (Figure 15). The Shillingham Point mussels varied in size with a greater range from 39mm to 73mm, whilst the Jupiter Point mussels had a smaller range, from 45mm to 71mm (Figure 16). The majority of the mussels on both beds are adult mussel (>45mm), with very little spat and only two juvenile mussels present (38mm and 43mm) at Shillingham.

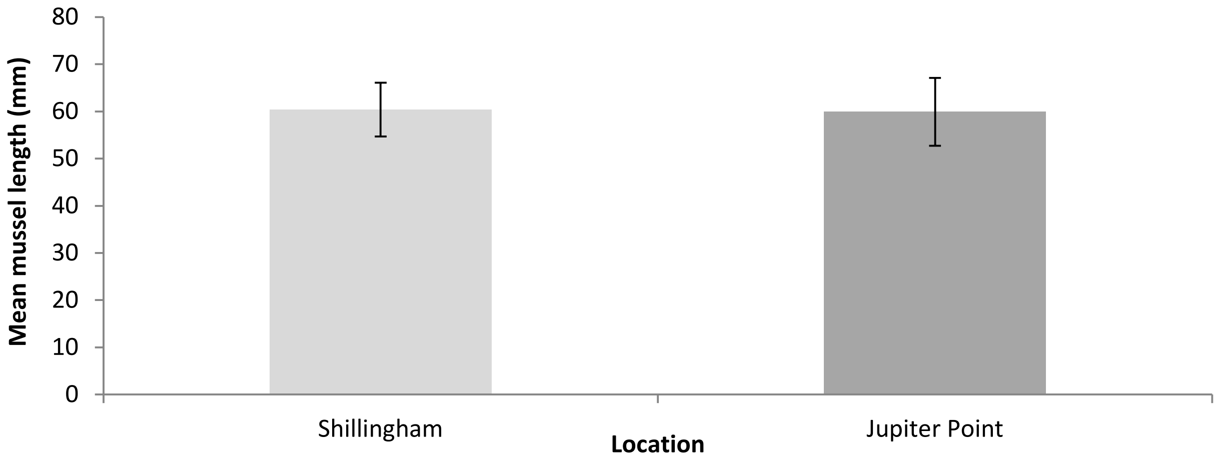


Figure 15: Mean mussel length (mm) of mussels sampled on the 19th September 2016 from the Shillingham Point and Jupiter Point mussel bed in the Lynher estuary.

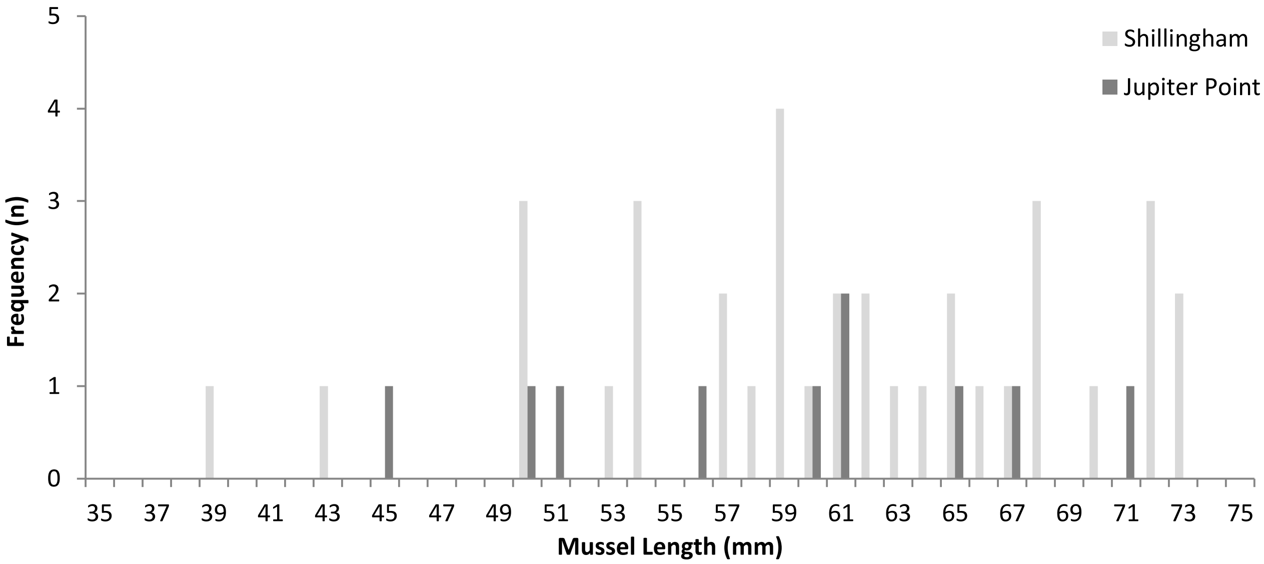


Figure 16: Size frequency distribution for mussels on the Shillingham Point and Jupiter Point beds, taken from samples collected on the 19th September 2016

3.5 Additional species and non-natives recorded

Surveyors noted several other species present on the mussel beds at Jupiter Point and Shillingham Point. Several non-natives species were recorded, as well as molluscs, sponges were common (including large sponge species like *Haliclona oculata*), algae, hydroids, bryozoans and crustaceans (Figure 17) including:

- Native oysters, *Ostrea edulis*,
- Pacific oyster, *Magallana gigas*
- Slipper limpets, *Crepidula fornicata*
- The sponge, *Haliclona oculata*
- An orange sponge, *Hymeniacidon perlevis*
- Red macroalgae indet.
- Hydroid and bryozoan turfs

Pacific oysters, *Magallana gigas*, were noted on both mussel beds. They were present as large individuals and very sparsely populated. No juveniles were observed on either bed.

Figure 17: Areas of mussel bed on the lower shore at Shillingham Point. The mussels are coated in bryozoans, hydroids and barnacles (Photo: Bryony Jones/ Work experience student).

4 Discussion

4.1 Mussel bed extent

Comparison with previous year's extents is difficult due to the differences in technique and tide height at time of survey; therefore no conclusions can be drawn as to any change in area.

The trial in collecting aerial imagery from a drone presented mixed success rates; for the shoreward side of the Shillingham Point bed the drone images were of suitable quality to identify the perimeter of the bed; however the patchier bed at Jupiter was difficult to map. Both the drone and previously used techniques have difficulties in identifying the seaward boundary of the beds as they both extend into the subtidal, and therefore are dictated by the tidal range on the day.

4.2 Stock assessment

As in previous surveys the mussel beds at Jupiter Point and Shillingham Point are of poor quality from a fishery point of view, with a high percentage of shell and the live mussel which appears to be dominated by a single year class.

For both beds, stock estimates are far less than the 2015 survey due to the smaller extent of the bed being surveyed in 2016. At Jupiter Point the percentage cover of mussels is far lower in 2016 than 2015 (10% and 34% respectively), this is likely to be because the area of the bed that was exposed at the time of survey is patchier than the full extent of the bed surveyed in 2015, and has therefore reduced the average. For Shillingham Point the density of mussels and percentage coverage of mussels is comparable to the 2015 survey, indicating very little change to the extent of the bed in this time.

Currently the beds are unclassified and therefore commercial exploitation is prohibited. Under current circumstances the bed conditions are not sufficient to make commercial exploitation economically viable.

4.3 Non-native species

Two non-native species, Pacific oyster (*Magallana gigas*) and slipper limpet (*Crepidula fornicata*), were found during these surveys. The surveys did not record the abundances of non-native species but serve as a record of the presence of these species on the mussel beds.

4.4 Recommendations

Due to the difficulties in establishing the lower extents of the mussel bed, it is suggested that a side scan survey conducted at high water may be more appropriate to establish the lower limits of the beds.

As commercial exploitation of the beds is currently prohibited it is unlikely that any changes to the density or extent of the bed are a result of fisheries activity. It is therefore suggested that annual surveys are not required; however the baseline that has been established in these surveys can be monitored against in the future.

5 References

Cornwall IFCA. 2015. Tamar Estuary Marine Conservation Zones blue mussel beds and native oyster scoping study. Cornwall Inshore Fisheries and Conservation Authority.

Curtis L.A. 2010. Littoral Biotope Survey and Condition Assessment of the Lynher Estuary SSSI:2010 Project :10-31 Report: ER 10-126. Ecospan Environmental Ltd. Plymouth.

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6 Appendices

Annex 1 - Mussel Assessment Method

Equipment

- Handheld GPS
- Approximately 1.2m bamboo cane with an 110mm ring attached to the end (so that the ring sits flat on the ground when the cane is held out to one side)
- Sample corer (made from a 150mm length of the same pipe as the ring therefore the same diameter as the ring)
- Riddle
- Container /bucket
- Electric Scales
- Recording sheets on waterproof paper; 10x 15 grid and shell length table

Field Method

1. Identify the perimeter of the bed; use the handheld GPS to mark waypoints around the perimeter.
2. To measure coverage and patch density assign transect lines through the bed to provide optimum coverage through the bed. *Note: transect lines do not need to be the same length as the spreadsheet can account for this later.*
3. Decide roughly how many samples to take from the bed; this will dictate how often you take a sample. For example; one sample to be taken on every 7th hit, or on smaller beds where there will be less total hits, one sample to be taken ever 2nd hit.
4. Ring method for transect lines:
    a. Identify your transect line with either a bearing or a fixed position to walk towards. Mark a waypoint of the start of the transect and the bearing (if you want this level of data)
    b. At the start of your transect line stand with the bamboo cane out to your side at a 90° angle, with the ring flat on the ground. As you start to walk along the transect line maintain the position of the ring on the ground until the cane is at a roughly 45° angle behind you (at this point you can feel the cane start to tug) then 'flick' the ring forwards to approximately 45° in front of you. Continue walking at a steady pace until again you feel the cane tug slightly as the ring is 45° behind you then repeat the flick forward, repeat the process along the transect line. There should be roughly a 1.8 - 2.0m spread between the points where the ring lands.
    c. As the ring is placed on the ground an assistant will record whether it was a *hit* or a *miss* within the ring area. A *hit* is recorded when there is one or more mussels within the ring, or if a mussel is partially in the ring it is a hit if more than 50% of the mussel falls within the ring. A *miss* contains no live mussel.
    d. For recording data, use the 15 X10 grid on waterproof paper. A *miss* is recorded with a strike '/'. A *hit* is recorded as a number, starting at 1, and then increasing by one until the sample station is reached (as predetermined in point 3.)
    e. When a sample is needed to be taken place the corer in the same spot that the ring was. *Twist* the ring into the mussel bed (*twist* rather than push so that any mussels falling slightly in or out of the area will naturally move into or out of the sample, rather than being pushed into the mud out of the sample).
    f. All of the mussels within the corer are placed in the bucket as a sample as well as any shell. All samples from one transect can be collected together, as the totals can be calculated for the whole transect line, or pool samples from all transect lines to reflect the whole bed.

Example recording sheet where a sample is to be taken on every 5th hit, after the sample is taken on the 5th hit the next hit is recorded at 1 again. Identify the sample hits by circling them to make it easier to see when counting the samples.

/	/	/	1	/	2	3	4	/	5
/	1	/	/	2	/	…	…	…	…

5. Continue the method in point 4 for each transect until all transects are completed.
6. Use the riddle to clean the mud off the sample as best as possible.
7. Separate the shell from the live mussel.
8. Measure the length of each mussel and record on the recording sheet. Separate the mussels under 25mm and over 25mm.
9. Weigh and record, in grams, the:
   a. total shell
   b. mussel under 25mm
   c. total mussel

Data analysis Method

1. Enter the waypoints from the GPS into MapInfo to create a polygon of the area and calculate the area of the bed (ha)
2. Enter all of the data in to the mussel survey spread sheet; the yellow boxes indicate where data needs to be entered. The following data needs to be entered in the relevant fields:
   a. Diameter of ring
   b. Area of bed (ha)
   c. Weight of mussels in samples (whole sample weight, <25mm sample weight, and shell weight).
   d. Number of samples taken in transect
   e. Number of hits in transect
   f. Number of misses in transect

If the samples were not divided into separate samples treat as one transect, otherwise enter the data for each transect.

3. The spreadsheet will then automatically calculate the % coverage, patch density, overall density and tonnes of stock.