Annex A **Solway Subtidal Mussels Sonar Survey April 2021**

using Side Scan Sonar and Hamon grab sampling

1. Background

Historically there has been a subtidal dredge mussel fishery in the Silloth Channel in the Solway, and although the fishery is not regular, when it has occurred it has been important for local boats who prosecute a range of fisheries. In the past this fishery was managed by Cumbria Sea Fisheries Committee.

In recent years the legislative framework for managing fisheries within European Marine Sites (EMS) has changed. Due to the area being designated as an EMS and lying within the Solway Firth Special Area of Conservation (SAC), Upper Solway Flats and Marshes Special Protection Area (SPA) and newly designated Solway Firth SPA (SPA), the NWIFCA is legally bound to carry out robust Habitats Regulations Assessments (HRA) on all fishing activities. For the Solway subtidal mussel, this requires sound evidence and data, not only on the stock to be fished, but also the functionality of this mussel in order to identify whether it can be classed as Annex I reef. Understanding the nature and longevity of the mussel resource will inform decisions on whether to assign it protected blue mussel reef status.

To obtain this data, NWIFCA have developed a methodology which includes using side scan sonar (SSS) and ground-truth using a Hamon grab. The aim is to assign substrate types to specific signals of SSS data with high levels of confidence in order to reduce the necessity to ground-truth with grab samples. This will enable more rapid and effective evidence gathering in an area that is particularly problematic to survey subtidally (due to turbidity, currents and shallow waters), allowing a full description of habitats and how they develop each year to be made. It is expected that a number of surveys will be required over a timeframe (possibly 3 years or more) to build the evidence required.

2. Methodology

Equipment Used

- Tritech Seaking Towfish SSS with the data acquisition through Tritech Seanet Pro Software (version 2.24)
- Hamon Grab - 0.1m² sample area

Tide Selection

Data collection took place on the 21st April 2021 onboard the NWIFCA patrol and survey vessel North Western Protector. Neap tides were chosen to ensure the best chance of the least amount of current. This coincided with low wind speeds giving the coincidental flat water conditions.

To get the most from the limited amount of time and good weather conditions, work was carried out throughout the tides over low and high tides on the survey day.

Survey Plan

Based on previous work with the SSS in September 2019 and 2020 it was decided to use an 80m range and 160m swathe at 675Khz, which would require a towfish altitude of approximately 8m from the sea bed (10% of range). The transect line plan is shown in Annex A. Each transects is 1km in length with a spacing of 150m.

Data Collection

SSS data was collected approximately 1-2 hours either side of high water, and as the grab could be operated in higher current speeds than the SSS, samples were taken during periods when SSS transects could not be completed.

i. Side Scan Sonar

During deployment the vessel maintained a speed over ground (SOG) of 1.8 - 3 knots. The tidal current speed varied between 0.1 and 1 knot. The tidal current speed was recorded at the start of each tow. When current speed was higher the SOG of the vessel was reduced. Data was only collected towing into the tide to ensure the towfish was straight. The antenna for the GPS hemisphere is located on the centre line of the vessel above the wheelhouse. The layback was calculated to be negligible due to the towfish being setup on the bow of the vessel, the length of the cable and the location of the GPS hemisphere antenna. Data collection was not recorded until the start location of each tow line had been reached and the towfish was fully deployed and collecting data, which was fed directly through to a laptop set up in the dry lab onboard the vessel.

Data collected in September 2019 showed some loss on the edges of the swathe which officers hoped to correct by adjusting the sonar gains and contrast. Unfortunately this did not rectify the issue. Instead the range was reduced to 50m (100m swathe) in 2020 to try to ensure useable data was collected to the edge of the swathe. However in 2020 100% coverage was not achieved, leaving data gaps. Therefore for 2021 the range was reverted back to 80m (160m swathe).

The settings within Seanet Pro for the data acquisition remained the same for each of the tows and are as follows:

- Sonar Gain – 25%
- Contrast – 47dB
- Range – 80m
- Resolution - Ult
- Frequency - 675kHz

Six tows (twenty-three transects) were completed with details provided at Annex A. A number of transects were completed in one tow to make the best use of time.

ii. Hamon Grab Sampling

As SSS data was collected, target locations for the hamon grab were identified from the live SSS waterfall data feed. Target areas were picked based on texture and hardness, with officers selecting a range of different textures and hardness from across the survey area.

North Western Protector was positioned over each target location. Due to the current a hand held GPS positioned at the stern of the vessel was used to record the location of the grab once it had hit the bottom. On retrieval the sample was assessed to see whether a full sample had been collected. A number of repeats were completed at each station to ensure a representative number of samples were collected. The number of repetitions depended on observations of the contents of the sample. If samples were similar in sediment and faunal types, fewer repeat samples were completed compared to those with differing sediment and fauna, or where the Hamon grab was not full. If the grab failed a number of times it was recorded as unknown and the vessel moved to the next target area.

The sediment type and fauna present was recorded for each sample, with mussel, *Sabellaria* ssp. and starfish present highlighted. A labelled photograph of each sample was taken.

Data Handling and Analysis

The processing software used was Coda Octopus GeoSurvey (version 7.3.2). As Seanet Pro records the data in a .V4LOG format, and Geosurvey cannot read this file format, all of the files were converted into .xtf format. Tritech Seanet DumpLog (version 2.29) program was used for the conversion of the file format.

The .xft files were loaded into Geosurvey. The first tow was played back in the waterfall display. Image enhancement was applied inverting the grey scale to give white as high and black as low backscatter. The data was scaled using auto scale to achieve the best image. Time varying gain was applied to increase the

gain at the outer edges of the swathe. Once the best image was achieved the settings were saved and applied to each of the tows. Seabed detection (identification of the seabed from imagery) was completed manually for each of the tows.

All the tows were loaded into the Mosaic window. Navigation smoothing was applied to all tows. The tows were layered from land in a north-westerly direction giving the best image. The image was exported as a north up geotiff, at a resolution of 2 pixels per geographical metre. The geotiff was loaded into mapping software MapInfo version 2019.3; the geotiff is georeferenced.

Data Acquisition

Twenty three transects were completed in six tows.

Eighty-six grab samples were completed from twenty-seven target areas.

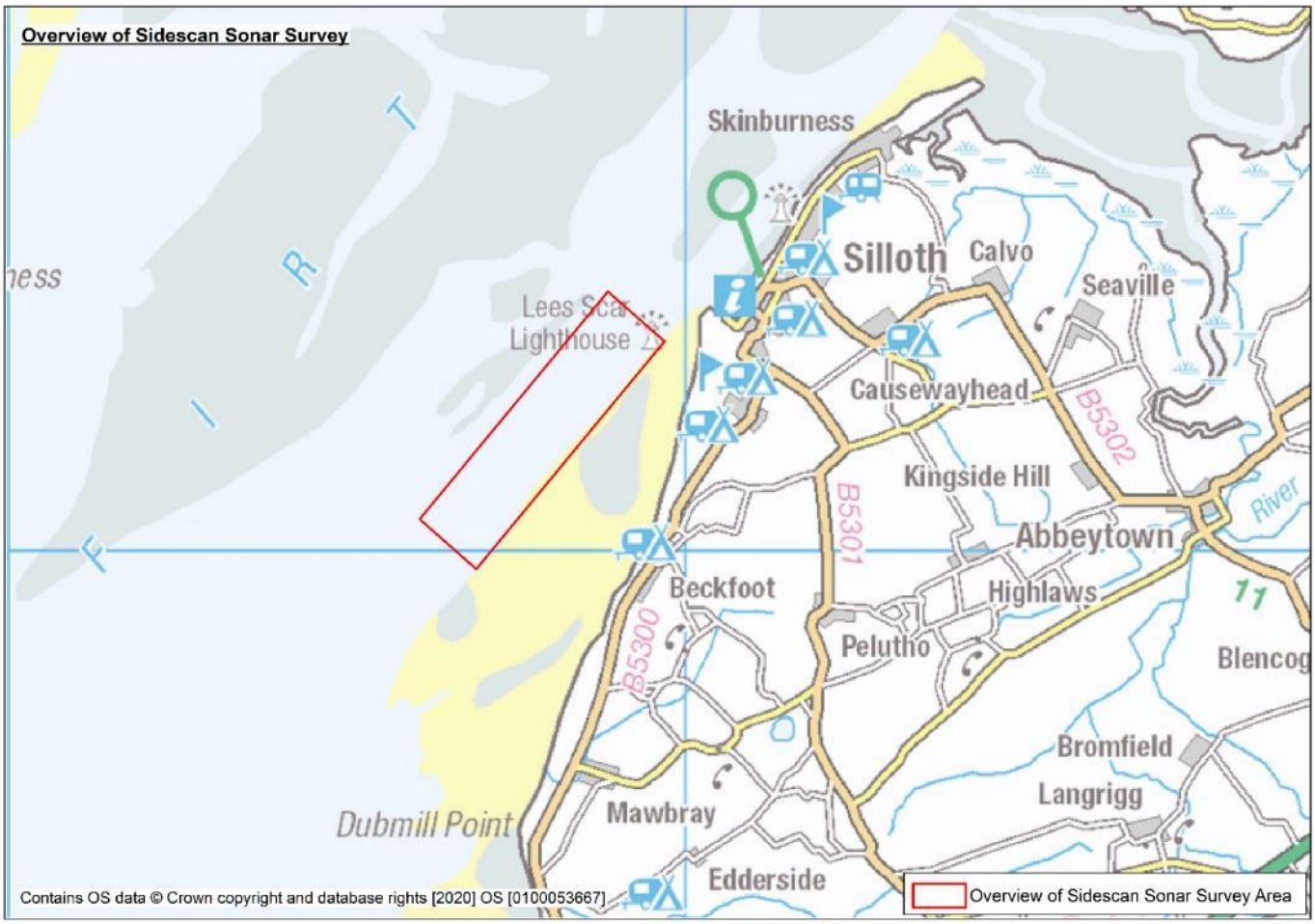

Figure 1 – Overview of the area covered by the SSS survey April 2021.

3. Results

Figure 1 shows the area surveyed and its location in relation to coastal features. Figures 2 to 4 show images of the SSS data collected. From the SSS data a number of target areas where created to ground-truth. These are shown in Figures 2 to 4 by boxed areas. A number of boxes are larger to include the overlap of target areas and to include samples that had increased distances between them due to tidal conditions when deploying the hamon grab. Boxes 1-10 (red) contained mussel and boxes 11-25 (green) did not.

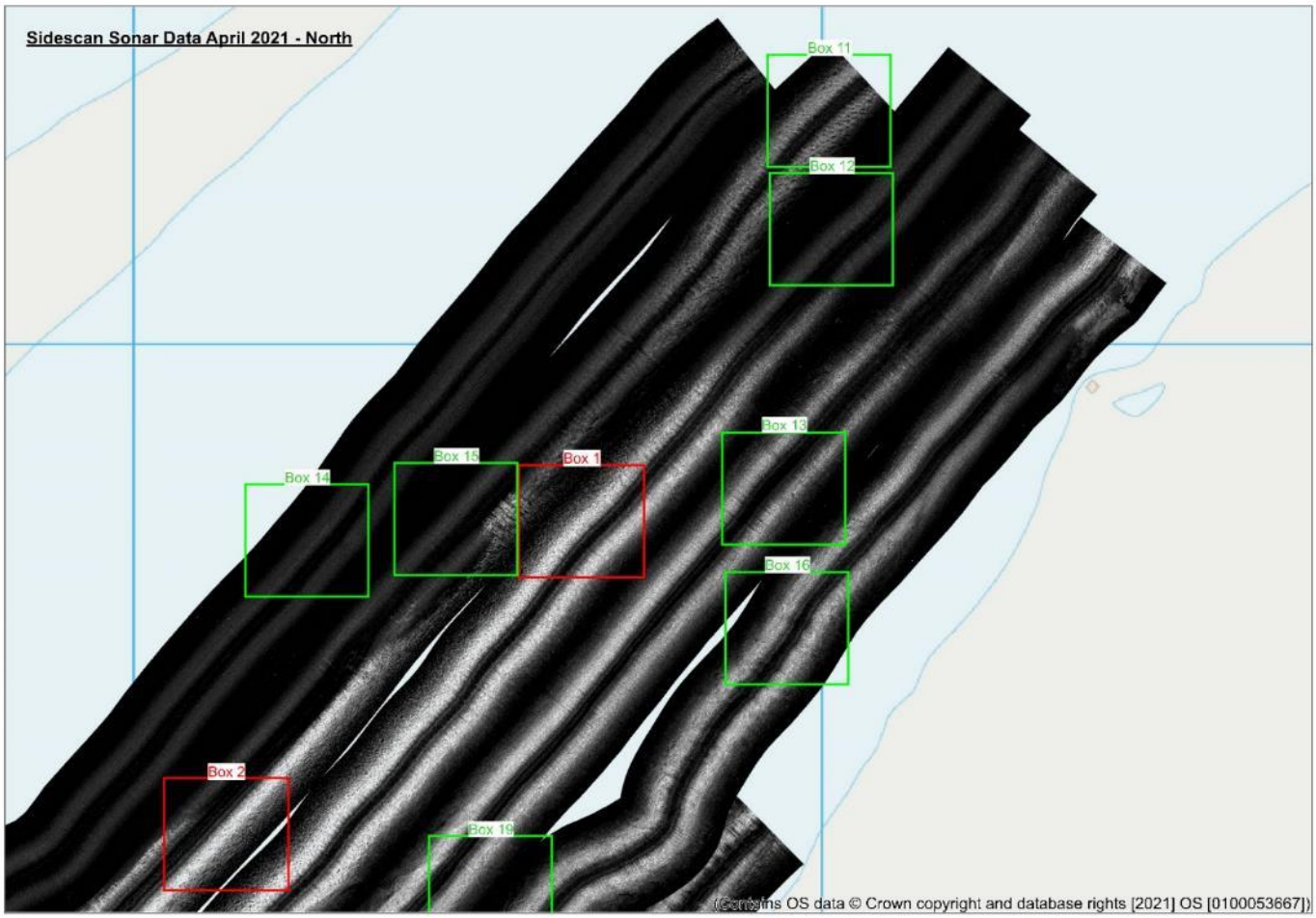

Figure 2 – Image of SSS data from the north of the surveyed area April 2021.

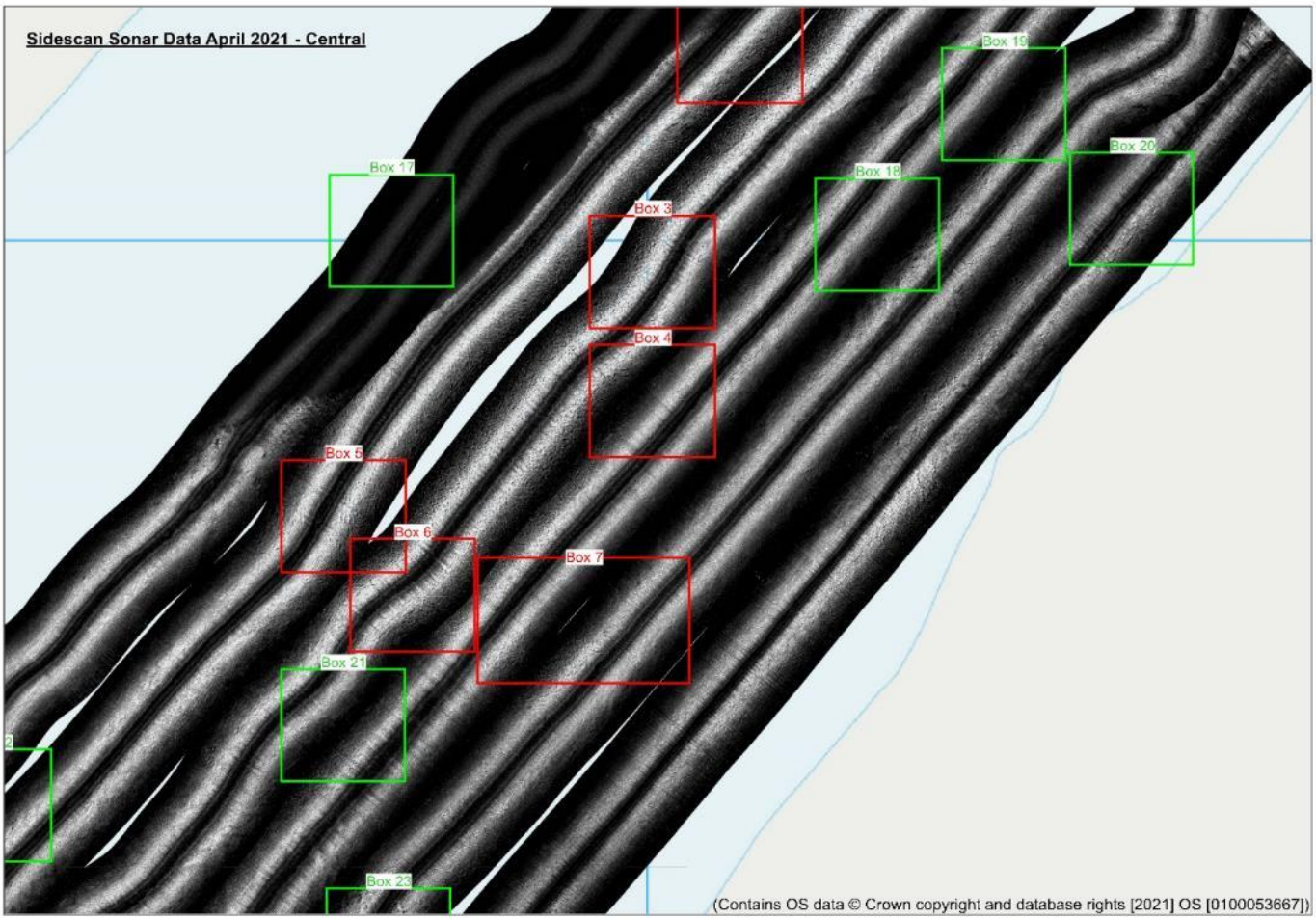

Figure 3 – Image of SSS data from the centre of the surveyed area April 2021.

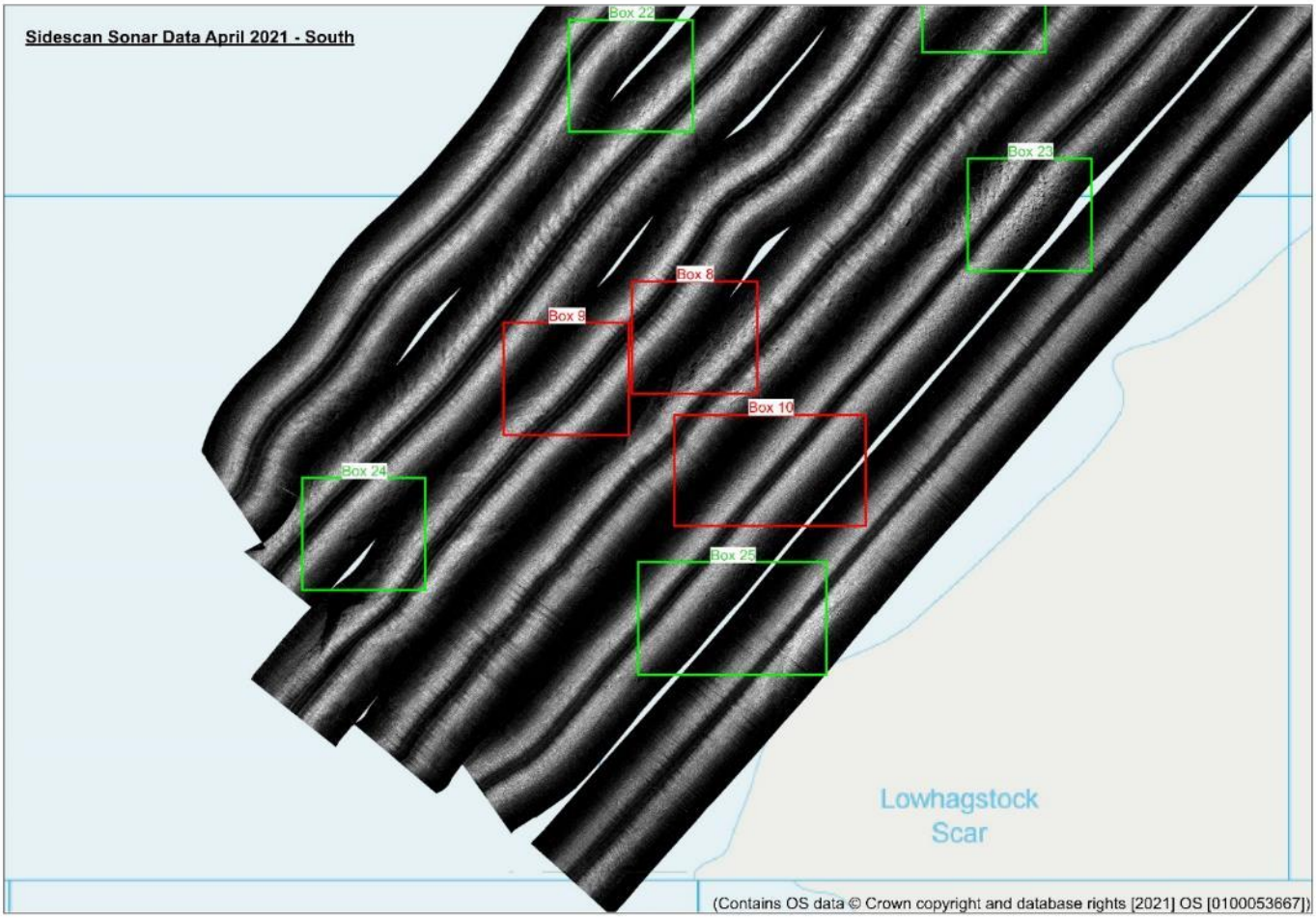

Figure 4 – Image of SSS data from the south of the surveyed area April 2021.

SSS Data

The data collected was of good quality with definition between hardness and texture which has allowed for the ground-truthing to take place. Unfortunately, although increasing the range to 80m (160m swathe), there are still some data gaps and 100% coverage of the area was not achieved. Also, processing of the data shows that the edges of the swathe are not showing data, resulting in lower coverage.

Grab samples

The grab samples contained a range of broad sediment types including mud, muddy sand, sandy mud, sand, mixed sediment, coarse sediment and cobble. In some areas the grab samples contained significant amounts of mussels as well as other species such as starfish and *Sabellaria* spp. In some areas it was not possible to obtain a successful grab sample, or collect any sediment in the grab, and these have been marked as unknown. It is likely that these areas contain harder compacted sediment types or rock. In total there were eight samples classified as unknown, shown in Figures 5, 7, 13, 17, 23 and 53.

Accompanying photos were taken of each grab sample. Unfortunately one photo was missing from box 24. Also, two photos are not available for box 25 as although the grab deployed correctly, no sample was obtained. It is likely that these areas contained hard, compact sediment types or rock.

Due to the fast currents, the time it took for the grab to hit the bottom and because 100% coverage was not achieved in the SSS data, some of the grab samples did not coincide with areas where there was SSS data. The data has still been included in the mapping although no corresponding SSS data is available (Box 22 – Figure 47).

i. Mussel

Figures 5, 7, 9, 11, 13, 15, 17, 19, 21 and 23 show higher magnification images of the SSS data around the areas where mussel was present in the grab samples from Boxes 1 to 10. Figures 6, 8, 10, 12, 14, 16, 18,

20, 22 and 24 show the contents of the grabs. Table 1 shows a summary of the sediment and condition of the mussel for samples within Boxes 1 to 10. Twenty-four samples contained live mussel. The mussel was present on a range of broad sediment types including mud, sand, mixed sediments and coarse sediments. Some samples recorded as unknown in boxes 1, 2, 5, 7 and 10 (Figures 5, 7, 13, 17 and 23) only contained mussel and no substrate; it is probable that the mussel here was on harder compact ground. The size of the live mussel was recorded and ranged from 10 to 70mm with the majority being either 10-20mm or 50-70mm. The mussel was typically clean and free of any fouling and loose with no byssal threads.

Table 1 – Summary of the substrate and condition of mussel in Boxes 1 to 10.

Box	Sample	Broad Sediment Type	Live Mussel	Size Class of Mussel (mm)
1	R1	Sand and Sandy Mud	Y	50-60
	R2	Sand and Sandy Mud	Y	50-60
	R3	Unknown	Y	50
2	V1	Sand and Sandy Mud	Y	50-70
	V2	Unknown	Y	60
	V4	Sand and Sandy Mud	Y	60-70
3	Q1	Mud and Muddy Sand	Y	50-60
	Q3	Mud and Muddy Sand	Y	50-70
	Q4	Coarse	Y	50-70
4	K1	Mixed	Y	50
5	W2	Unknown	Y	60
	W3	Sand and Sandy Mud	Y	50-60
6	P1	Sand and Sandy Mud	Y	50-60
	P3	Sand and Sandy Mud	Y	50-60
7	J2	Unknown	Y	50
	G8	Mud and Muddy Sand	Y	50
8	I1	Coarse	Y	15-20
	I2	Coarse	Y	15-20
	I3	Mud and Muddy Sand	Y	15-20
9	N2	Sand and Muddy Sand	Y	10-20
	N3	Sand and Muddy Sand	Y	10-20
10	E1	Mud and Muddy Sand	Y	15-20
	E2	Sand and Sandy Mud	Y	10-20
	E4	Unknown	Y	10-20

ii. Starfish

Ten grab samples contained starfish, two samples in Box 8 (Figure 19) and Box 9 (Figure 21), and one sample in Box 3 (Figure 9), Box 6 (Figure 15), Box 7 (Figure 17), Box 10 (Figure 23), Box 13 (Figure 29) and Box 19 (Figure 41). Figures 10, 18, 20, 22, 24 and 42 show images of samples that contained starfish. As the Hamon Grab sample surface area is 0.1m² and the samples contained up to 3 large starfish, this could indicate a significant starfish presence in these areas.

iii. Sabellaria spp.

Twenty grab samples contained *Sabellaria* spp. tubes; eleven were historic tubes with no live S*abellaria* spp. polychaetes present and nine samples contained live specimens. A summary is provided in Table 2. (Where *Sabellaria* spp. has been classified as historic (dead) this is due to the tube structures being very degraded and worn, black in colour, appear to have been dead for some time and likely to have been under the mussel mud which was present). Five of the higher magnification mussel boxes contained evidence of *Sabellaria* spp. tubes. Boxes 5, 6 and 7 (Figures 13, 15 and 17) all contained one sample containing dead historic tubes; in Box 9 (Figure 21) all three of the samples contained dead historic tubes and one sample contained live

Sabellaria spp.; and in Box 10 (Figure 23) two samples contained live *Sabellaria* spp. Seven of the higher magnification non mussel boxes contained evidence of *Sabellaria* spp. tubes and three of these boxes contained live *Sabellaria* spp. Box 13 (Figure 29) contained three samples of live *Sabellaria* spp. and one sample contained historic dead *Sabellaria* spp. tubes; Boxes 16, 19 and 20 (Figures 35, 41 and 43) each contained one sample of historic dead *Sabellaria* spp. tubes; Box 21 (Figure 45) contained two samples containing dead historic *Sabellaria* spp. tubes; Box 23 (Figure 49) contained one sample with live *Sabellaria* spp and one sample with dead historic *Sabellaria* spp tubes; and Box 24 (Figure 51) contained two samples with live *Sabellaria* spp.

Table 2 - Summary of the substrate, condition of *Sabellaria* spp. and if mussel present.

Box	Sample	Sediment	Live Mussel	Sabellaria spp.
5	W1	Cobble	N	Dead
6	P2	Mud and Muddy Sand	N	Dead
7	J3	Mixed	N	Dead
9	N1	Cobble	N	Dead
	N2	Sand and Sandy Mud	Y	Dead
	N3	Sand and Sandy Mud	Y	Live and Dead
10	E3	Unknown	N	Live
	E4	Unknown	Y	Live
13	M1	Mud and Muddy Sand	N	Live and Dead
	M2	Mud and Muddy Sand	N	Live
	M3	Mud and Muddy Sand	N	Live
16	A4	Sand and Sandy Mud	N	Dead
19	B3	Mud and Muddy Sand	N	Dead
20	F3	Mud and Muddy Sand	N	Dead
21	O2	Mixed	N	Dead
	O3	Mixed	N	Dead
23	D1	Coarse	N	Dead
	D2	Coarse	N	Live
24	X1	Sand and Sandy Mud	N	Live
	X2	Mixed	N	Live

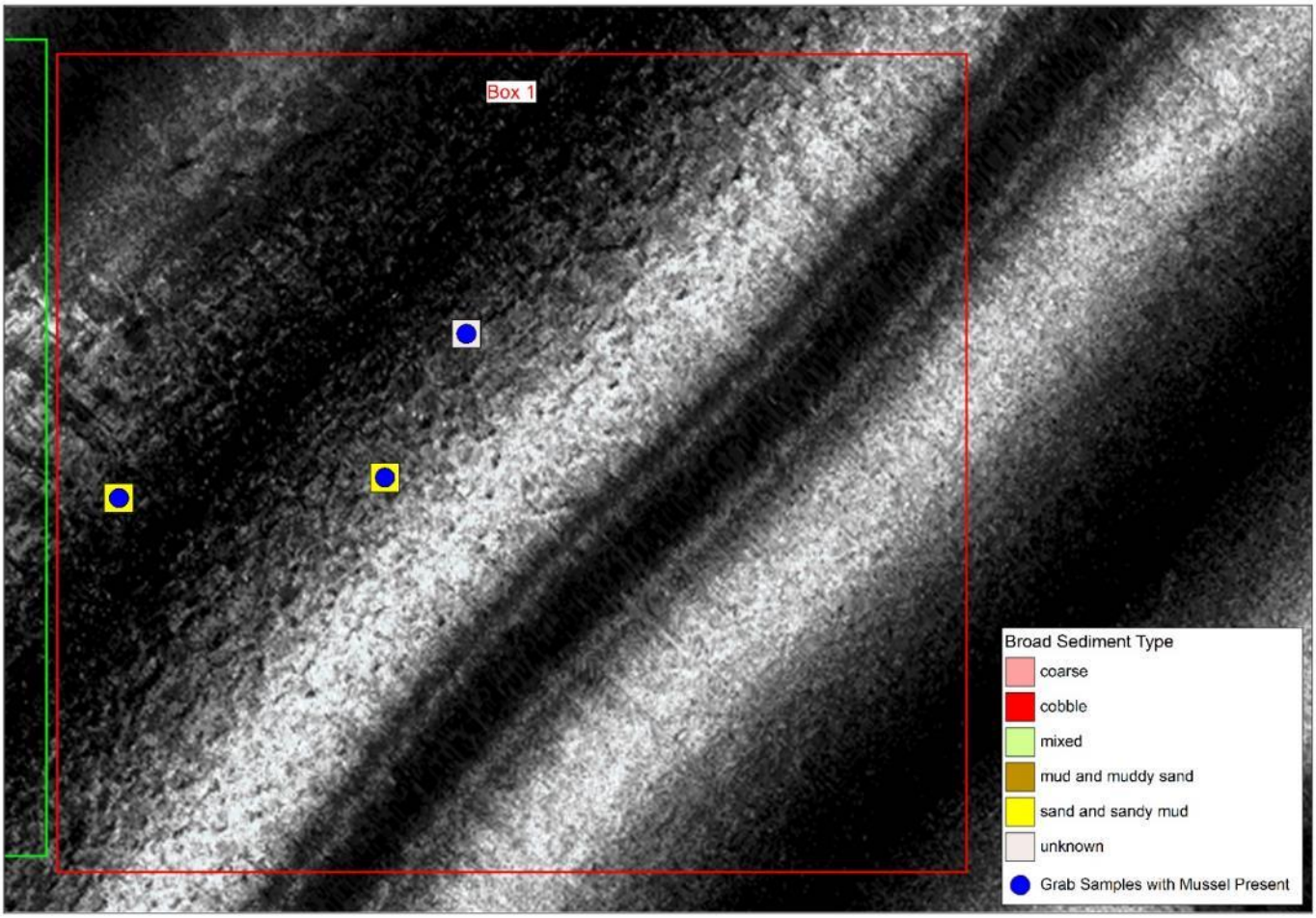

Figure 5 – Higher magnification of SSS data from Box 1 and grab sample contents for ground-truthing

Figure 6 – Hamon Grab samples taken from Box 1.

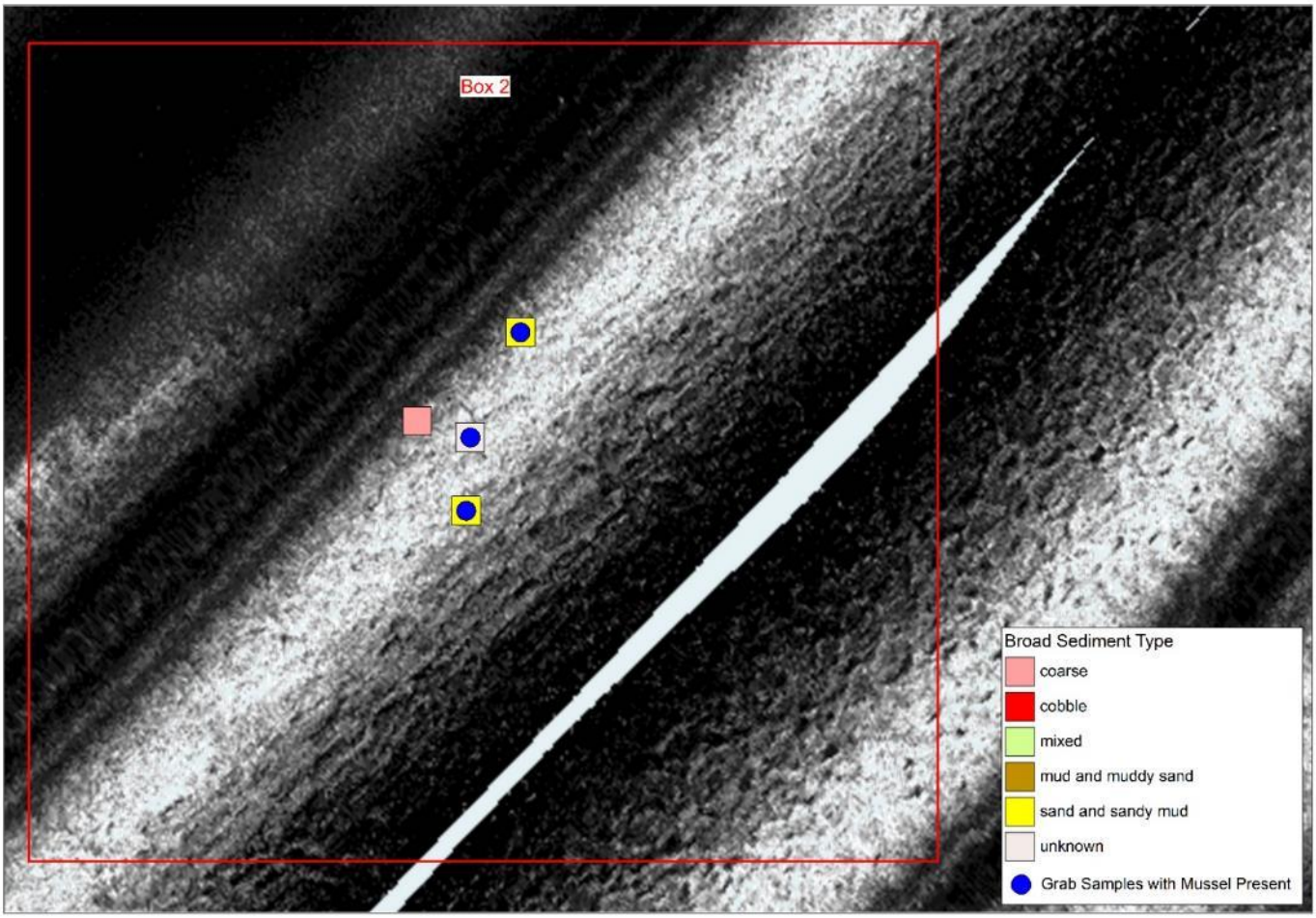

Figure 7 – Higher magnification of SSS from Box 2 and grab sample contents for ground-truthing.

Figure 8 – Hamon Grab samples taken from Box 2.

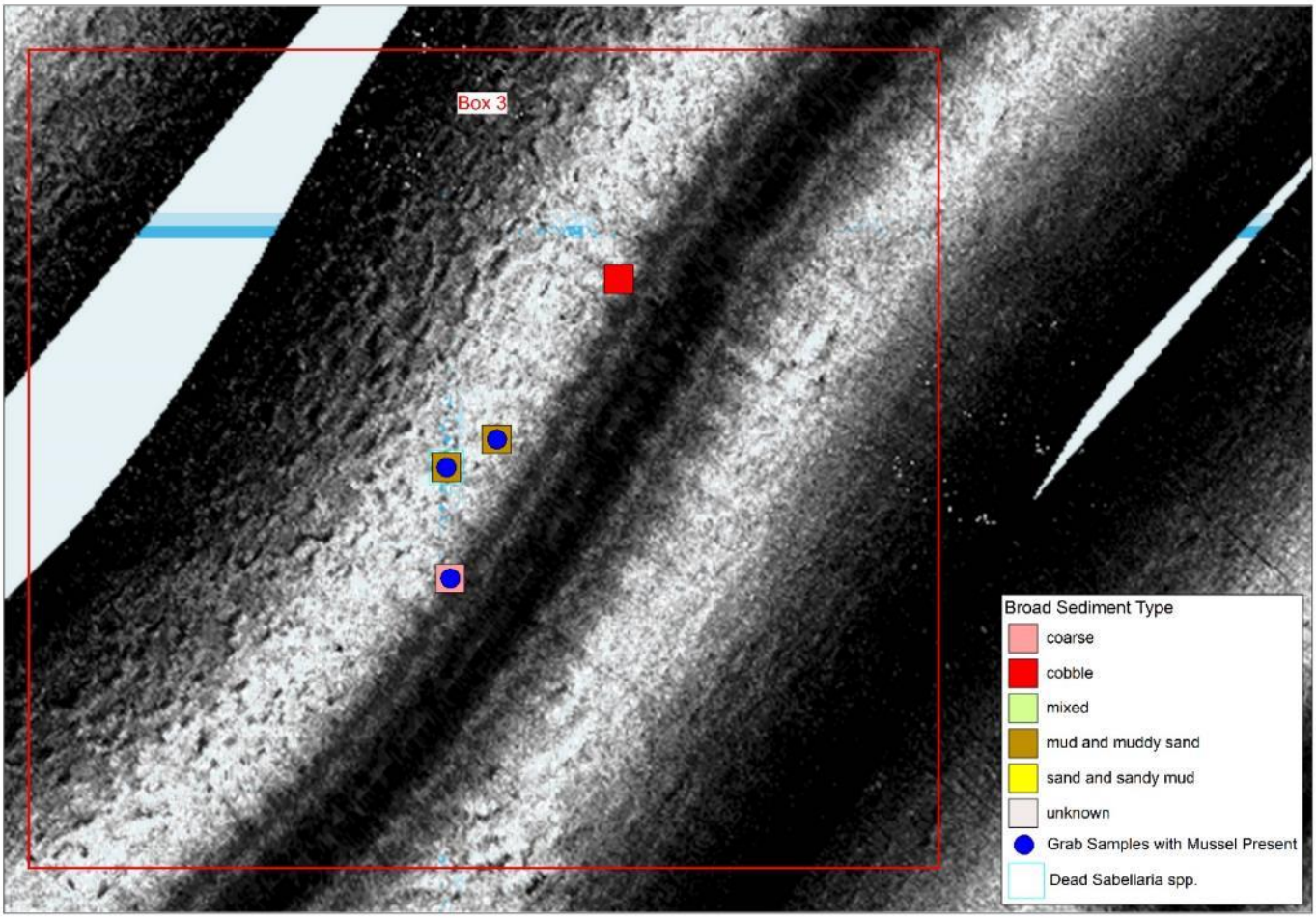

Figure 9 – Higher magnification of SSS from Box 3 and grab sample contents for ground-truthing.

Figure 10 – Hamon Grab samples taken from Box 3.

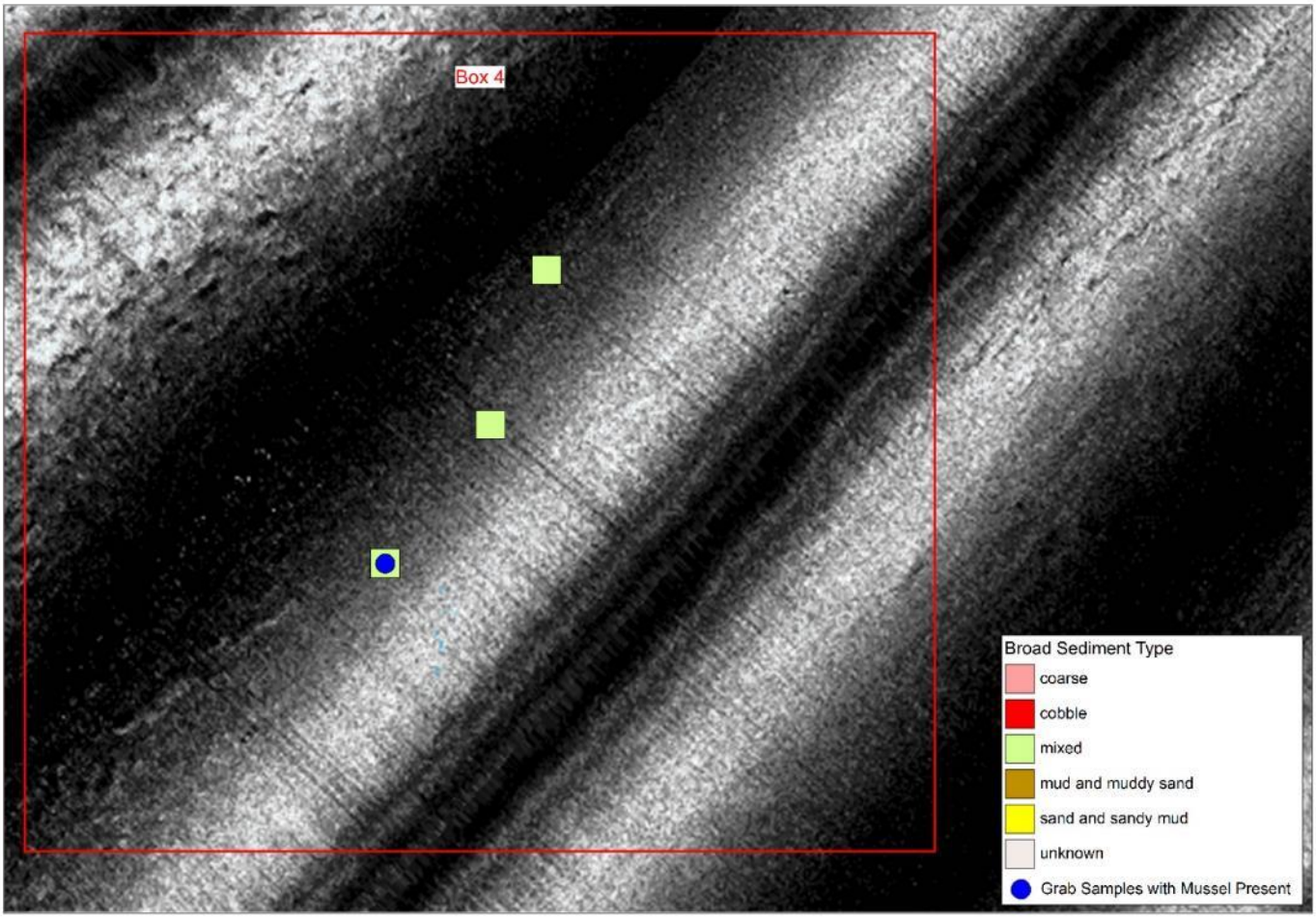

Figure 11 – Higher magnification of SSS from Box 4 and grab sample contents for ground-truthing.

Figure 12 – Hamon Grab samples taken from Box 4.

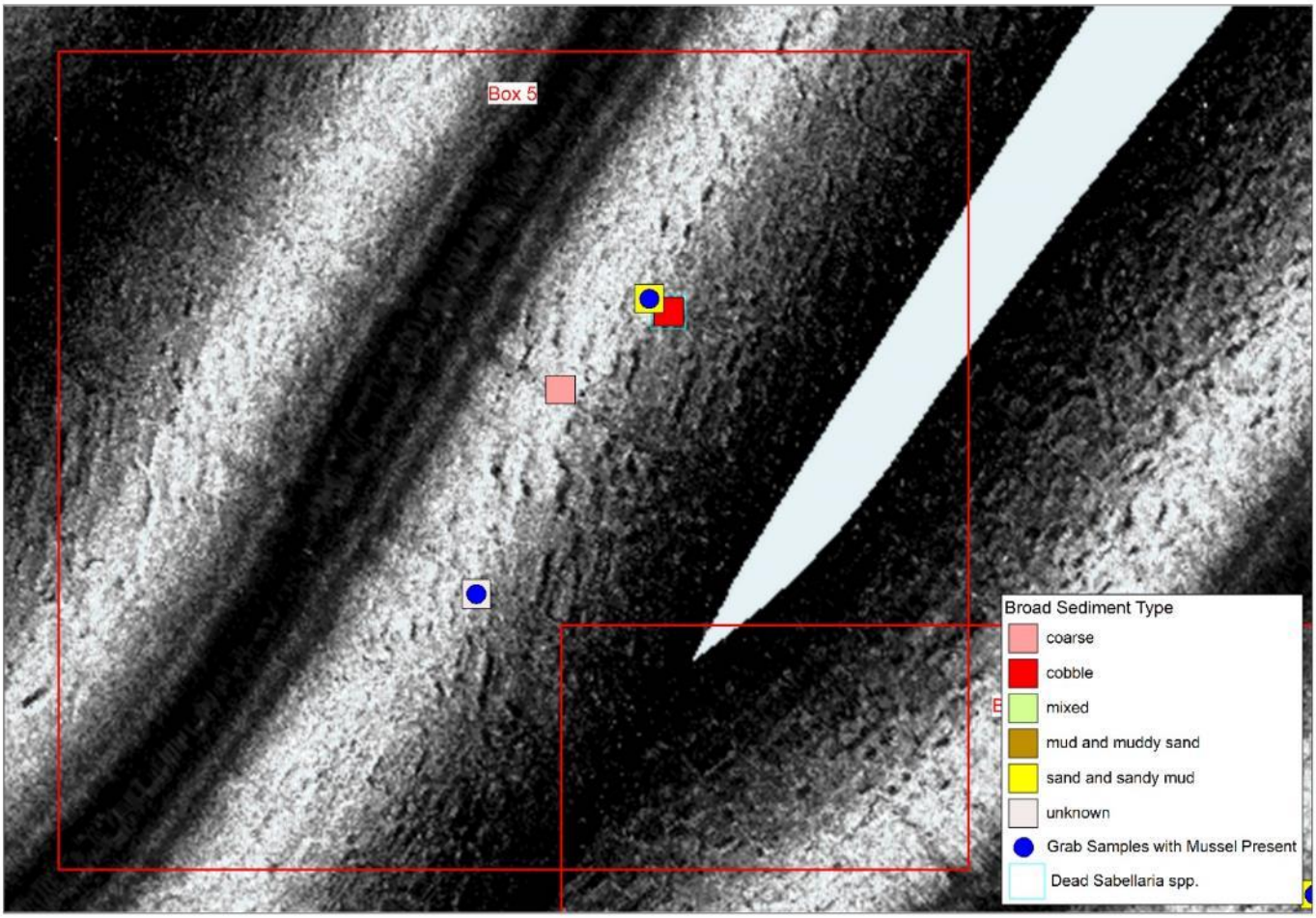

Figure 13 – Higher magnification of SSS from Box 5 and grab sample contents for ground-truthing.

Figure 14 – Hamon Grab samples taken from Box 5.

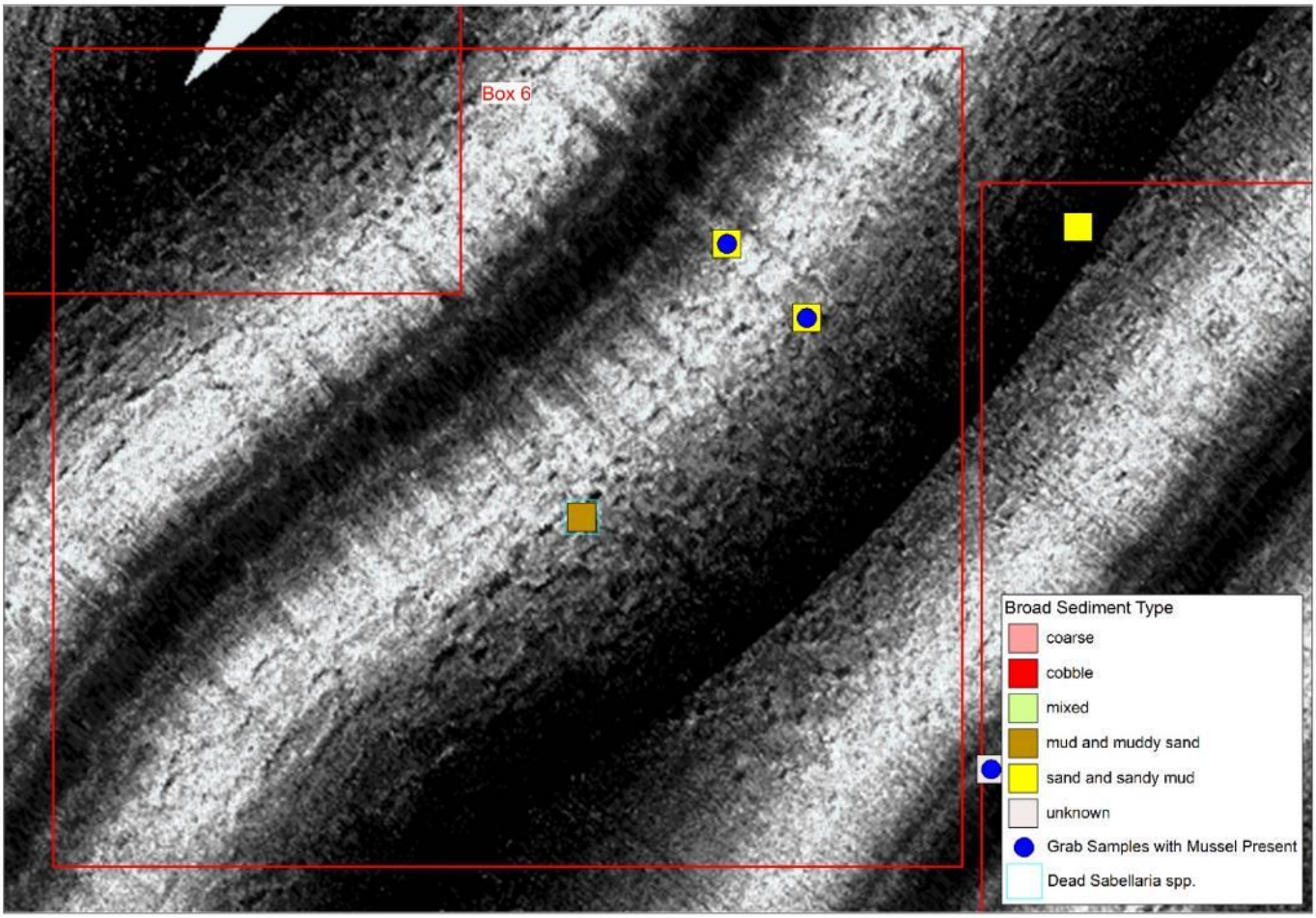

Figure 15 – Higher magnification of SSS from Box 6 and grab sample contents for ground-truthing.

Figure 16 – Hamon Grab samples taken from Box 6.

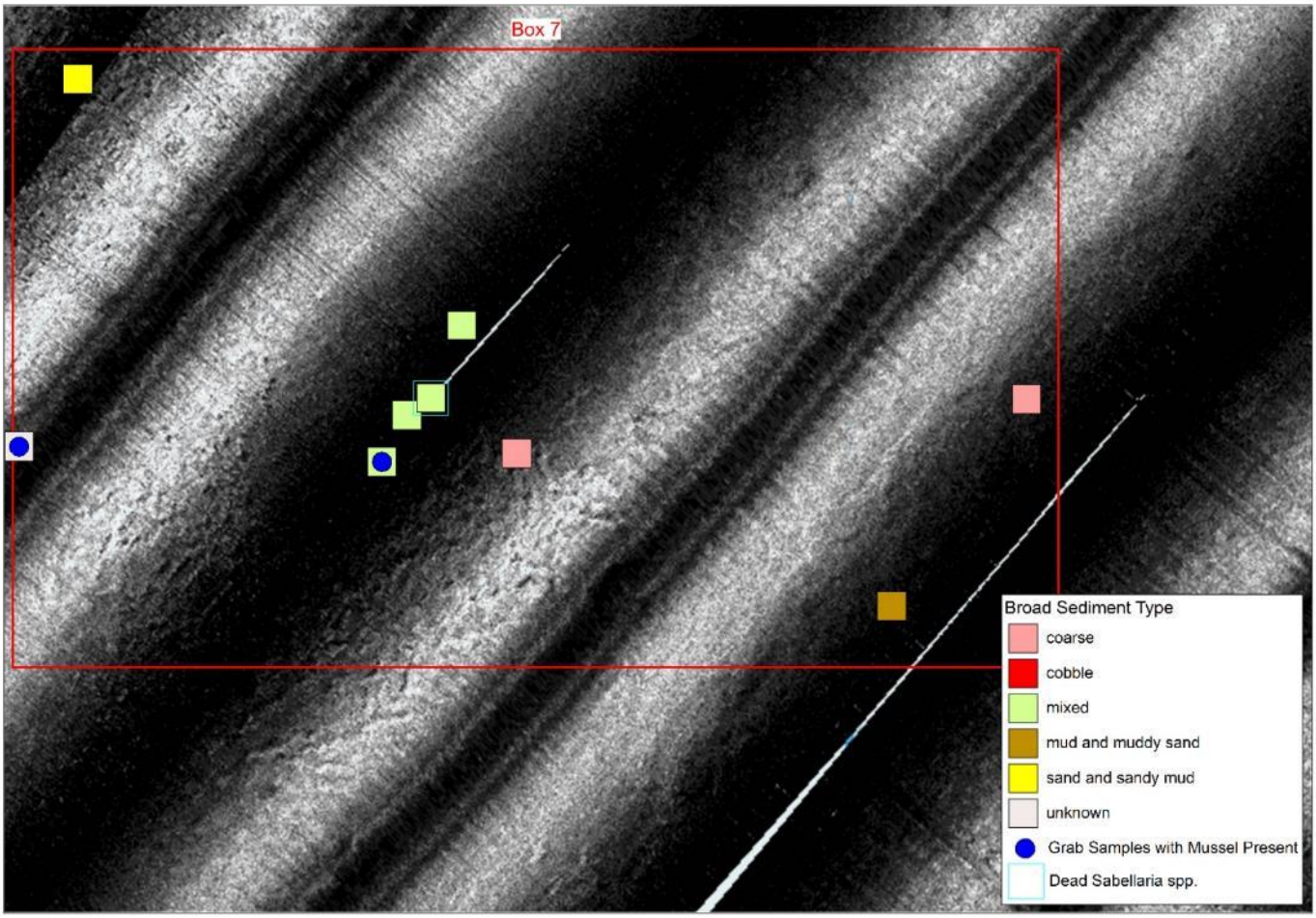

Figure 17 – Higher magnification of SSS from Box 7 and grab sample contents for ground-truthing.

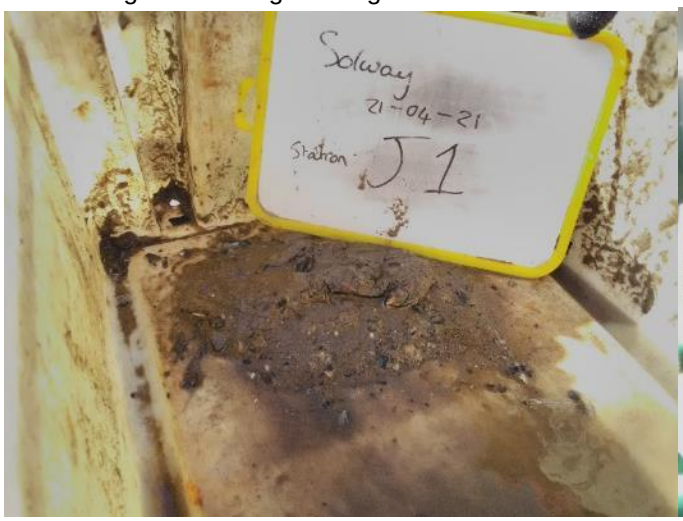

Figure 18 – Hamon Grab samples taken from Box 7.

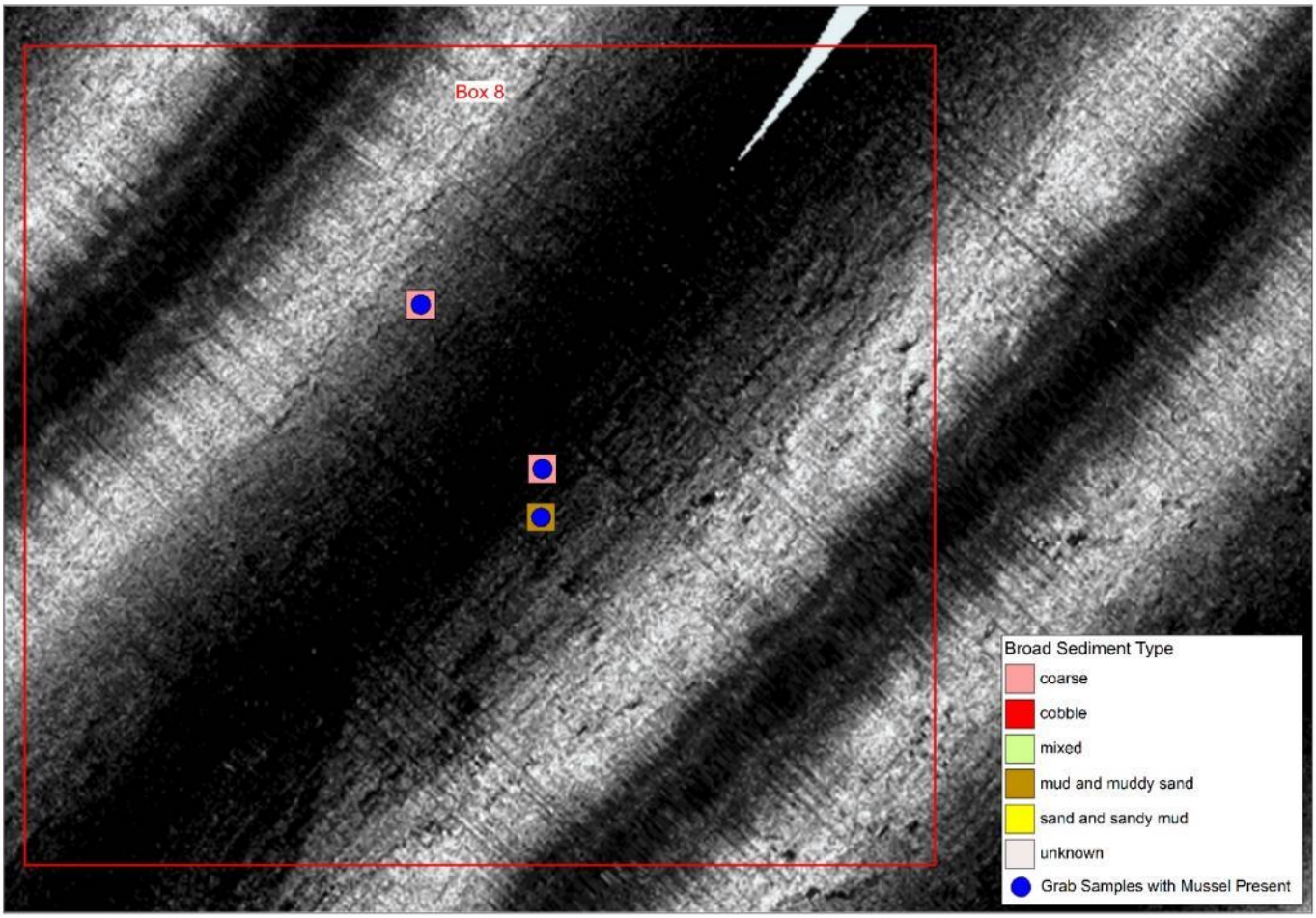

Figure 19 – Higher magnification of SSS from Box 8 and grab sample contents for ground-truthing.

Figure 20 – Hamon Grab samples taken from Box 8.

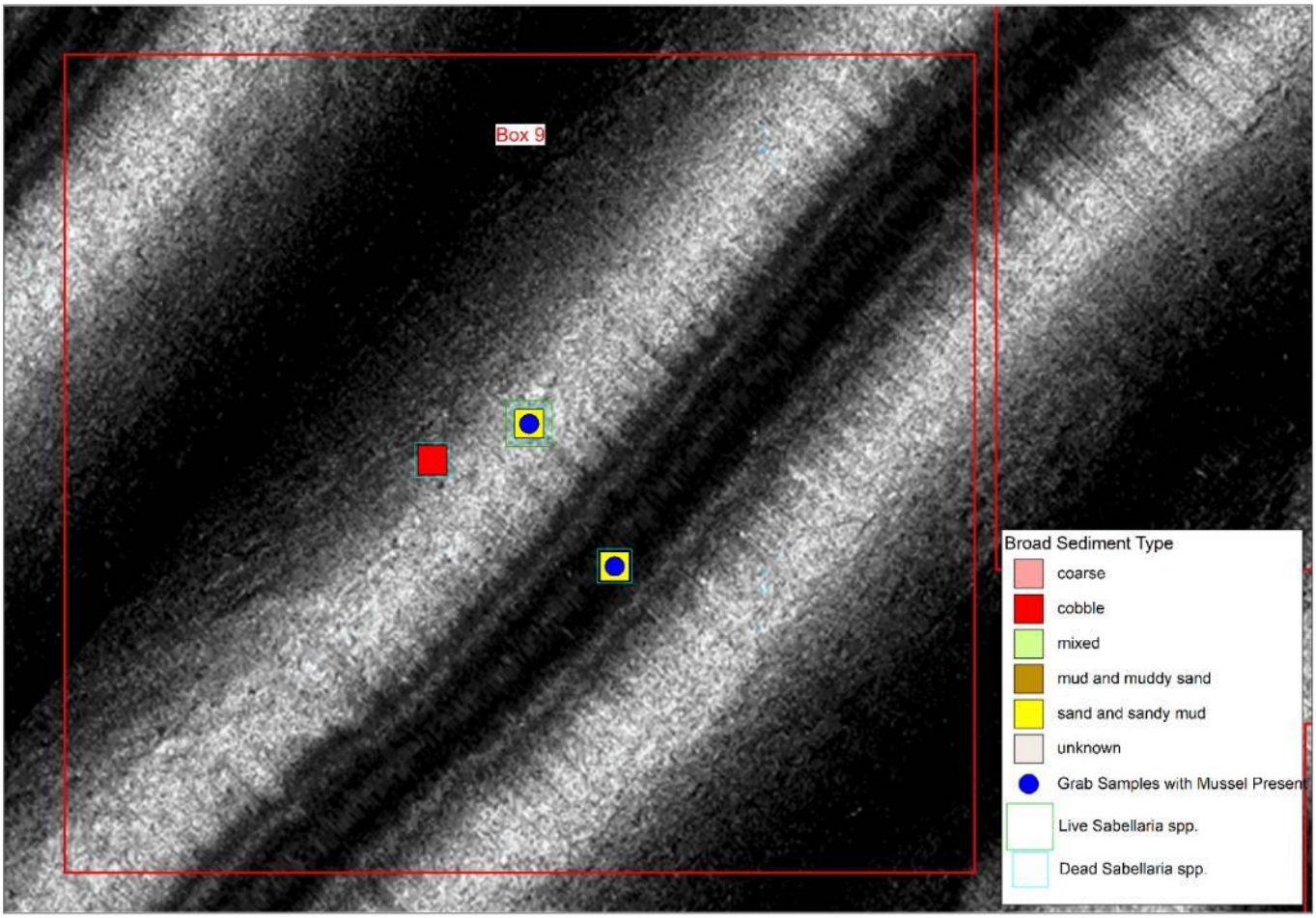

Figure 21 – Higher magnification of SSS from Box 9 and grab sample contents for ground-truthing.

Figure 22 – Hamon Grab samples taken from Box 9.

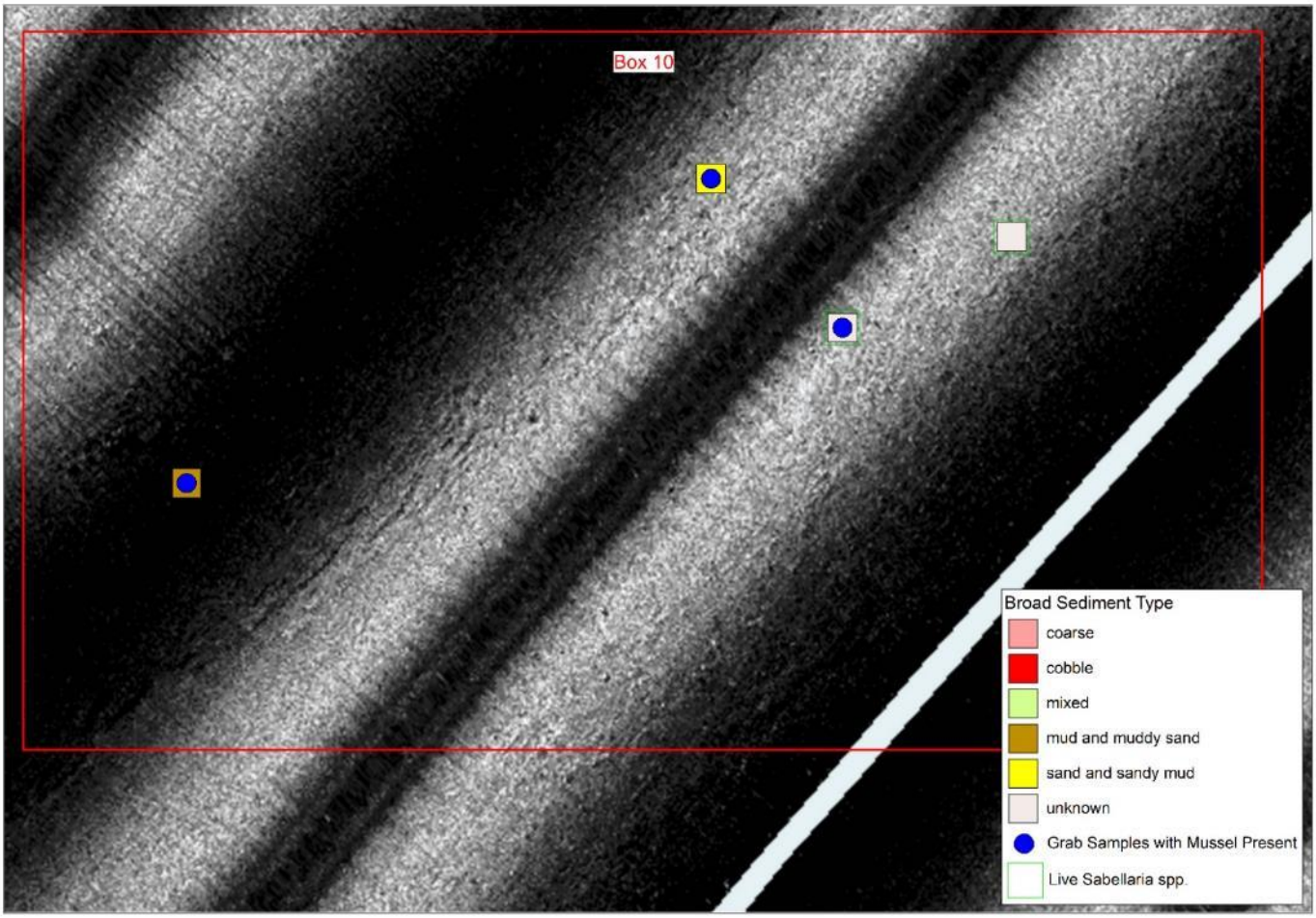

Figure 23 – Higher magnification of SSS from Box 10 and grab sample contents for ground-truthing.

Figure 24 – Hamon Grab samples taken from Box 10.

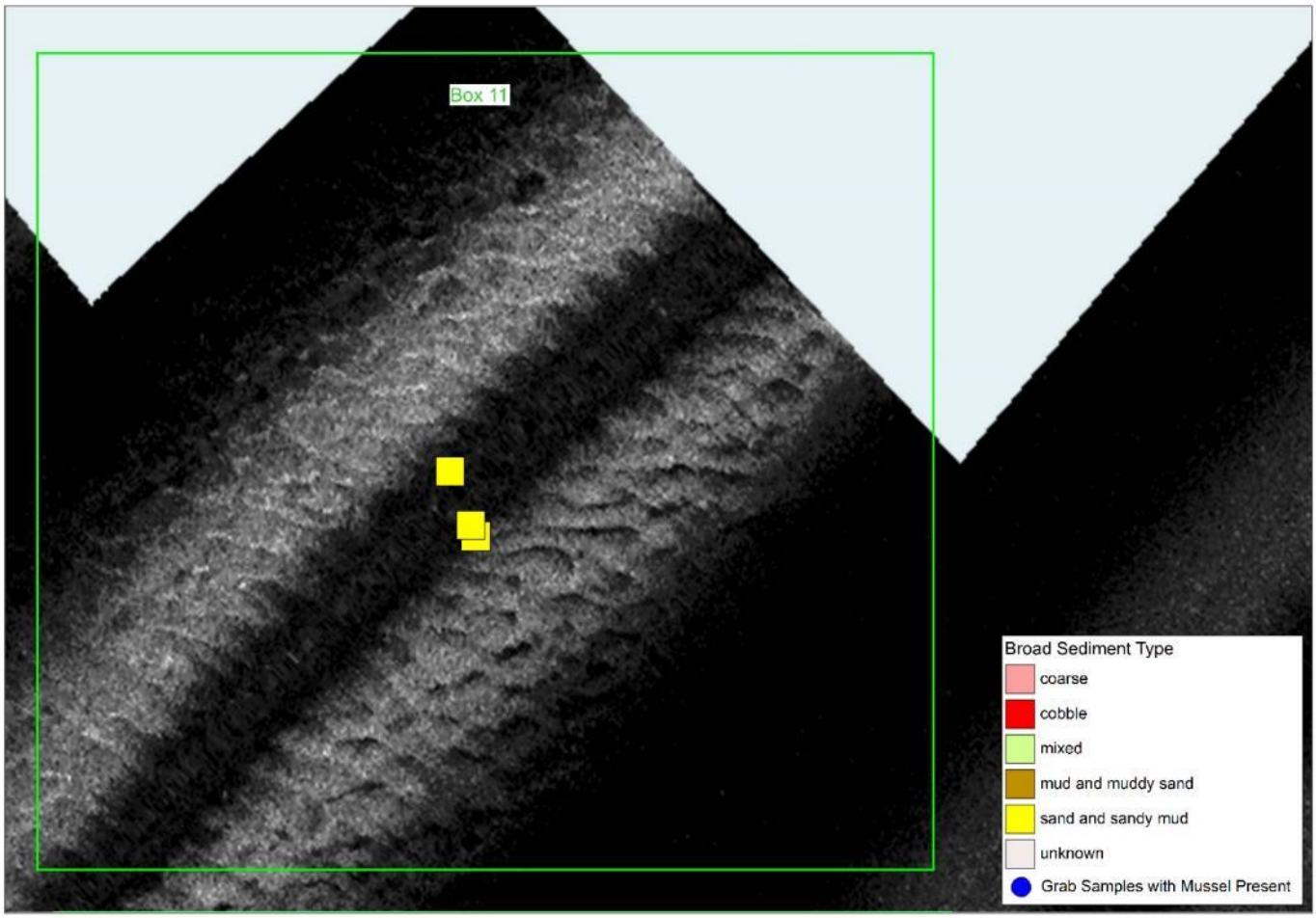

Figure 25 – Higher magnification of SSS from Box 11 and grab sample contents for ground-truthing.

Figure 26 – Hamon Grab samples taken from Box 11.

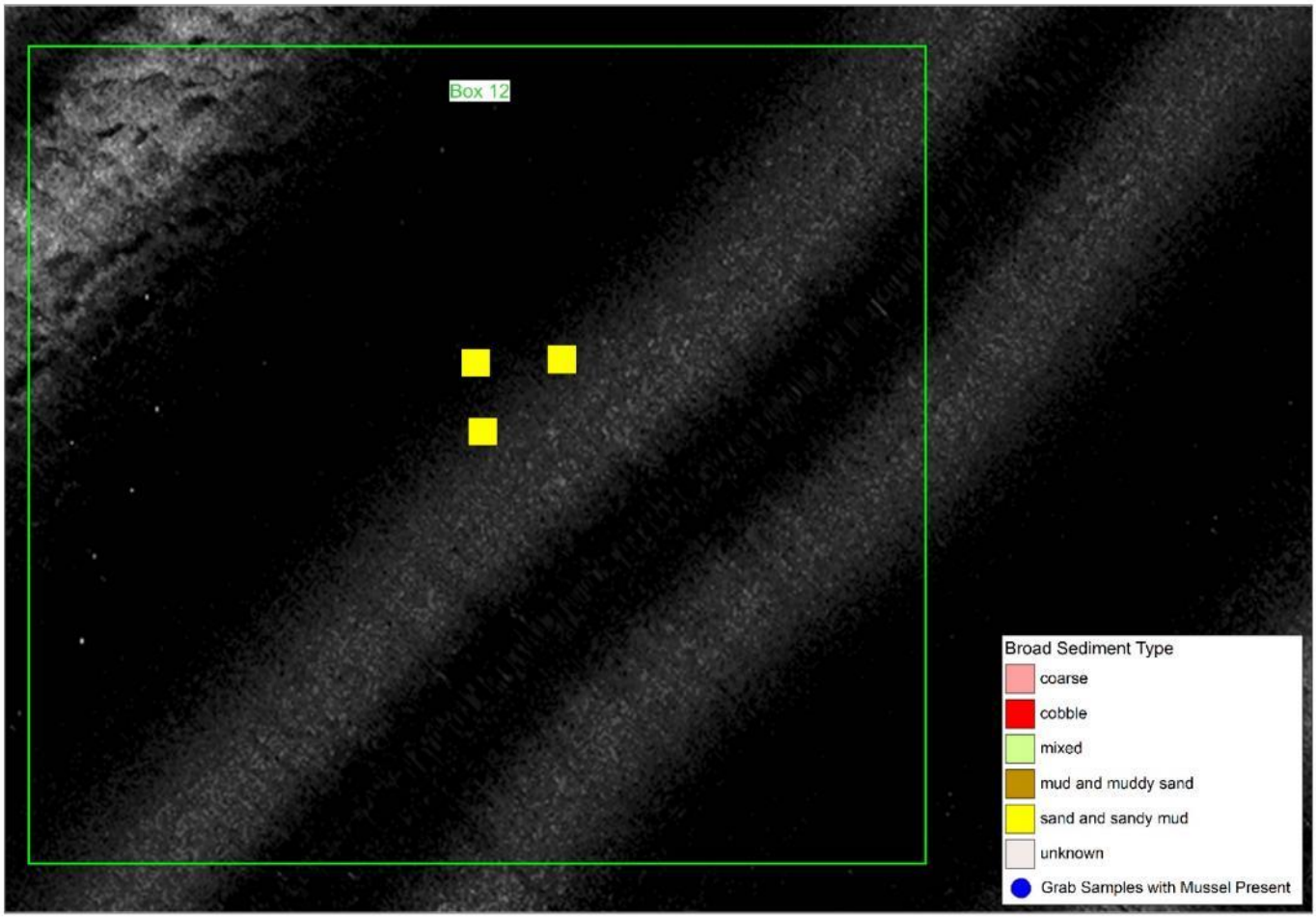

Figure 27 – Higher magnification of SSS from Box 12 and grab sample contents for ground-truthing.

Figure 28 – Hamon Grab samples taken from Box 12.

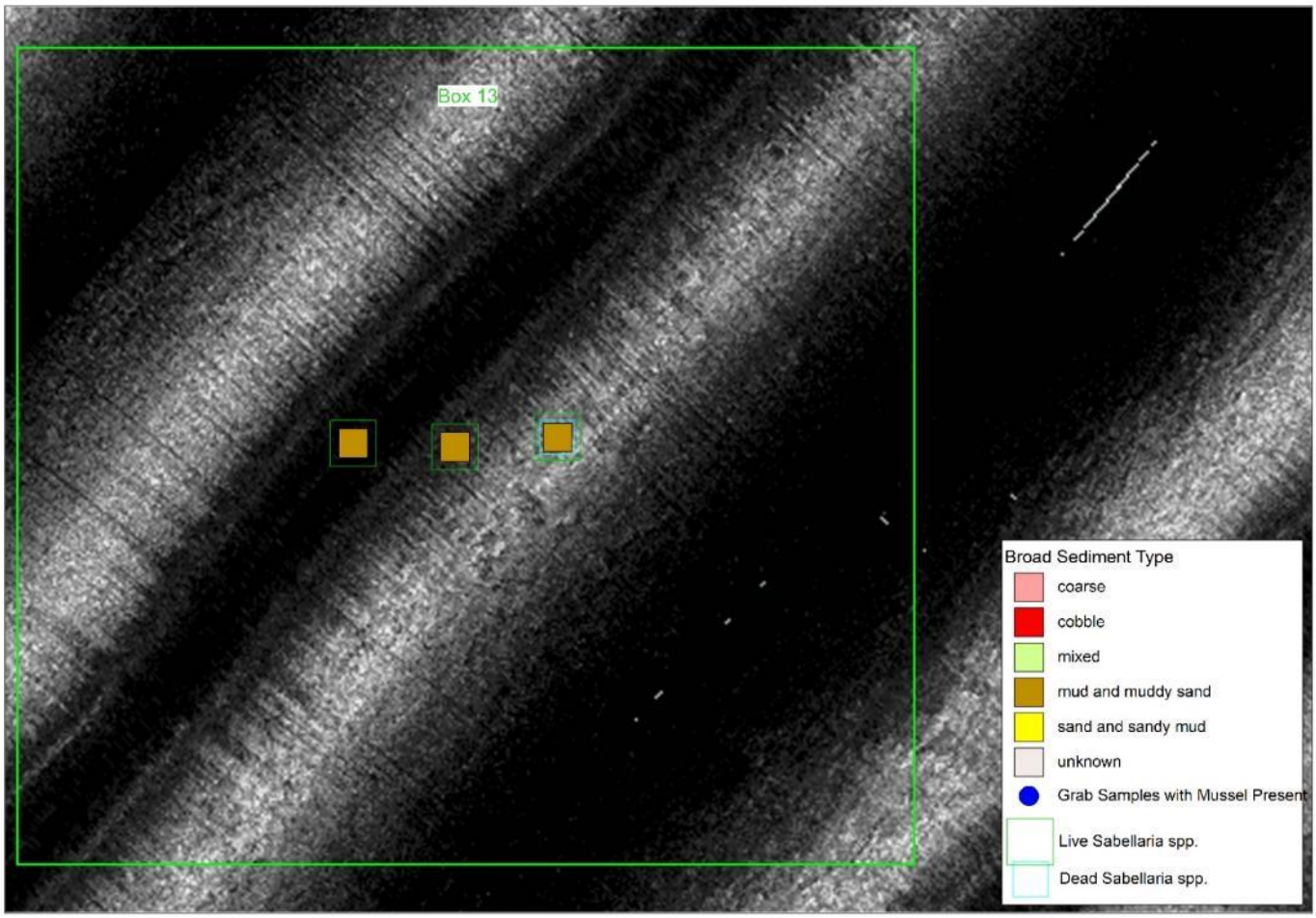

Figure 29 – Higher magnification of SSS from Box 13 and grab sample contents for ground-truthing.

Figure 30 – Hamon Grab samples taken from Box 13.

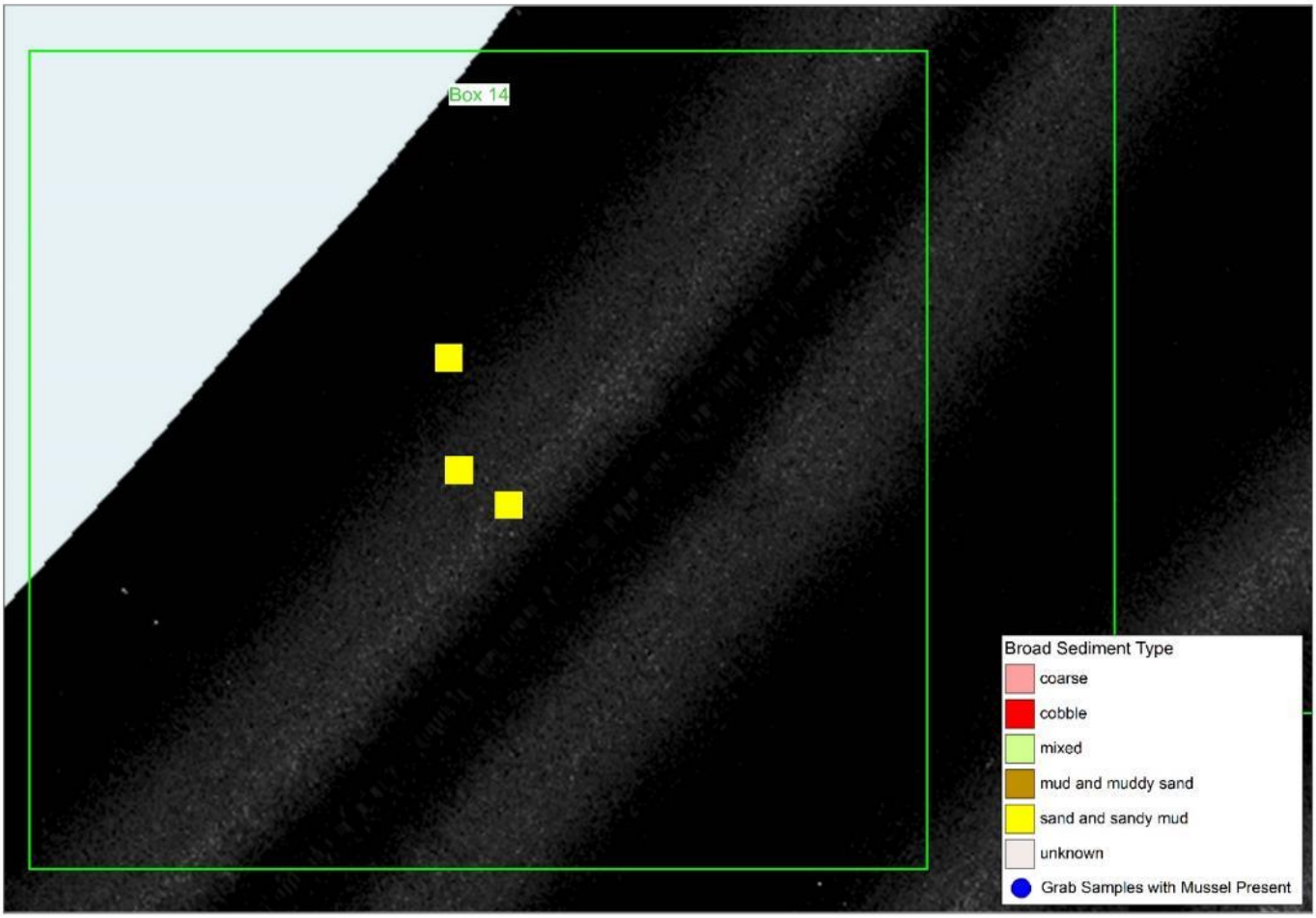

Figure 31 – Higher magnification of SSS from Box 14 and grab sample contents for ground-truthing.

Figure 32 – Hamon Grab samples taken from Box 14.

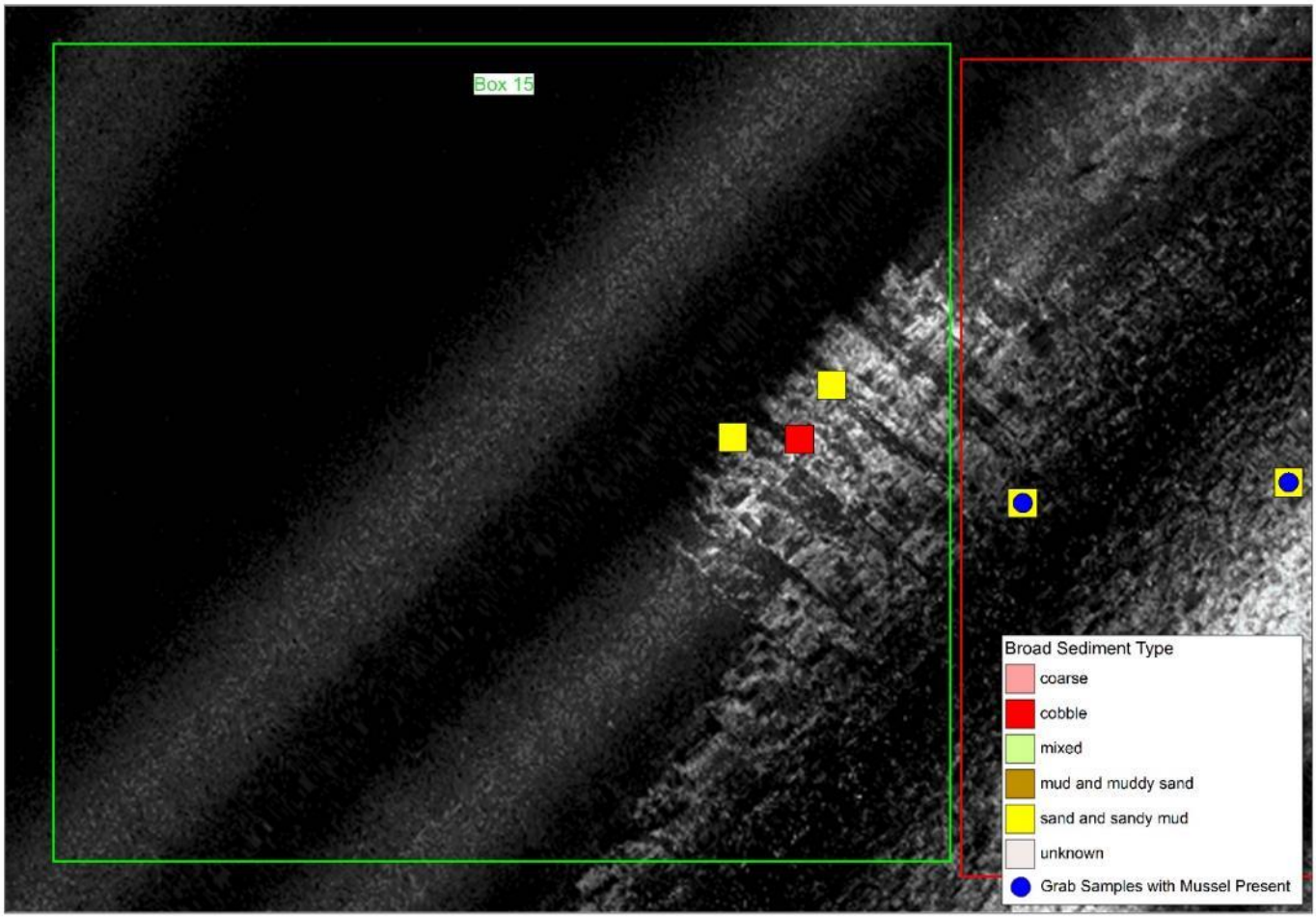

Figure 33 – Higher magnification of SSS from Box 15 and grab sample contents for ground-truthing.

Figure 34 – Hamon Grab samples taken from Box 15.

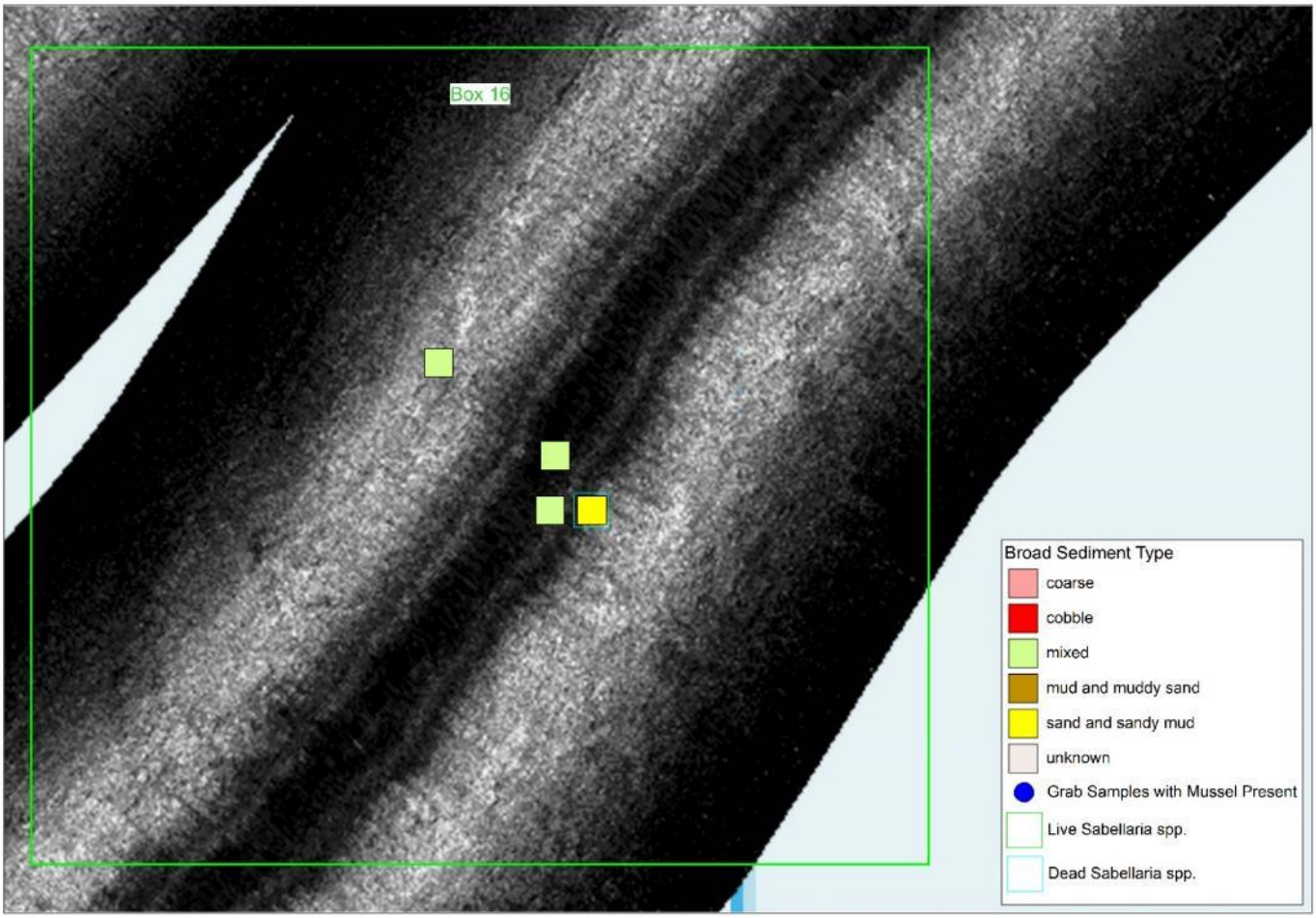

Figure 35– Higher magnification of SSS from Box 16 and grab sample contents for ground-truthing.

Figure 36 – Hamon Grab samples taken from Box 16.

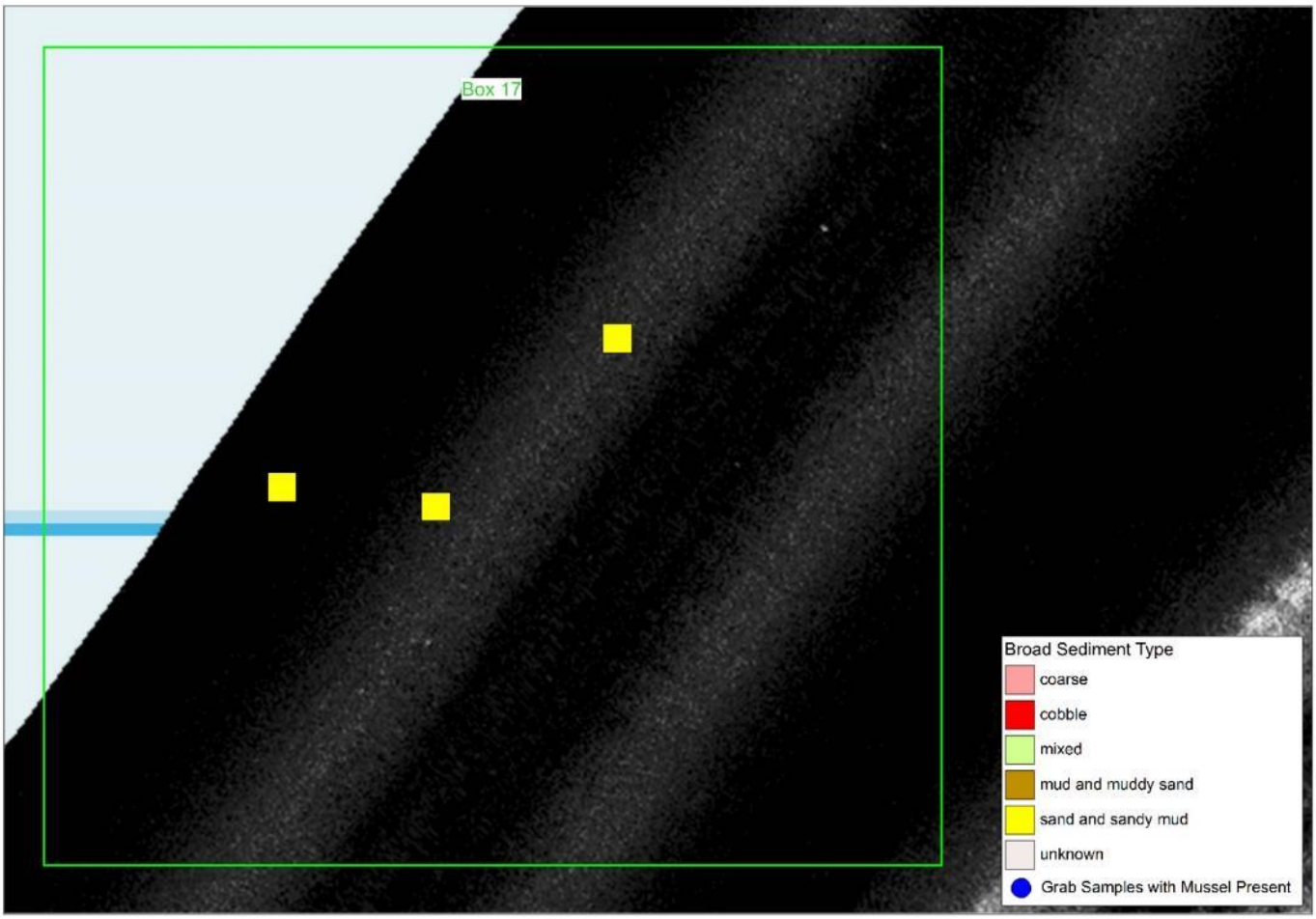

Figure 37 – Higher magnification of SSS from Box 17 and grab sample contents for ground-truthing.

Figure 38 – Hamon Grab samples taken from Box 17.

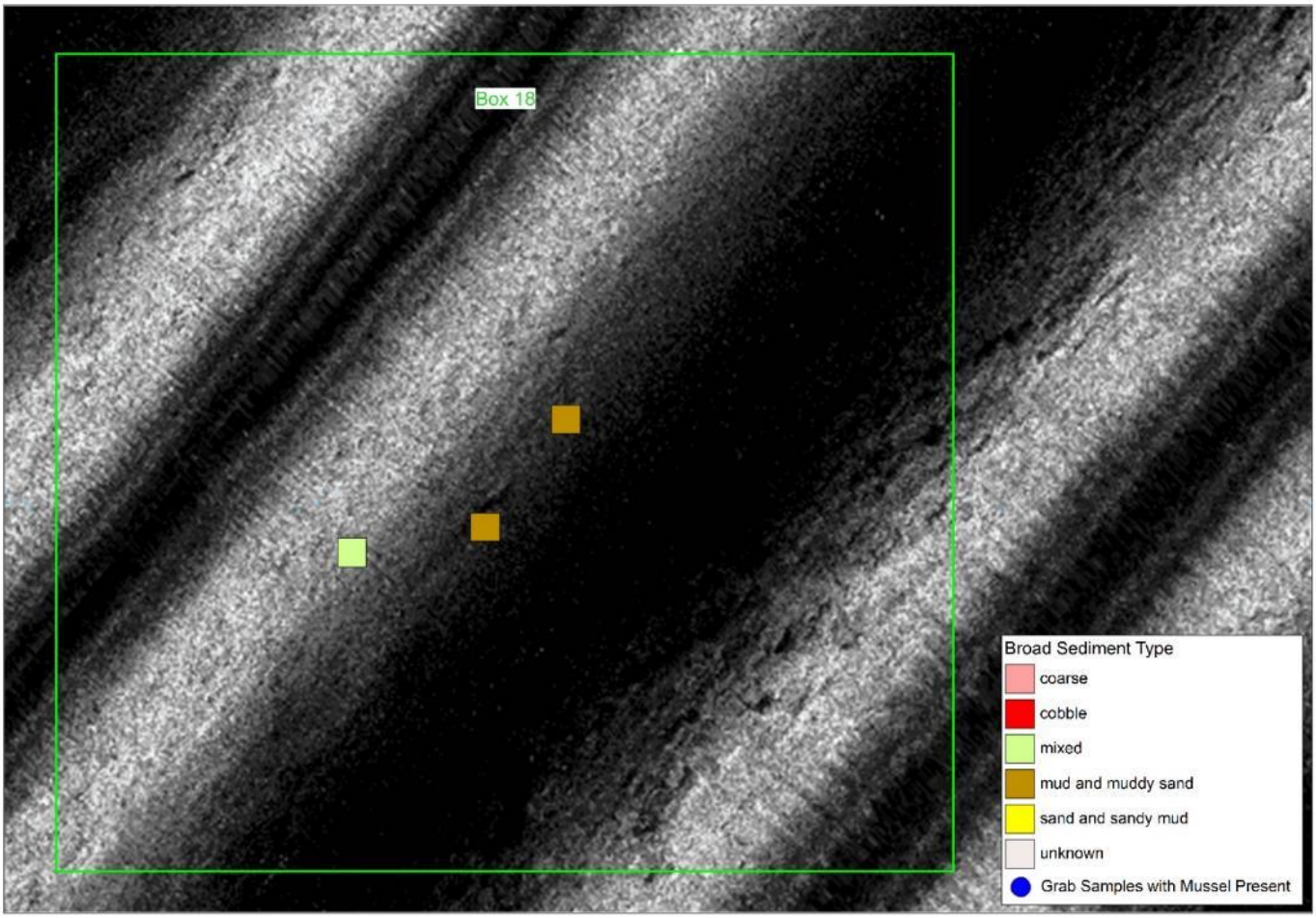

Figure 39 – Higher magnification of SSS from Box 18 and grab sample contents for ground-truthing.

Figure 40 – Hamon Grab samples taken from Box 18.

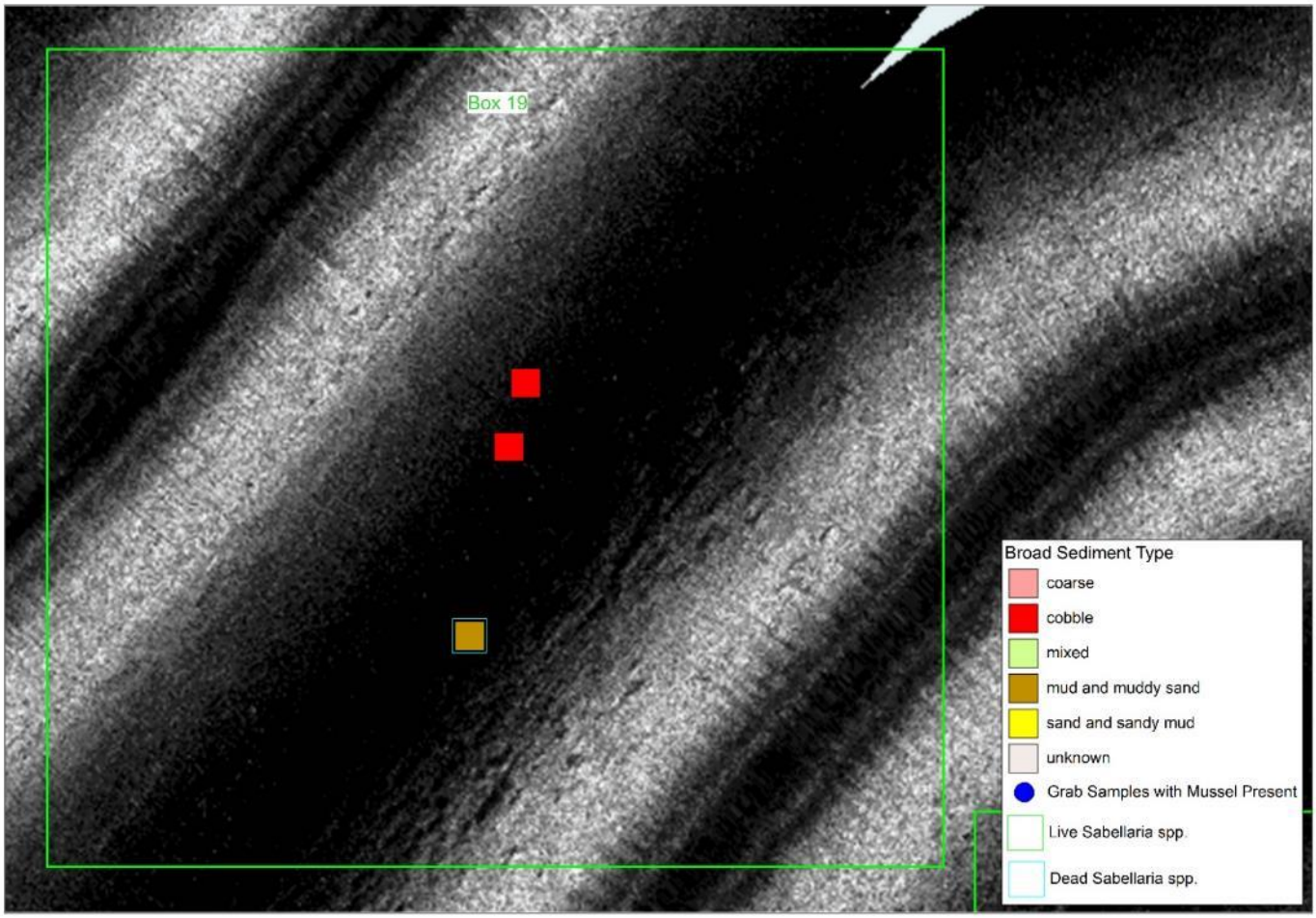

Figure 41 – Higher magnification of SSS from Box 19 and grab sample contents for ground-truthing.

Figure 42 – Hamon Grab samples taken from Box 19.

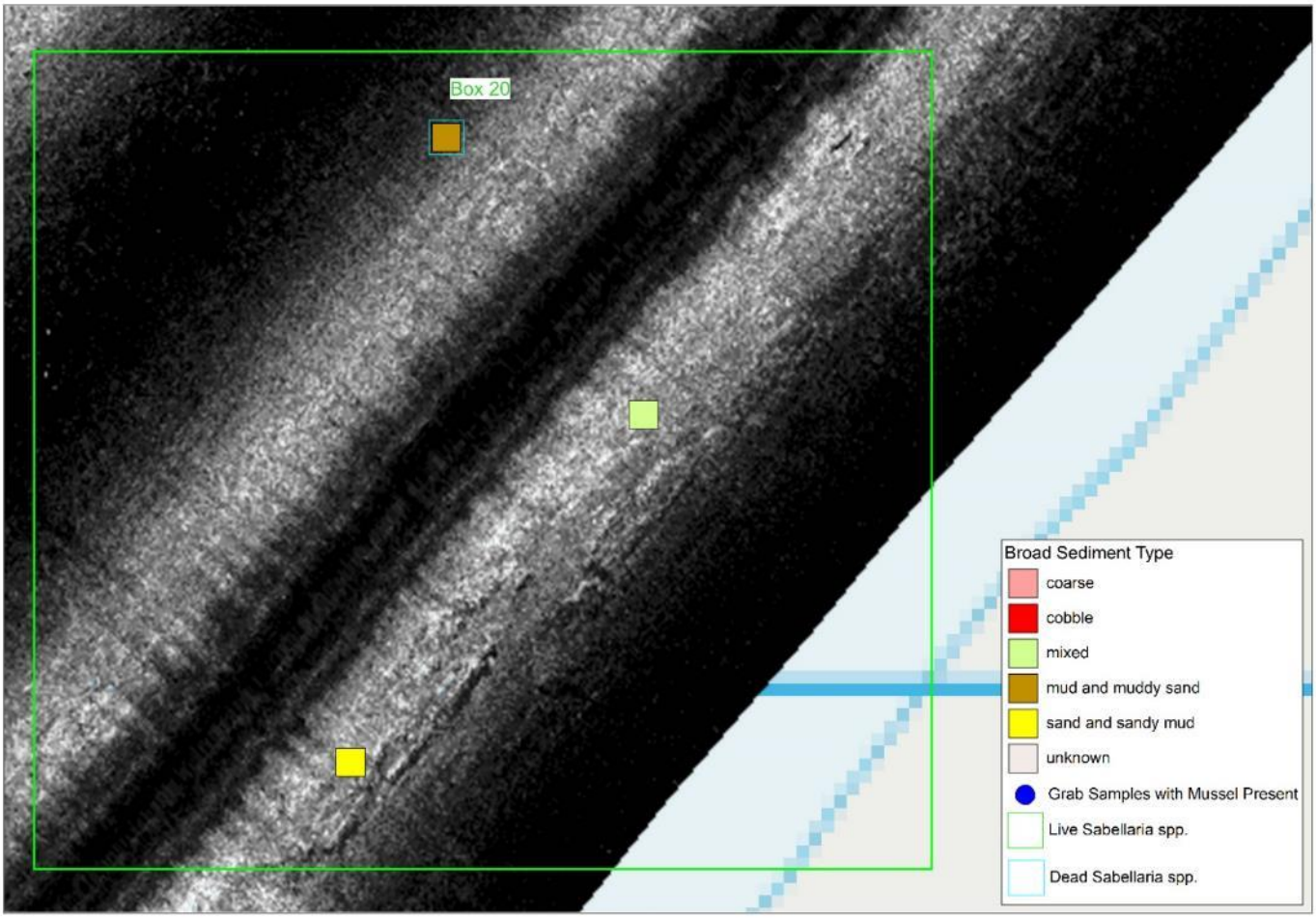

Figure 43 – Higher magnification of SSS from Box 20 and grab sample contents for ground-truthing.

Figure 44 – Hamon Grab samples taken from Box 20.

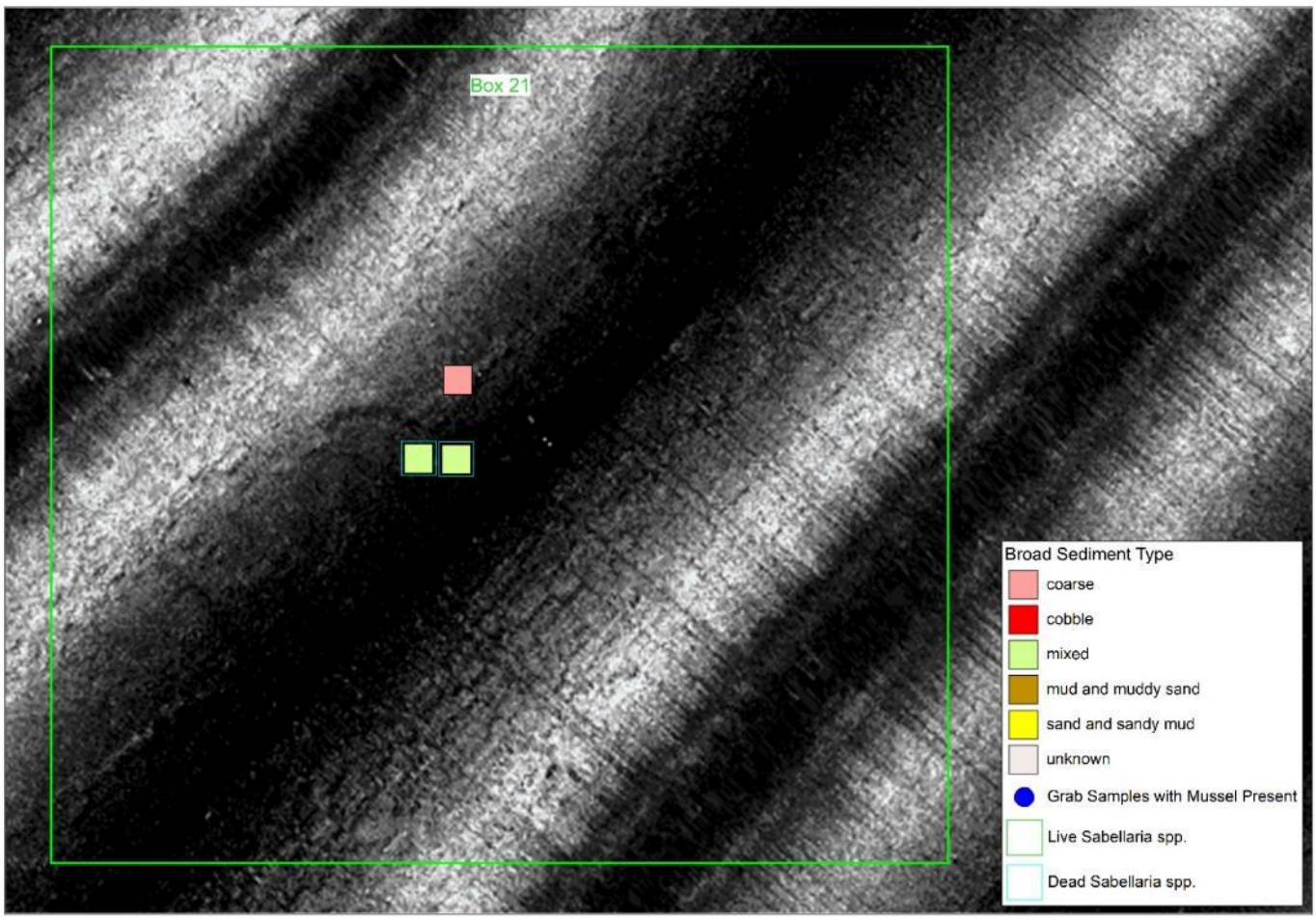

Figure 45 – Higher magnification of SSS from Box 21 and grab sample contents for ground-truthing.

Figure 46 – Hamon Grab samples taken from Box 21.

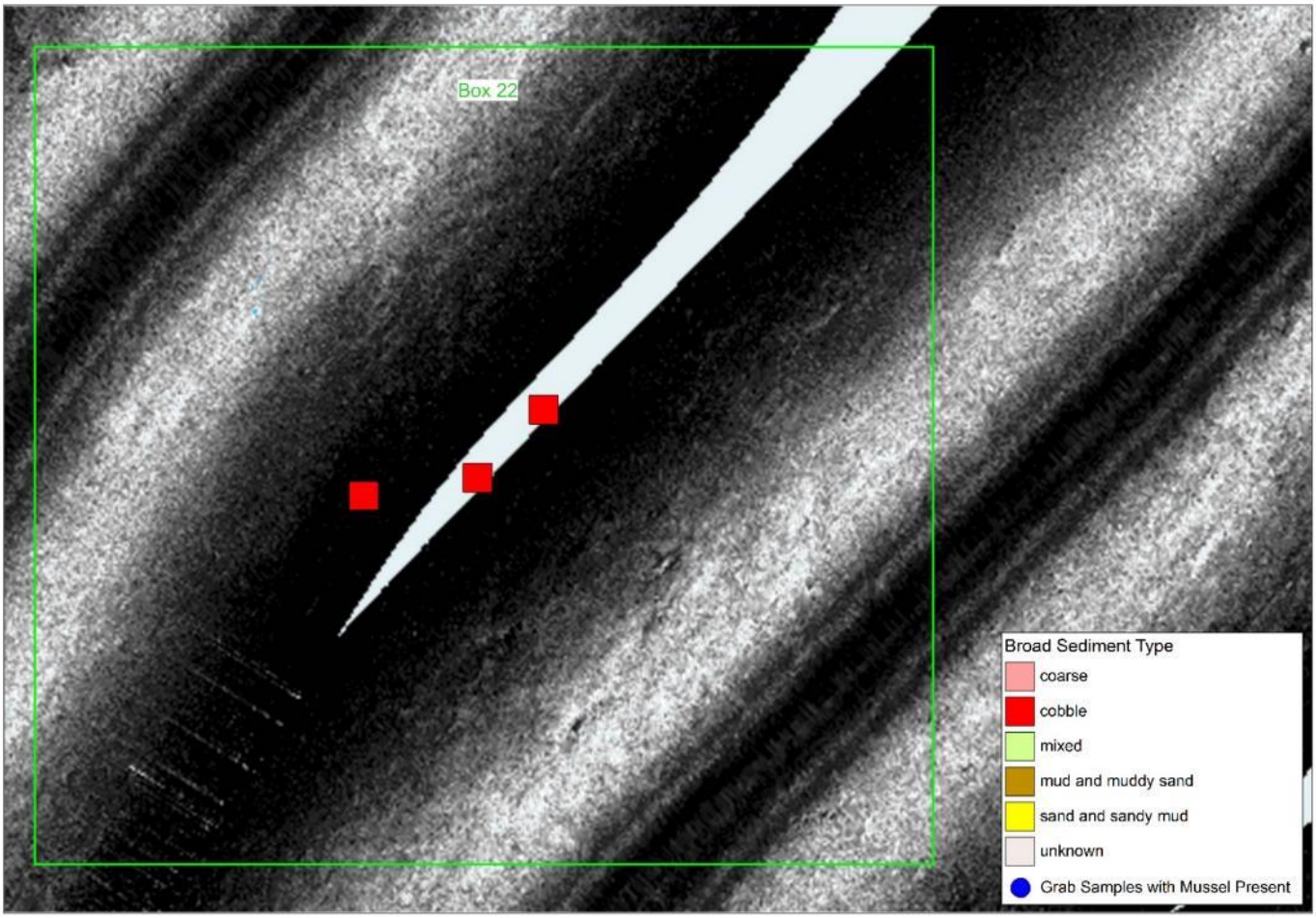

Figure 47 – Higher magnification of SSS from Box 22 and grab sample contents for ground-truthing.

Figure 48 – Hamon Grab samples taken from Box 22.

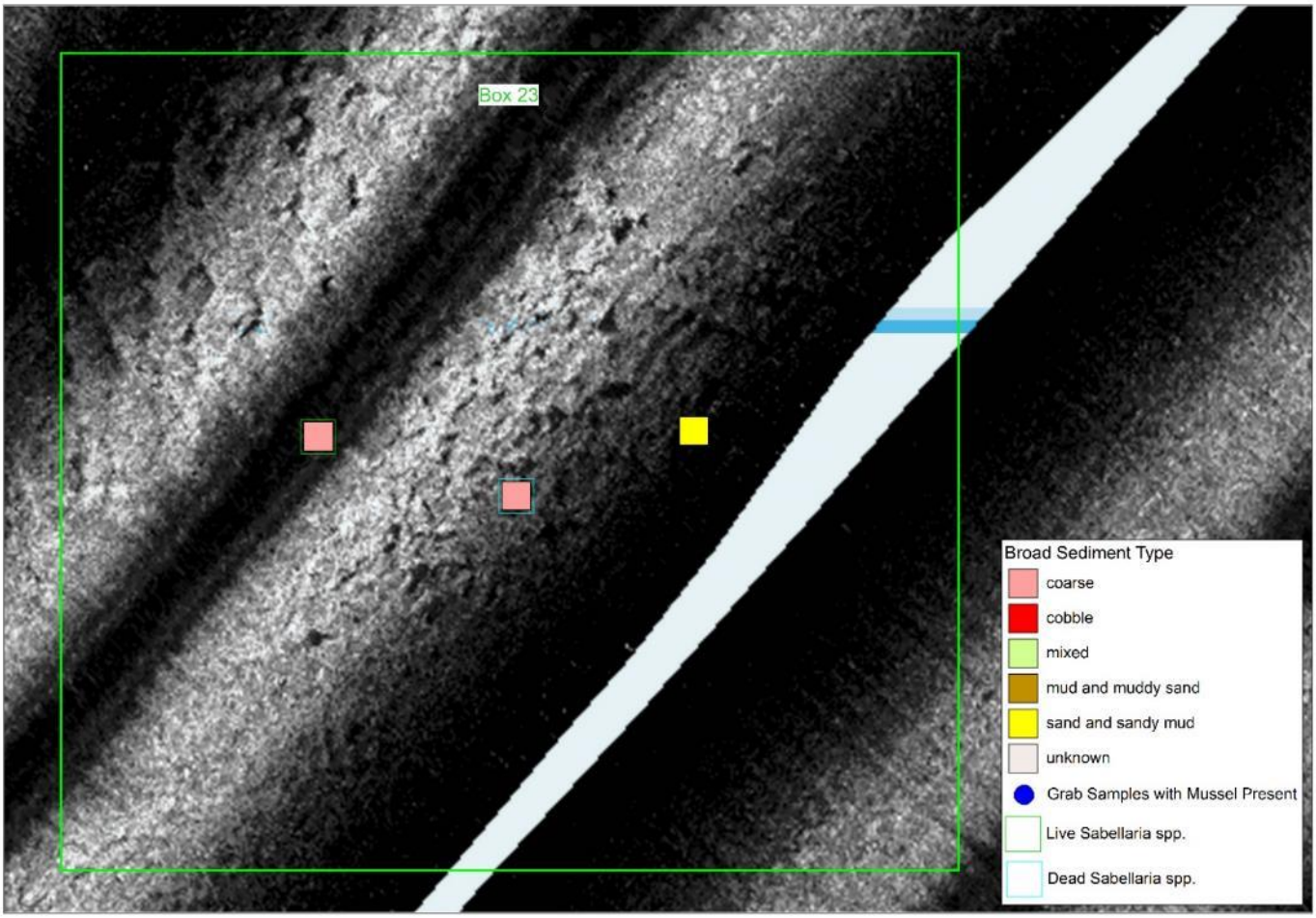

Figure 49 – Higher magnification of SSS from Box 23 and grab sample contents for ground-truthing.

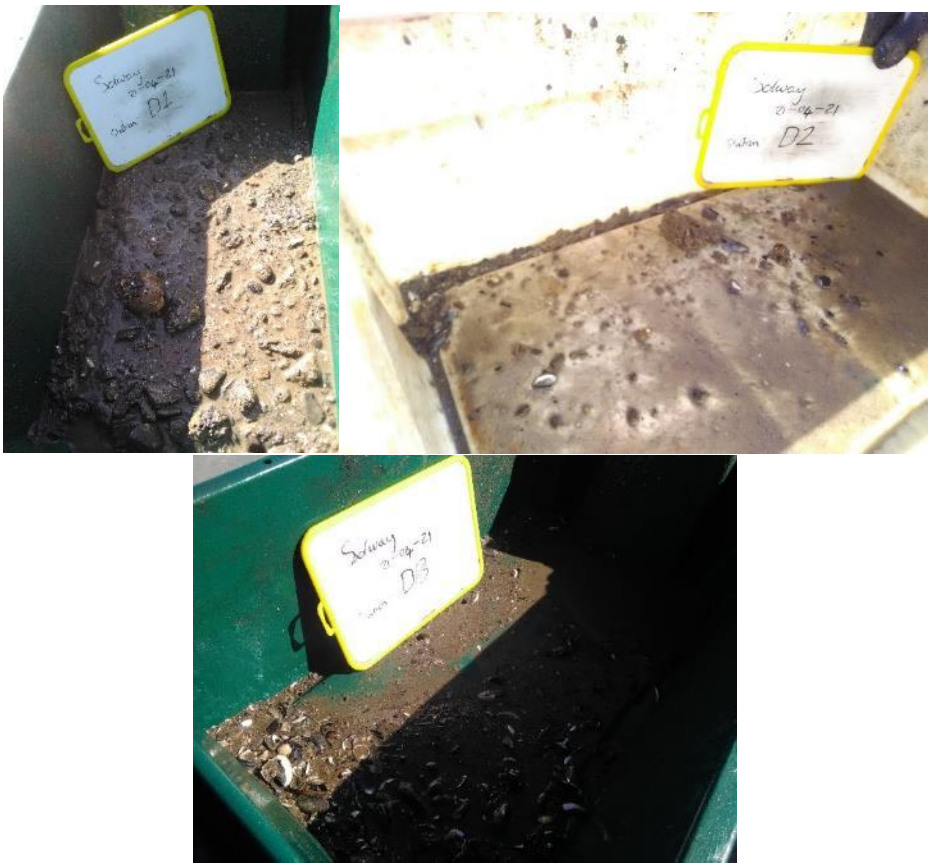

Figure 50 – Hamon Grab samples taken from Box 23.

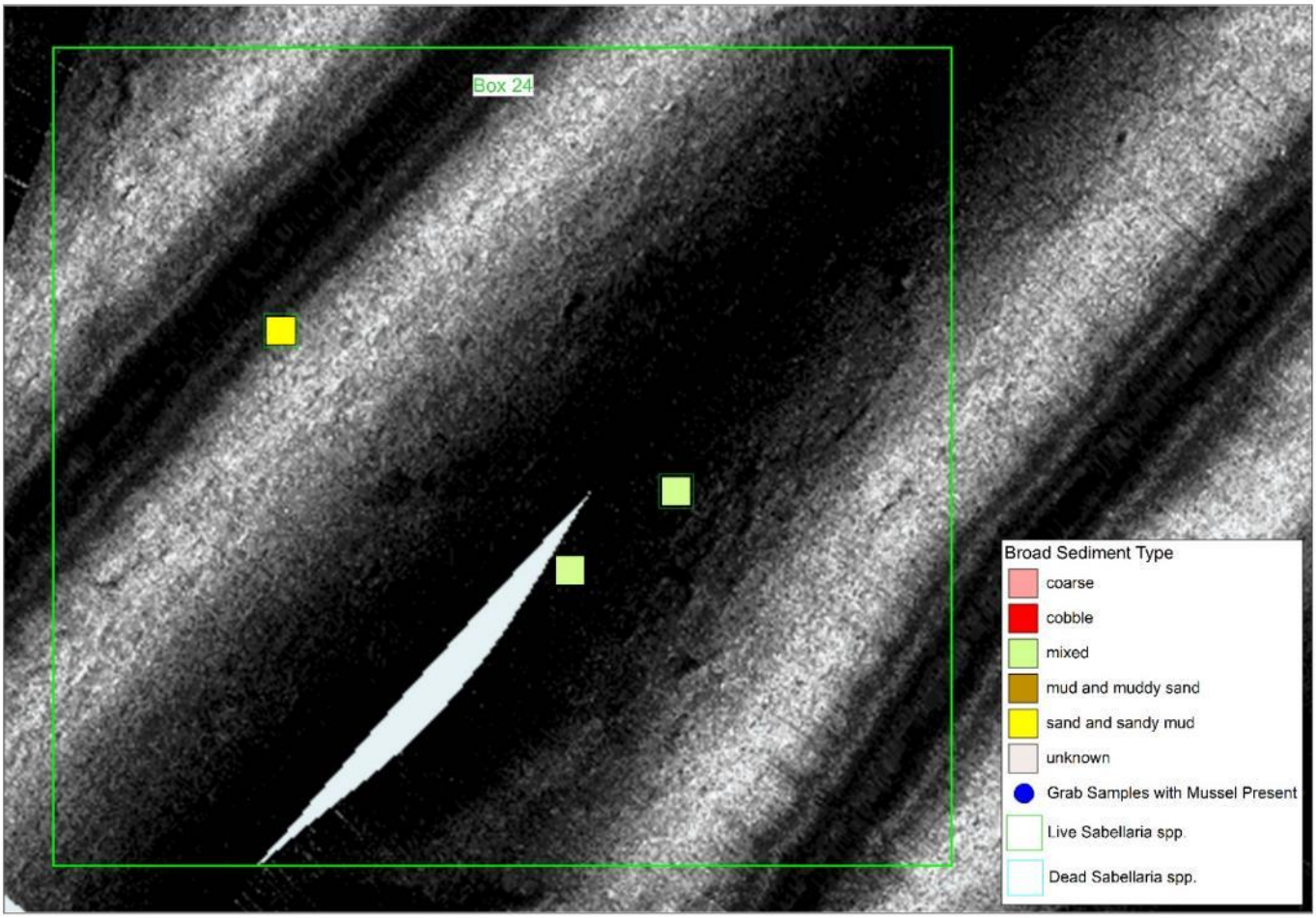

Figure 51 – Higher magnification of SSS from Box 24 and grab sample contents for ground-truthing.

Figure 52 – Hamon Grab samples taken from Box 24.

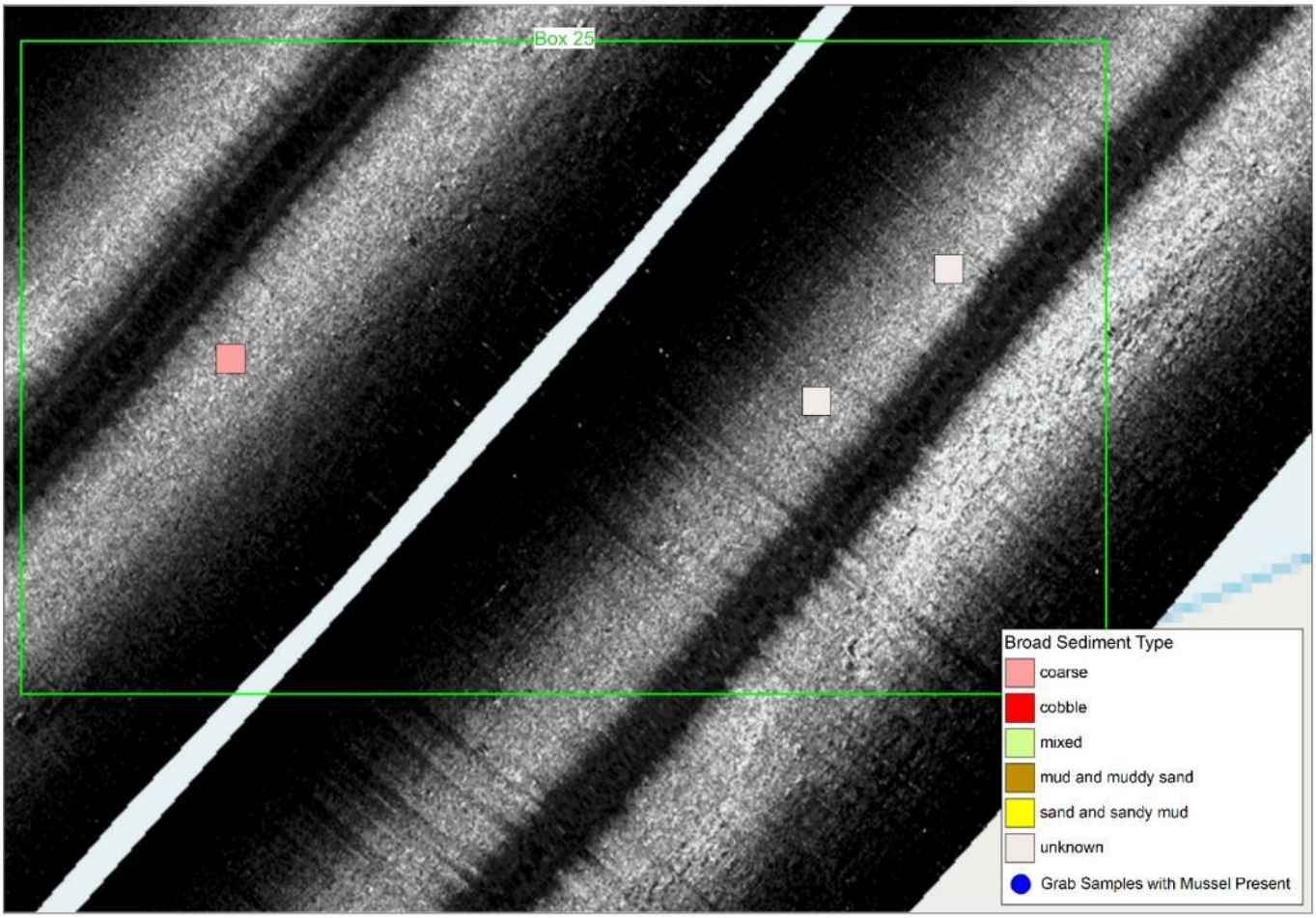

Figure 53 – Higher magnification of SSS from Box 25 and grab sample contents for ground-truthing.

Figure 54 – Hamon Grab samples taken from Box 25.

4. Discussion

Use of SSS data and grab samples in the target survey area enabled an illustration to be produced of the array of habitat types in this area of the Solway. The survey has indicated that large areas have the potential to be covered with mussel and that mussel can be found on a range of sediment types. This is the second NWIFCA SSS survey which has been ground-truthed, building on the previous survey in 2020. This increases the evidence available of the area and habitats present. The data has been split into two sections for discussion; samples that had no mussel present and samples with mussel.

Habitat

The grab samples indicated that Boxes 11, 12, 14, 15 and 17 (Figures 25, 27, 31, 33 and 37) were sand and the SSS imagery was very similar for all of the boxes, giving a dark imagery with very few strong returns. Mixed, coarse, cobble and unknown (potentially hard ground) all gave a lighter image with varying degrees of texture and a strong return. Notable features include; Box 13 (Figure 33) showed hard ground meeting sand and Box 23 (Figure 49) showed mottled ground creating shadows suggesting a more substantial feature.

Mussel

Boxes 1, 2, 3, 5, and 6 (Figures 5, 7, 9, 13 and 15) all had similar imagery where there was a mottled appearance with a contrast of light and dark areas from weak and strong returns potentially indicating areas of mussel and bare soft sediment, or areas of varying height or a mixture of both. The grab samples from these areas contained mussel on sand and muddy sand predominantly, with some on mud and muddy sand. Although some of the samples contained *Sabellaria spp.* it is unlikely this could be visible in the SSS imagery.

Boxes 4, 7, 8, 9 and 10 (Figures 11, 17, 19, 21 and 23) showed a varying range of imagery. The grab samples indicated that mussel was present in these areas and was on a mix of sediment types including mud, sand, mixed sediments, coarse sediment and unknown. There was no clear similarity which can be drawn from the SSS images for each of the different sediment types, and unfortunately some grab data in boxes 7, 8 and 9 falls in areas with little SSS data on track edges.

From the grab samples the mussel ranged from 10 to 70mm with the majority being in two size categories of either 10-20mm or 50-70mm indicating two settlements. The mussel was typically clean and free of any fouling and loose with no byssal threads. The mussel was loose which could suggest it may be prone to scouring in storms. Table 3 provides a summary of the number and percentage by sediment type of the samples that contained mussel. Some samples contained starfish in a high number which could indicate that the mussel may also be prone to starfish predation.

Table 3 – Summary of the substrate and condition of mussel in Boxes 1 to 10 by number and percentage of samples.

Broad Sediment Type	No. of Samples with this Sediment Type	Percentage of Samples with this Sediment Type	No. of Samples with Live Mussel	Size Class of Mussel (mm) across all samples
Sand and sandy mud	10	42%	10	10-20 and 50-70
Mud and muddy sand	5	21%	5	15-20 and 50-70
Coarse	3	12%	3	15-20 and 50-70
Mixed	1	4%	1	50
Unknown	5	21%	5	10-20 and 50-60

Future Improvement to Survey Design

100% coverage was not achieved due to lower quality data at the edges of the swathe. Some small sections of the survey area were also lost due to the boat track being affected by tidal conditions, but these areas had very little effect on overall data collection. Increasing the swathe width from 100m to 160m increased

coverage. For future surveys the aim will be to achieve 100% coverage and ensure that all grab samples coincide with areas of SSS.

NWIFCA

July 2021

Annex A – Solway SSS Line and Transect Plan

Annex B - NWIFCA Sidescan Sonar Survey Transects Log Sheet April 2021

Tow Name	Date	Tow Start Time (UTC)	Start Co-ordinate (dec.degrees)		Tow End Time (UTC)	End Co-ordinates (dec.degrees)		Direction of Tow (degrees)	Speed of Current (knots)	Speed over Ground (knots)	Length of Cable in Water (m)	Depth of Water (m)	Altitude of Towfish (m)
			Lat	Long		Lat	Long						
1A-3A	21/04/21	07:13	54º51.339N	003º25.259W	07:46	54º50.150N	003º27.082W	225º	0.5	2.6	2	8.8	8-10
1B-4B	21/04/21	06:05	54º51.849N	003º24.780W	07:02	54º50.222N	003º27.211W	225º	0.9	1.8	2	11.3	8-10
1C-4C	21/04/21	07:51	54º50.249N	003º27.304W	08:50	54º51.924N	003º24.856W	45º	1	2.0	2	8.5	8-10
1D-4D	21/04/21	11:38	54º50.287N	003º27.444W	12:26	54º51.989N	003º25.945W	45º	0.5	2.5	2	7.6	8-10
1E-4E	21/04/21	12:31	54º52.010N	003º25.095W	13:16	54º50.386N	003º27.492W	225º	0.4	3	2	5.5	8-10
1F-4F	21/04/21	13:19	54º51.443N	003º27.576W	14:00	54º52.003N	003º25.273W	45º	0.1	3	2	10.1	8-10