Annex A **Solway Subtidal Mussels Sonar Survey March 2020**

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 Solway Firth proposed SPA (pSPA), 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 4th and 5th March 2020 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 both days.

Survey Plan

Over the first high water it was decided to commission the Hamon grab as this would be the first time it had been used, and it was expected that there would need to be some adjustments made on the weighting of the grab and practicalities of operating it from North Western Protector.

Based on previous work with the SSS in September 2019 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 1.2 - 2.7 knots. The tidal current speed varied between of 0.6 to 2 knots. The tidal current speed was not recorded for each tow due to the time it took to measure the current speed and the limited amount of time available for SSS work. 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) to ensure that useable data was collected to the edge of the swathe. This meant the area covered was reduced, and to compensate for this the line spacing was reduced. Due to time constraints and not having mapping software available on the survey vessel the line positions had to be adjusted by eye on the Olex system in the wheelhouse.

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 – 50m
- Resolution - Ult
- Frequency - 675kHz

Nine tows (twenty-one 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

The initial setup of the Hamon Grab was trialled across the surveyed area with areas picked at random. Once the Hamon grab had been commissioned and SSS data collected, target locations 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 2.27) 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 2019.2; the geotiff is georeferenced.

Data Acquisition

Twenty one transects were completed in nine tows. Transects 1E and 2E were not completed due to time constraints. By reducing the distance between transects an additional tow (four transects) was completed at the north west of the survey area and these are named 1G-4G.

Seven grab samples were completed whilst commissioning and finding the best set up for the Hamon grab, and a further sixty-one samples were taken from twenty five-target areas.

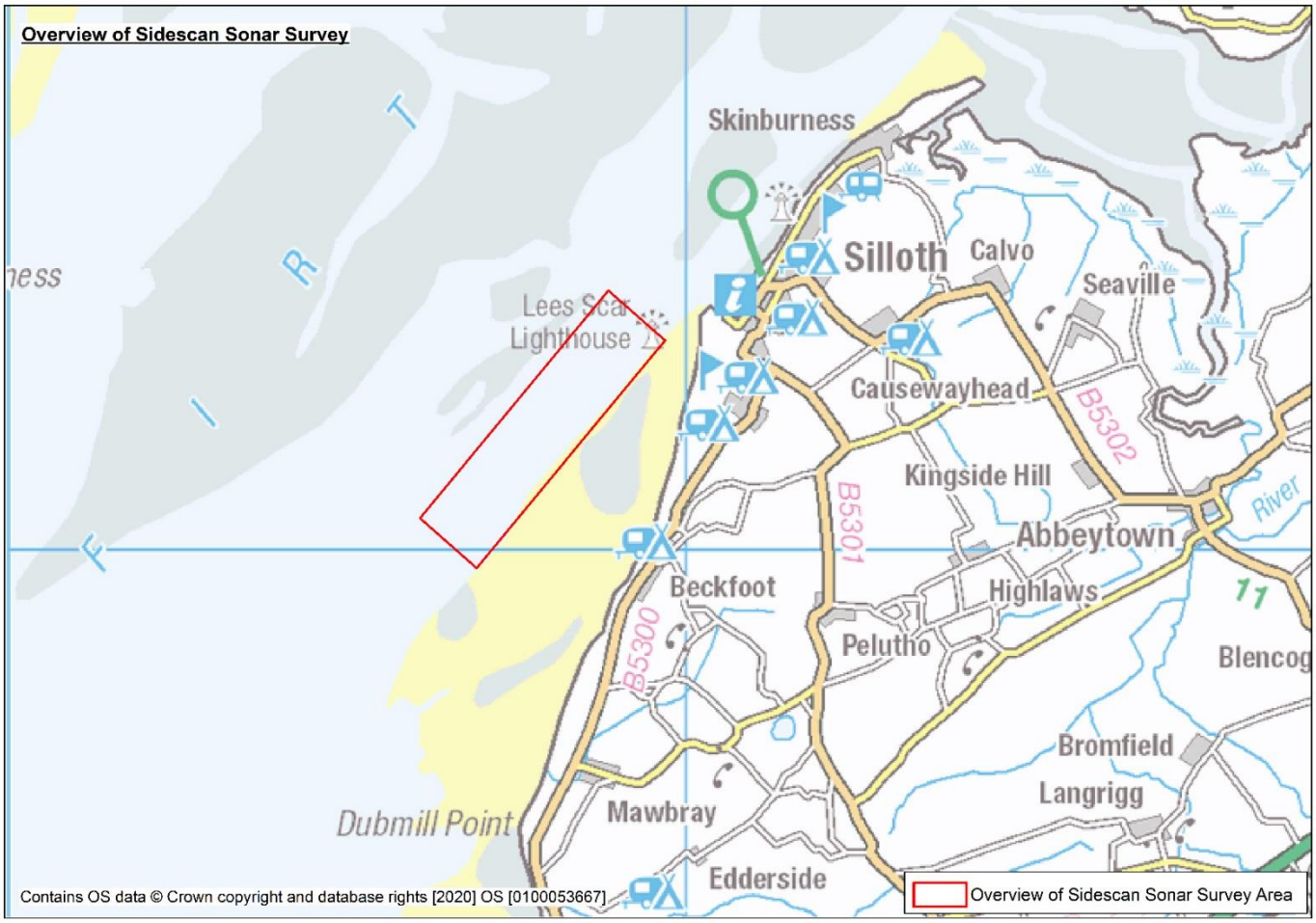

Figure 1 – Overview of the area covered by the SSS survey March 2020

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. Boxes 1-9 (red) contained mussel and boxes 10-20 (green) did not.

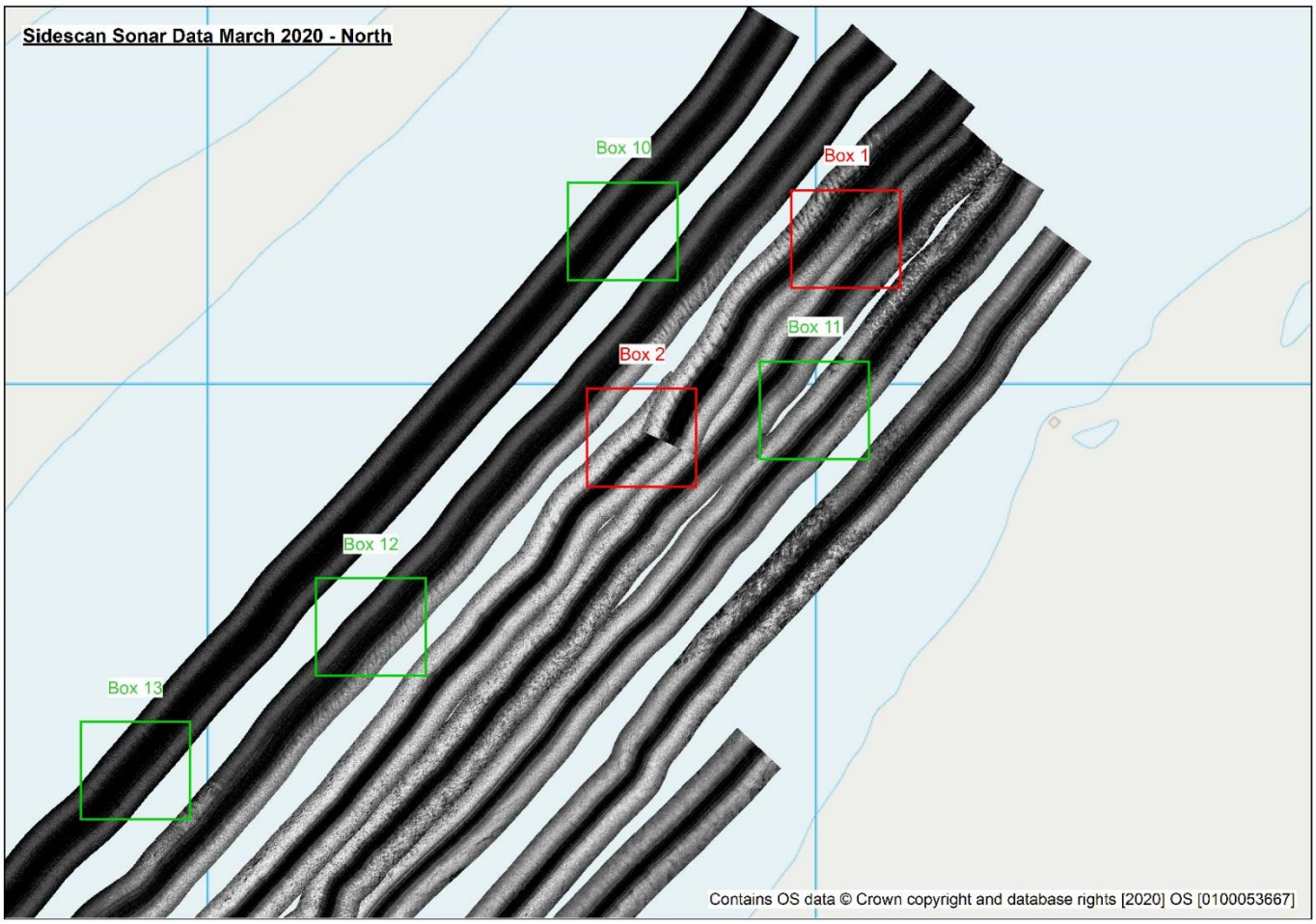

Figure 2 – Image of SSS data from the north of the surveyed area March 2020

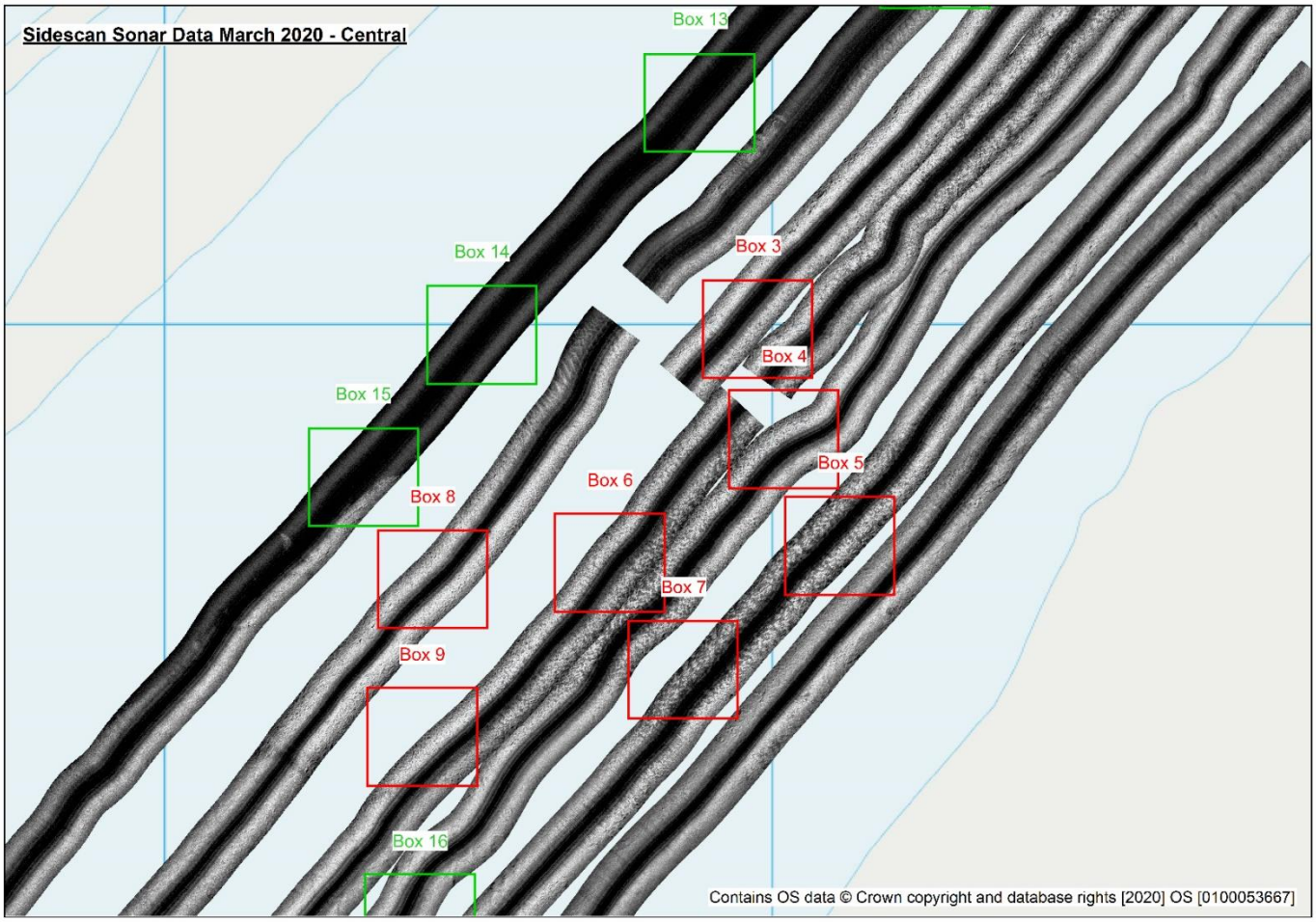

Figure 3 – Image of SSS data from the centre of the surveyed area March 2020

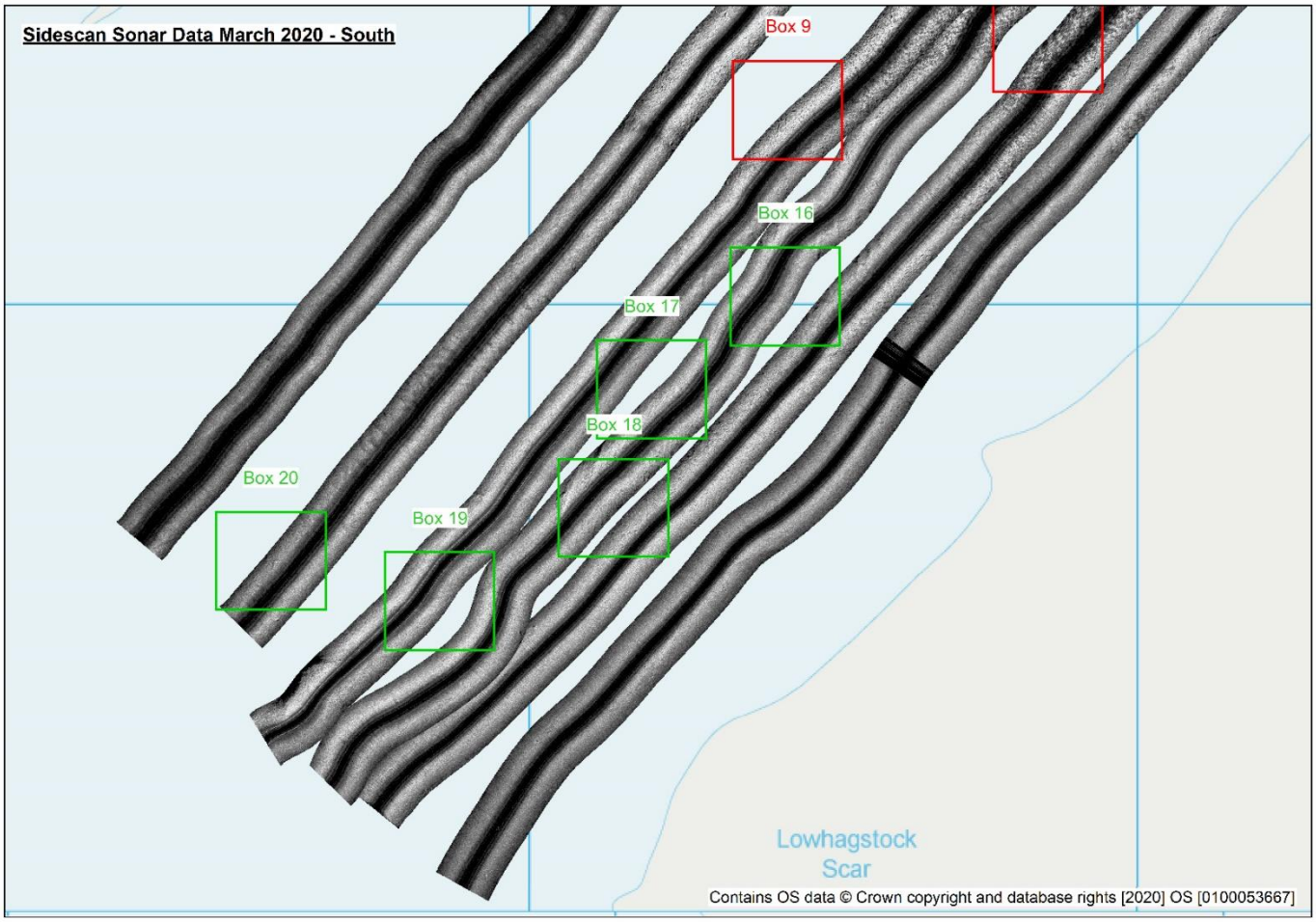

Figure 4 – Image of SSS data from the south of the surveyed area March 2020

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 due to reducing the range to 50m (100m swathe), and not having mapping software and the time to amend the line plan, 100% coverage of the area was not achieved leaving some data gaps.

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 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 and these have been marked as unknown. It is likely that these areas contain harder compacted sediment types or rock. In total there were six samples classified as unknown, shown in Figures 19, 21, 32 and 37.

Although a photo was taken of each sample, a number of photos were of poor quality and it could not be distinguished which sample number they were, and a number of photos were missing due to an issue with the camera. Unfortunately Figures 25, 39 and 40 have no accompanying photos.

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. For this reason nine samples have not been included in the maps as there is no associated SSS data.

i. Mussel

Figures 5, 7, 9, 11, 13, 15, 17, 19 and 21 show higher magnification images of the SSS data around the areas where mussel was present in the grab samples from Boxes 1 to 9. Figures 6, 8, 10, 12, 14, 16, 18, 20 and 22 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 9. Excluding the nine samples that have been omitted from the data, twenty-five samples contained mussel, of those samples twelve contained live mussel only, five contained recently dead mussel only, five contained a mix of live and recently dead mussel and three contained a mixture of live mussel, dead mussel and what appeared to be recently empty shells based on the shell appearance (not discoloured or weathered), defined muscle scar and the strength of the bivalve hinge. In the samples from Box 4 the mussel was a mix of dead mussel and empty shell with only the occasional live mussel which could be a sign of starfish predation. The mussel was present on a range of broad sediment types including mud, sand, mixed sediments, coarse sediments and cobble. A sample in Box 8 (Figure 19) 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 30 to 60mm with the majority being 40-60mm. The mussel was typically clean and free of any fouling and loose with no byssal threads, other than one sample in Box 8 (Figure 19) where the mussel was on cobble and had byssus threads and a small amount of barnacle fouling.

Table 1 – Summary of the substrate and condition of mussel in Boxes 1 to 9

Box	Sample	Broad Sediment Type	Live Mussel	Dead Mussel	Empty Shell	Size Class of Mussel (mm)
1	1	Mud and muddy sand	N	Y	N	-
	2	Mud and muddy sand	Y	Y	N	60
	3	Mixed	N	Y	N	-
2	1	Mixed	Y	N	N	50-60
	2	Mud and muddy sand	Y	Y	N	40-60
3	1	Mixed	Y	N	N	50-60
	2	Mud and muddy sand	Y	Y	N	50-60
4	1	Mud and muddy sand	Y	Y	Y	40-60
	2	Mud and muddy sand	Y	Y	Y	40-50
	3	Mud and muddy sand	Y	Y	Y	40-60
5	1	Mud and muddy sand	N	Y	N	-

	2	Mud and muddy sand	Y	Y	N	45-60
	3	Mud and muddy sand	Y	N	N	45
6	1	Mud and muddy sand	Y	N	N	50
	2	Mixed	Y	Y	N	40-60
7	1	Mud and muddy sand	N	Y	N	-
	2	Mud and muddy sand	N	Y	N	-
	3	Mud and muddy sand	Y	N	N	30-50
8	1	Sand and sandy mud	Y	N	N	50-60
	2	Sand and sandy mud	Y	N	N	50-60
	3	Sand and sandy mud	Y	N	N	50-60
	4	Cobble	Y	N	N	50-60
	5	Unknown	Y	N	N	45-50
9	1	Sand and sandy mud	Y	N	N	50-60
	2	Coarse	Y	N	N	55

ii. Starfish

Four grab samples contained starfish, three samples in Box 4 (Figure 11) and one in Box 9 (Figure 21). Figure 12 shows images of samples that contained starfish. As the Hamon Grab sample surface area is 0.1m² and the samples contained four large starfish, this could indicate a significant starfish presence in these areas.

iii. Sabellaria spp.

Nine grab samples contained *Sabellaria* spp*.* tubes; eight were historic tubes with no live S*abellaria* spp. polychaetes present and one sample contained live specimens. A summary is provided in Table 2. (Where *Sabellaria* spp. has been classified as historic 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).. Three of the higher magnification mussel boxes contained dead historic *Sabellaria* spp*.* tubes. In Box 1 (Figure 5) all three of the samples contained dead historic tubes; in Box 3 (Figure 9) one sample contained dead historic tubes and Box 5 contained two samples with dead historic tubes. Two of the higher magnification non mussel boxes contained historic *Sabellaria* spp*.* tubes and one box contained live *Sabellaria* spp*.* Box 11 (Figure 25) contained one sample of historic dead *Sabellaria* spp*.* tubes, and Box 18 (Figure 37) contained one sample of historic dead *Sabellaria* spp*.* tubes and one live sample.

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

Box	Sample	Sediment	Live and / or Dead Mussel	Sabellaria spp.
1	1	Mud and muddy sand	Y	Dead
	2	Mud and muddy sand	Y	Dead
	3	Mixed	Y	Dead
3	1	Mixed	Y	Dead
5	1	Mud and muddy sand	Y	Dead
	3	Mud and muddy sand	Y	Dead
11	1	Mud and muddy sand	N	Dead
18	1	Coarse	N	Dead
	2	Coarse	N	Alive

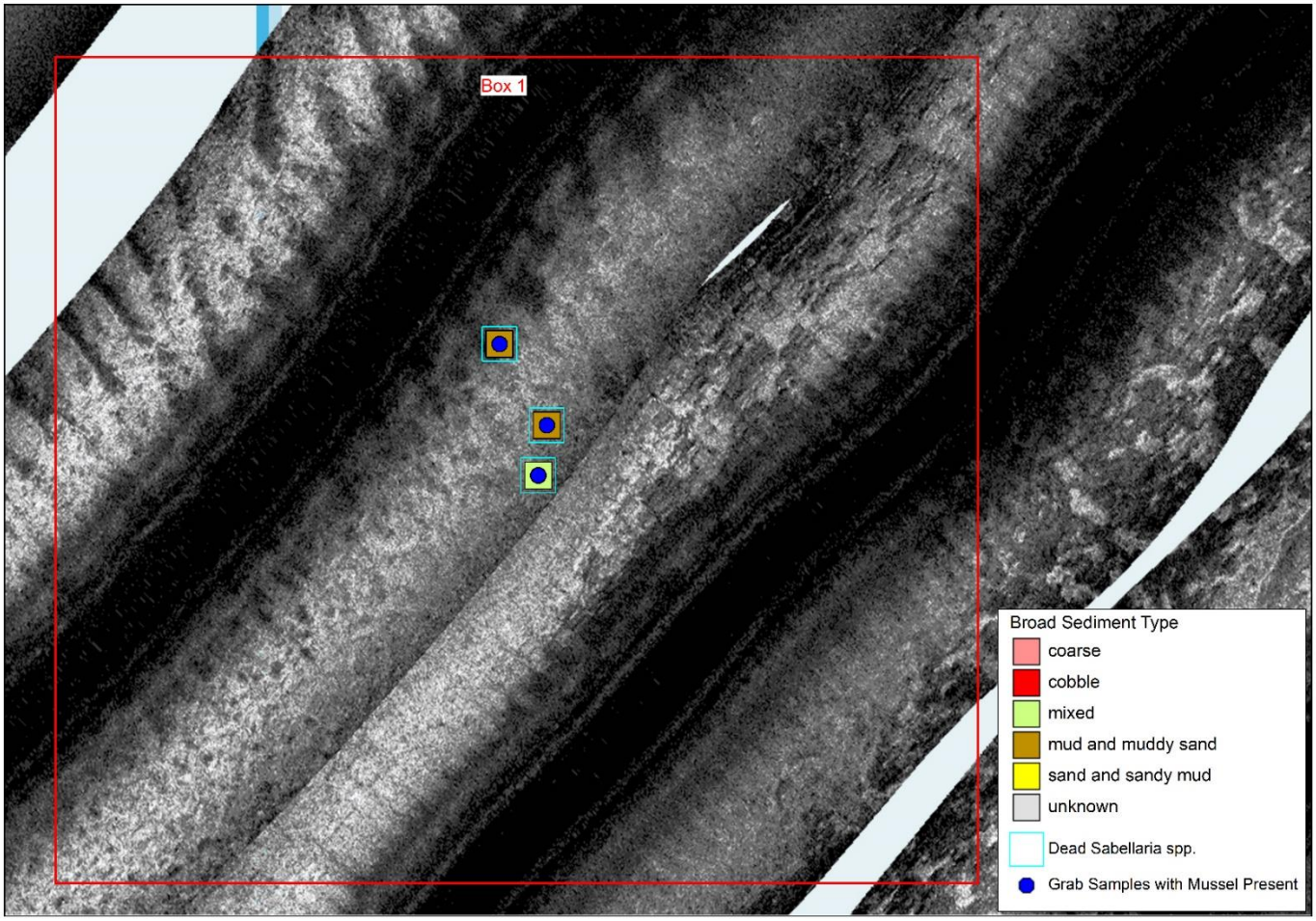

Figure 5 – Higher magnification of SSS data from Box 1 and grab sample contents for ground-truthing

Figure 6 – Hamon Grab samples taken from Box 1

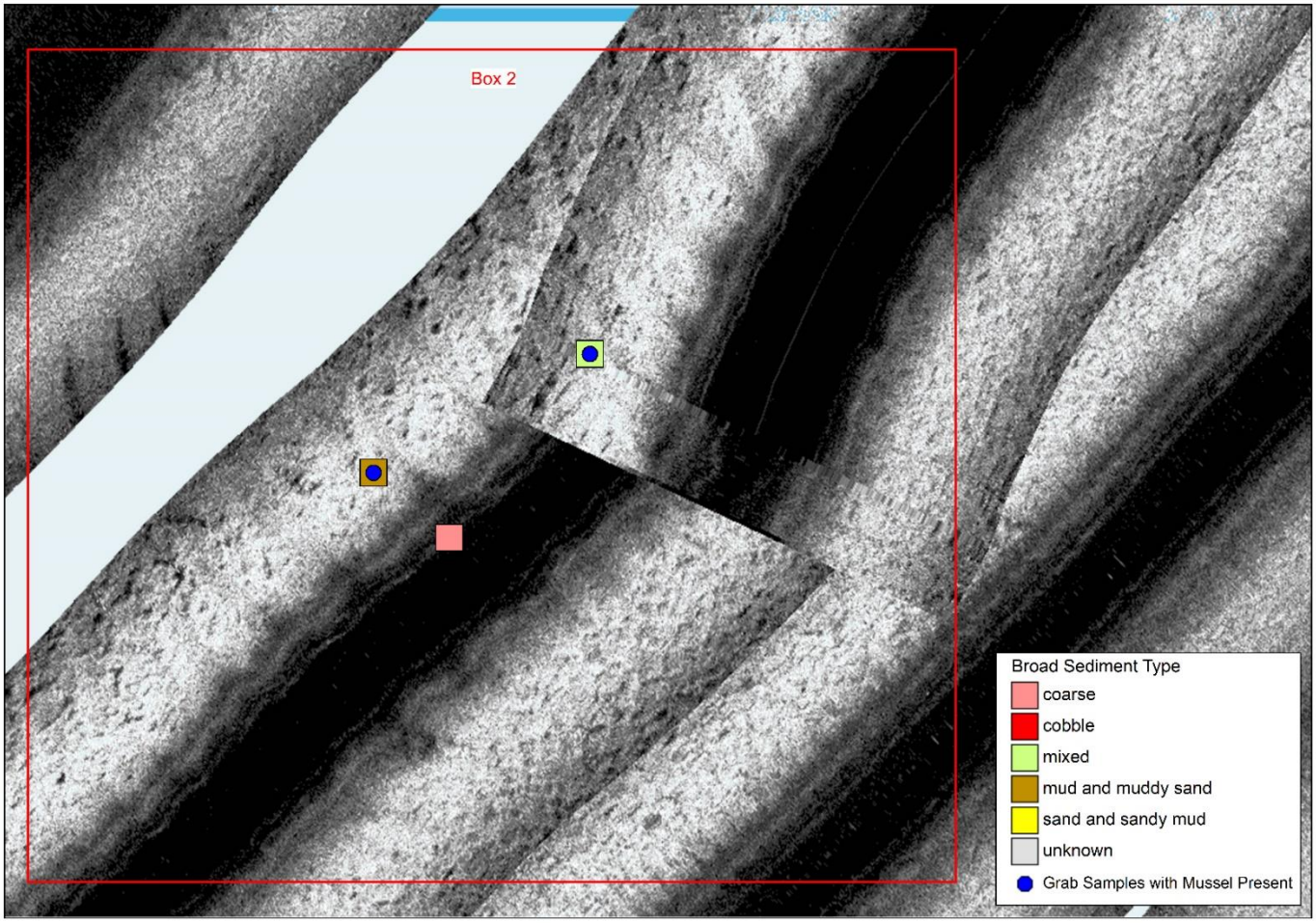

Figure 7 – Higher magnification of SSS from Box 2 and grab sample contents for ground-truthing

Figure 8 – Hamon Grab samples taken from Box 2

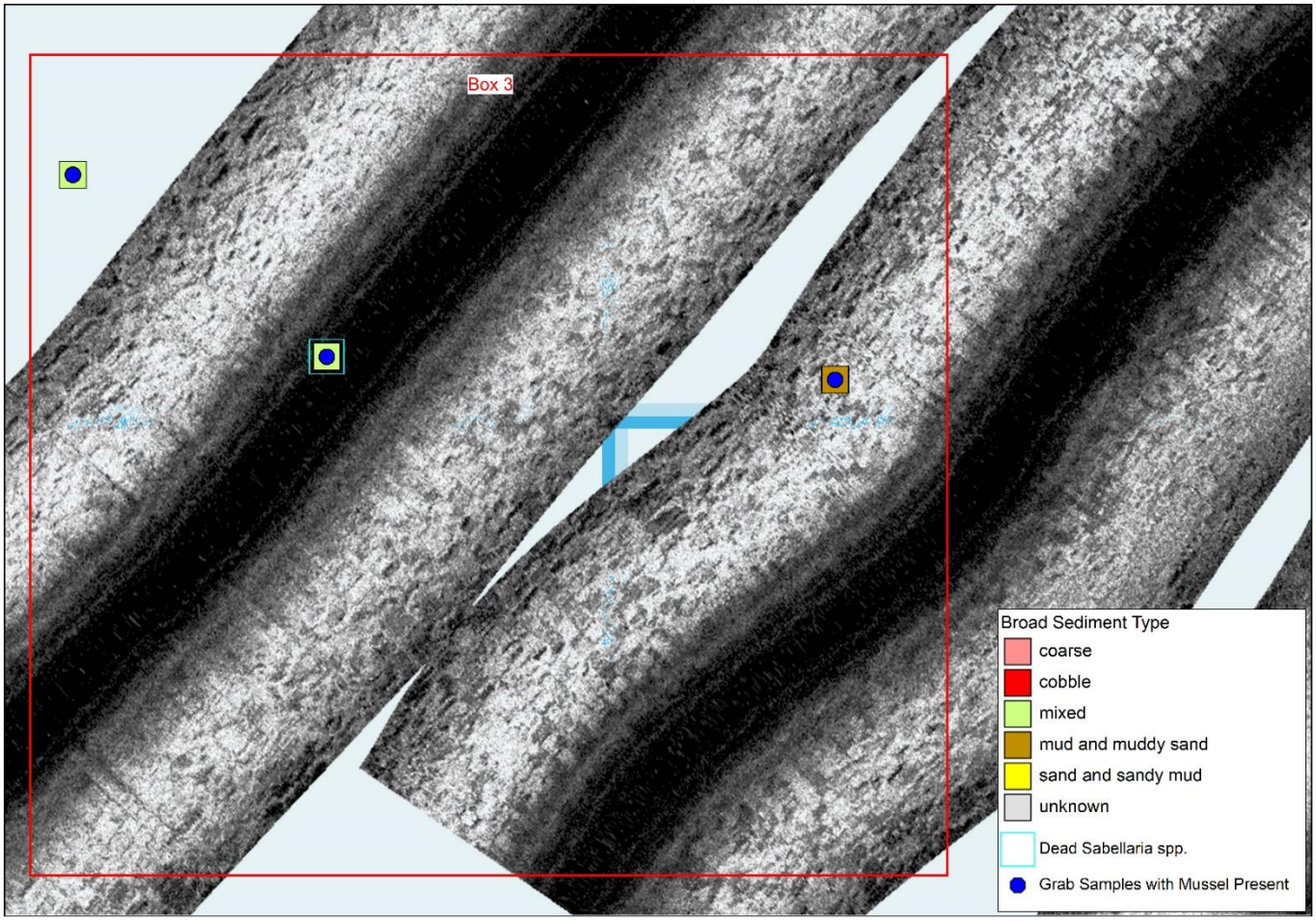

Figure 9 – Higher magnification of SSS from Box 3 and grab sample contents for ground-truthing

Figure 10 – Hamon Grab samples taken from Box 3

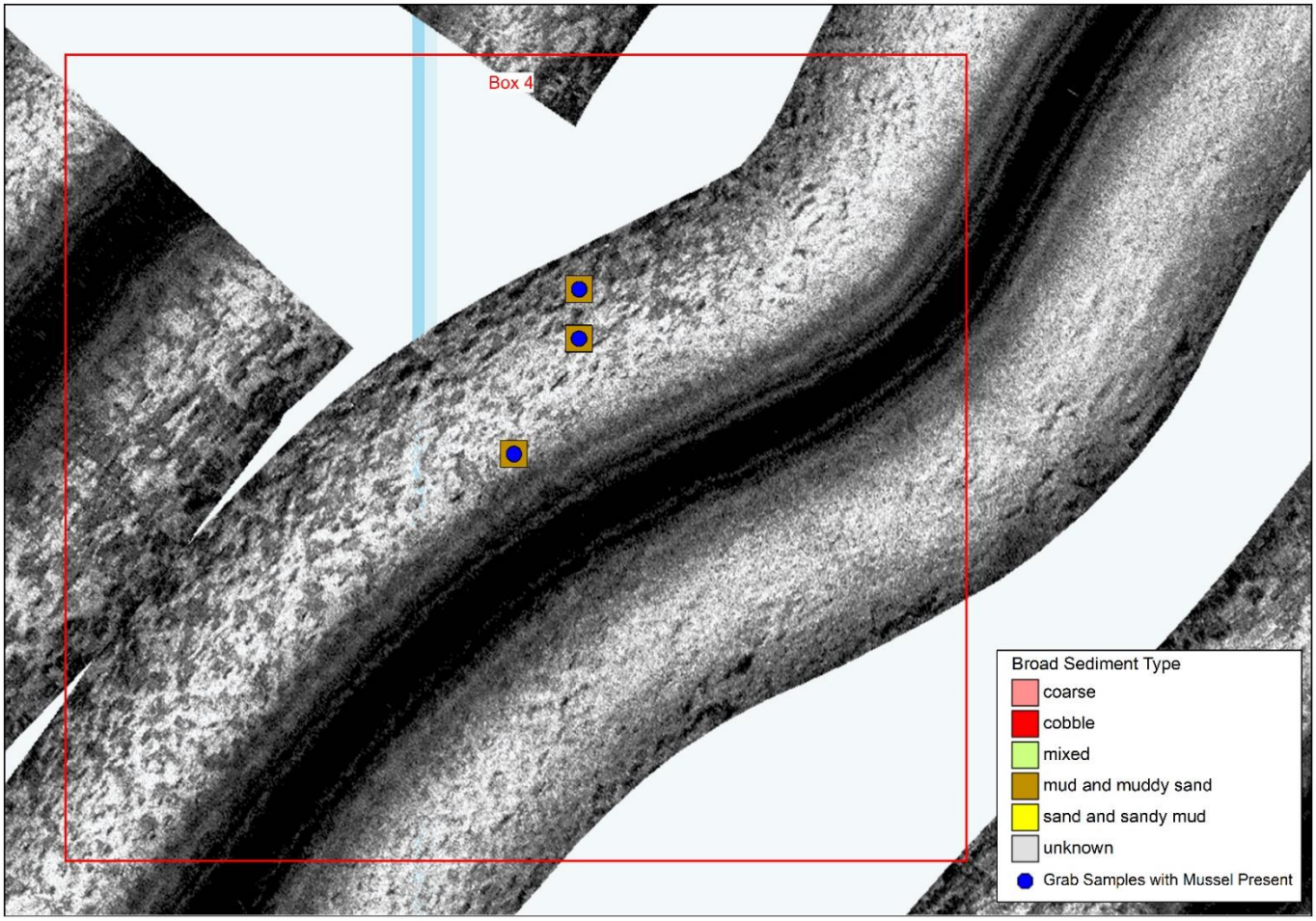

Figure 11 – Higher magnification of SSS from Box 4 and grab sample contents for ground-truthing

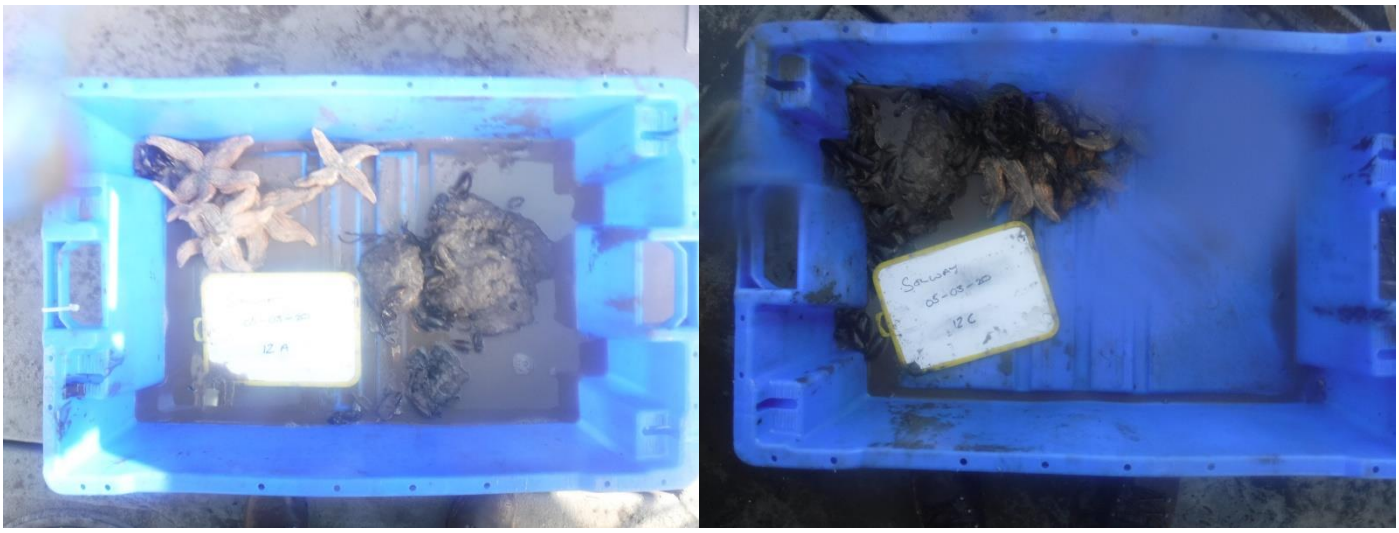

Figure 12 – Hamon Grab samples taken from Box 4

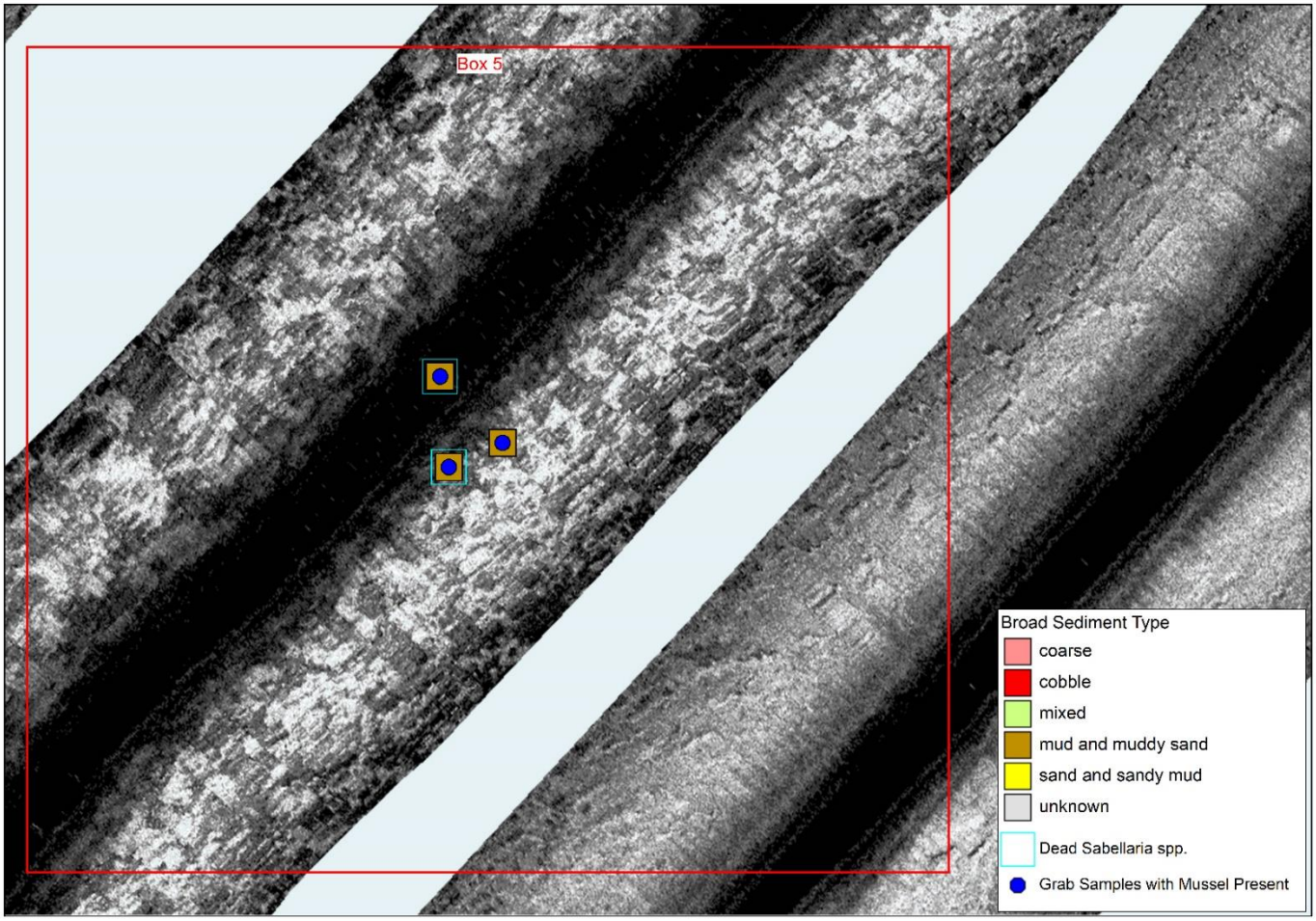

Figure 13 – Higher magnification of SSS from Box 5 and grab sample contents for ground-truthing

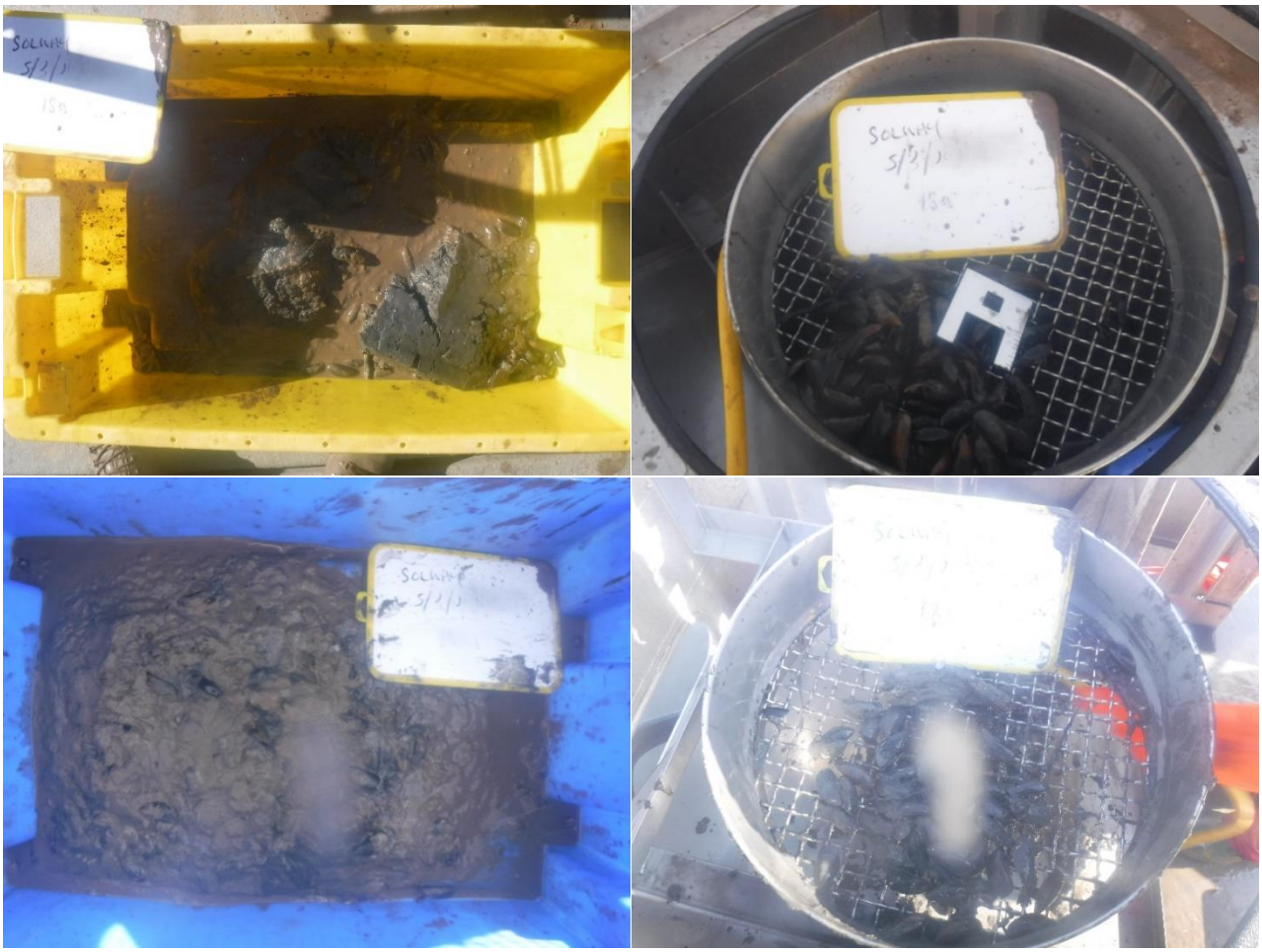

Figure 14 – Hamon Grab samples taken from Box 5

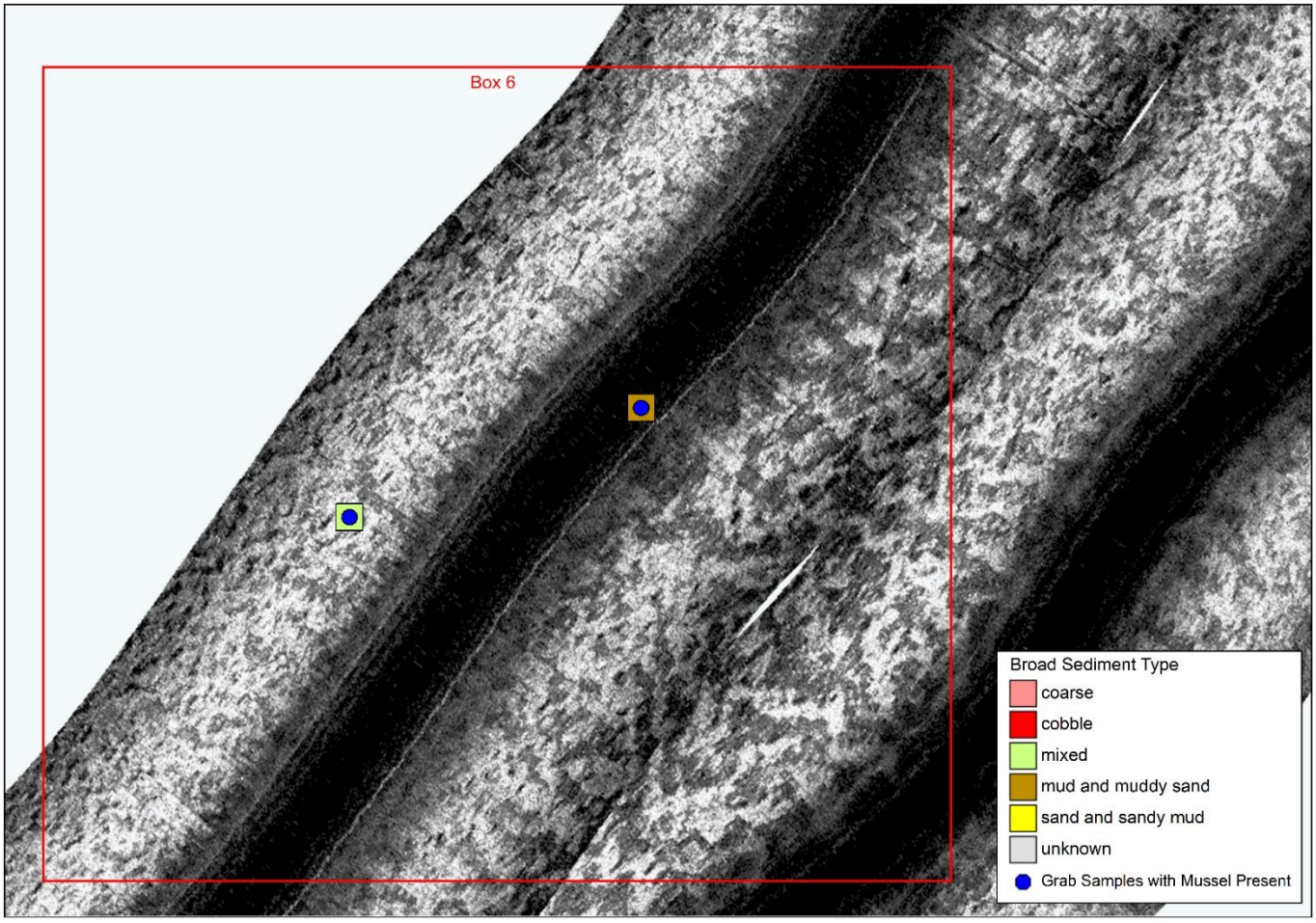

Figure 15 – Higher magnification of SSS from Box 6 and grab sample contents for ground-truthing

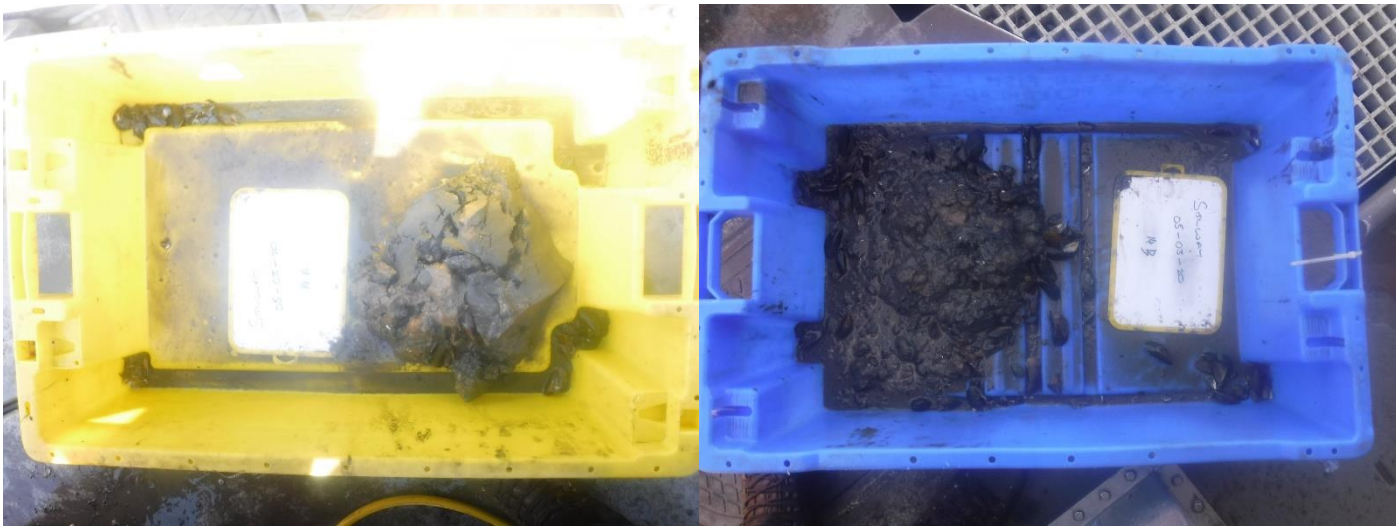

Figure 16 – Hamon Grab samples taken from Box 5

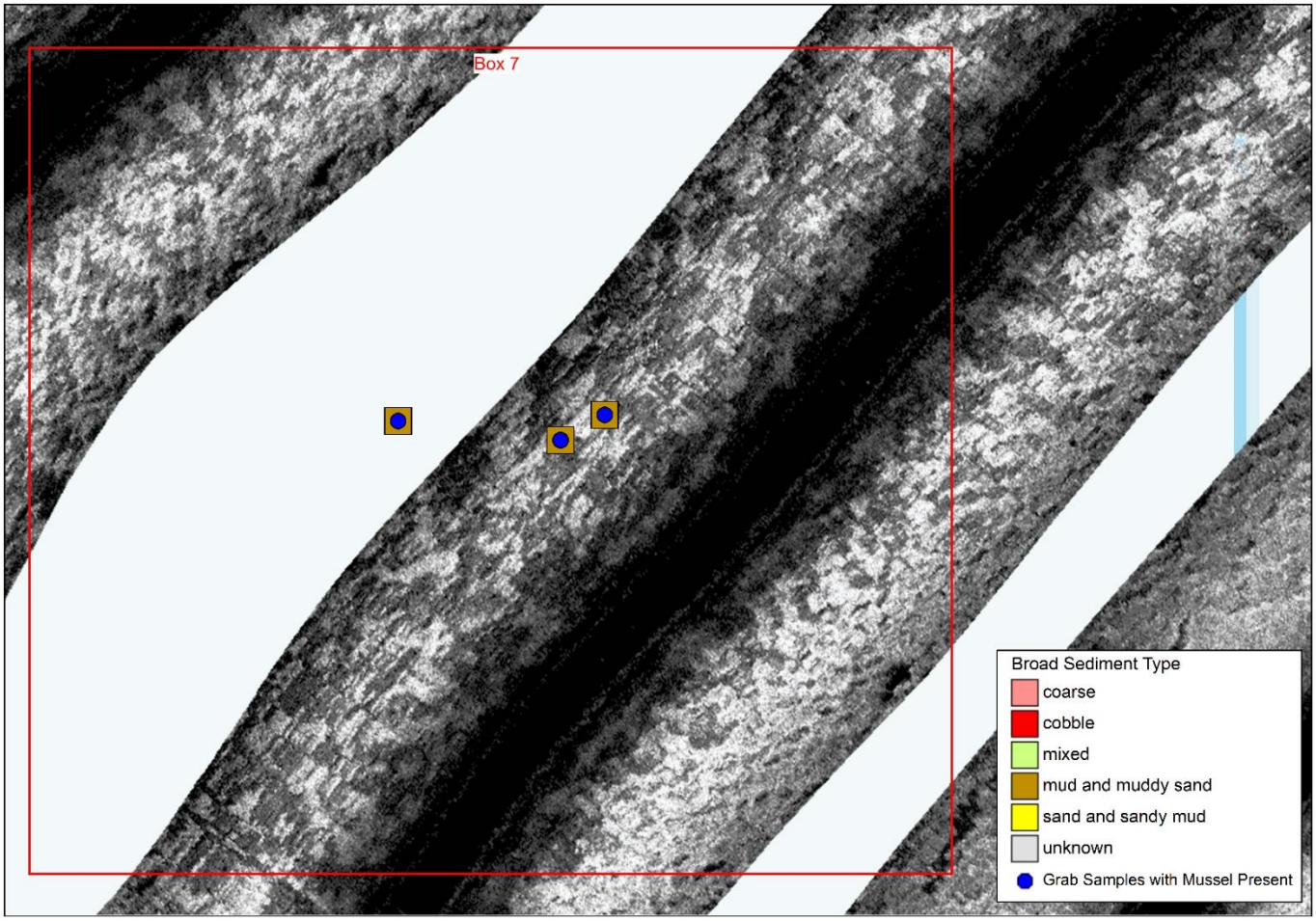

Figure 17 – Higher magnification of SSS from Box 7 and grab sample contents for ground-truthing

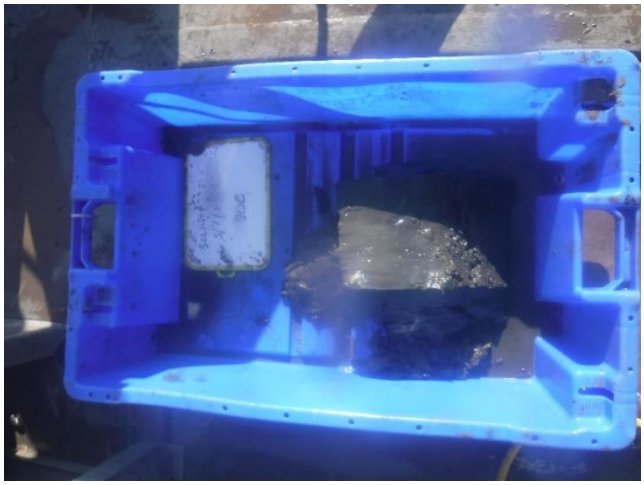

Figure 18 – Hamon Grab samples taken from Box 7

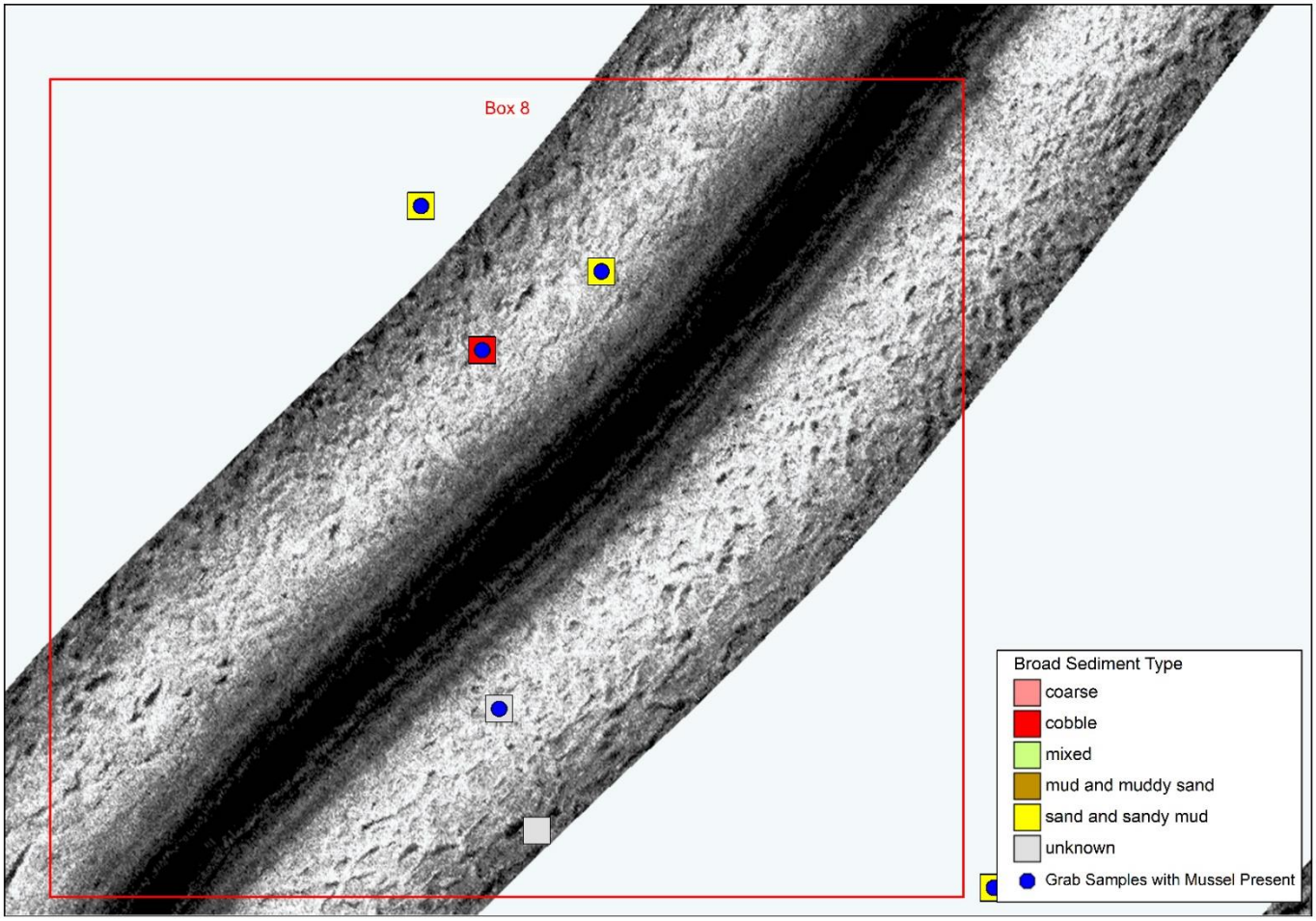

Figure 19 – Higher magnification of SSS from Box 8 and grab sample contents for ground-truthing

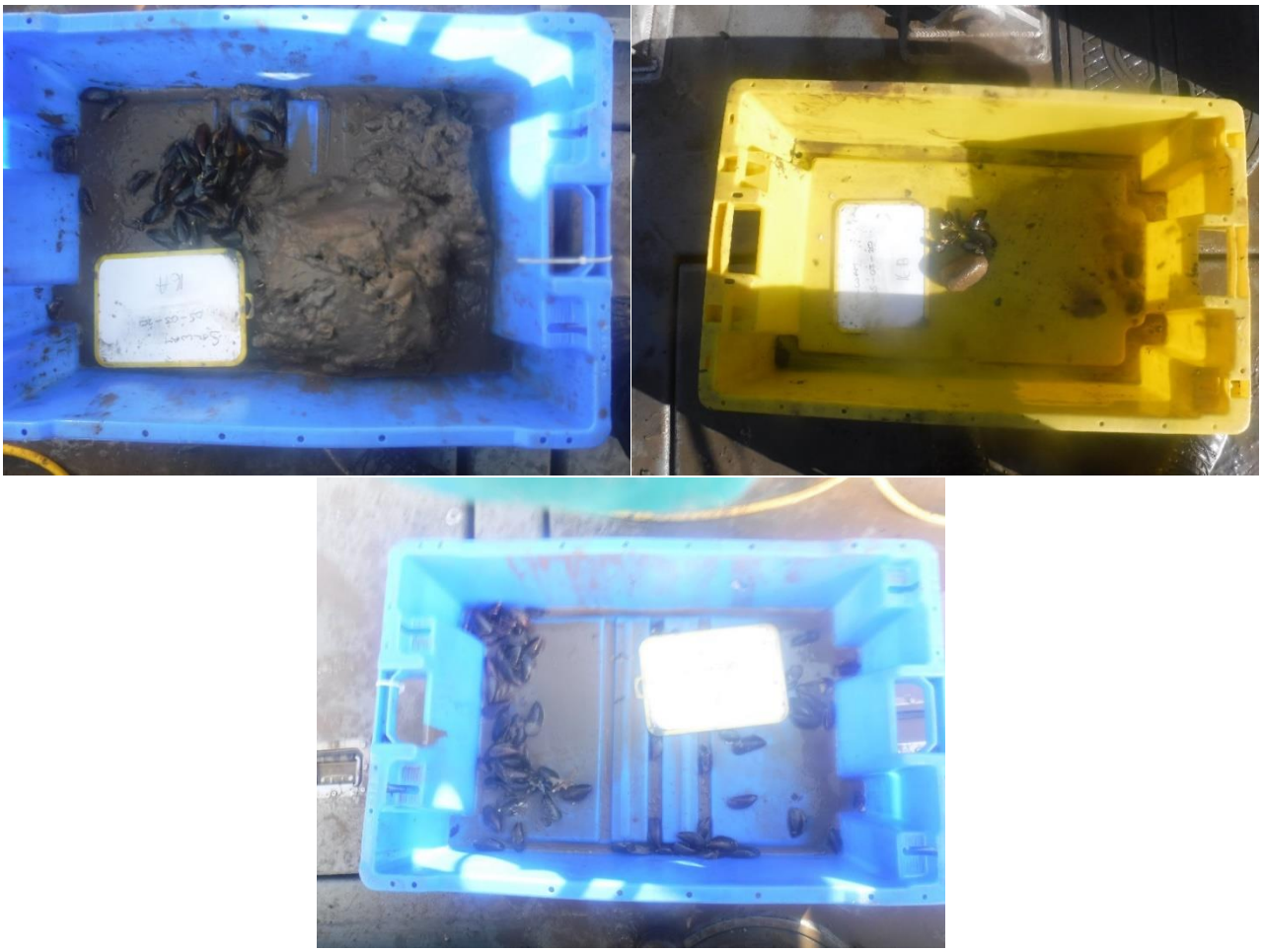

Figure 20 – Hamon Grab samples taken from Box 8

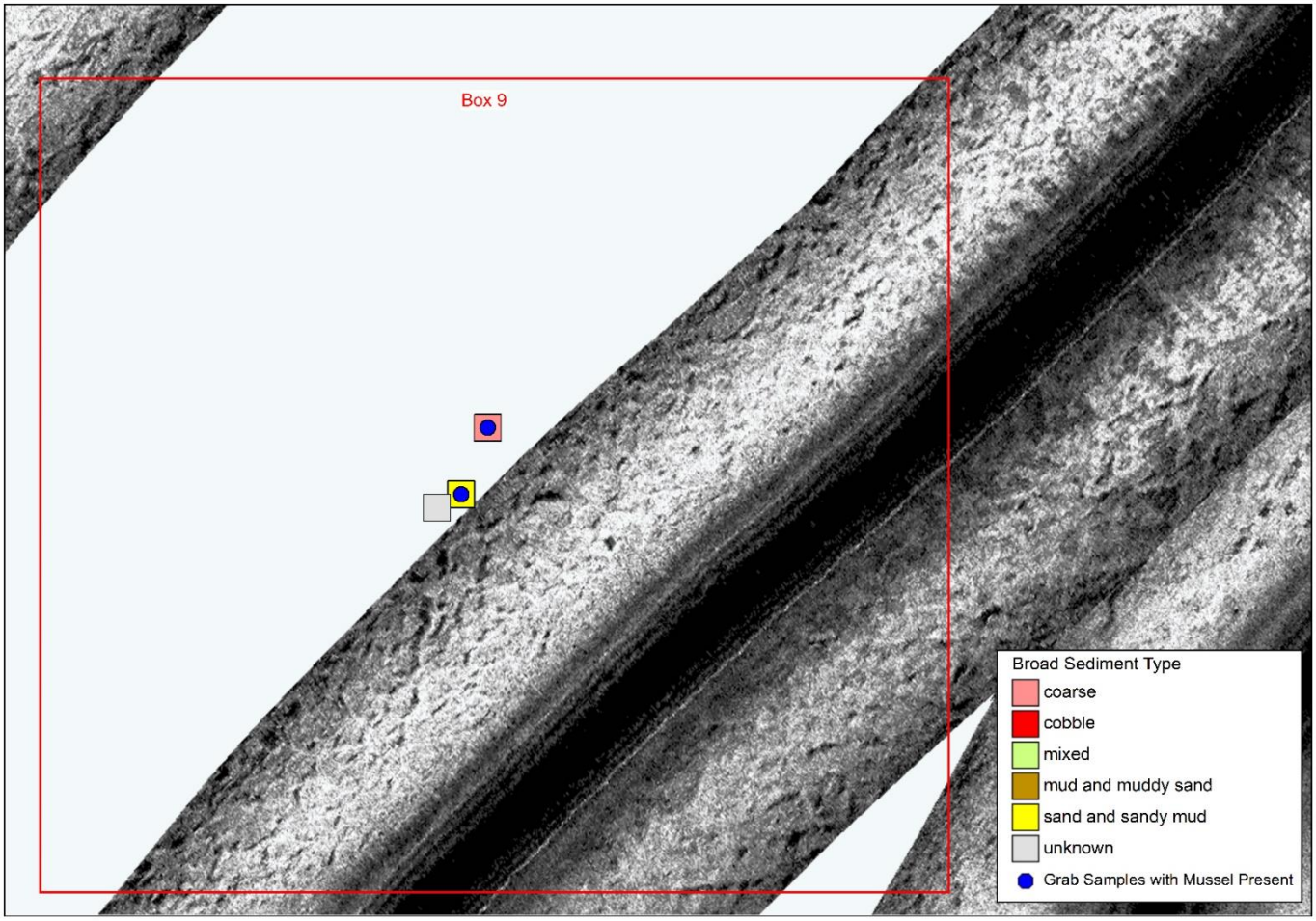

Figure 21 – Higher magnification of SSS from Box 9 and grab sample contents for ground-truthing

Figure 22 – Hamon Grab samples taken from Box 9

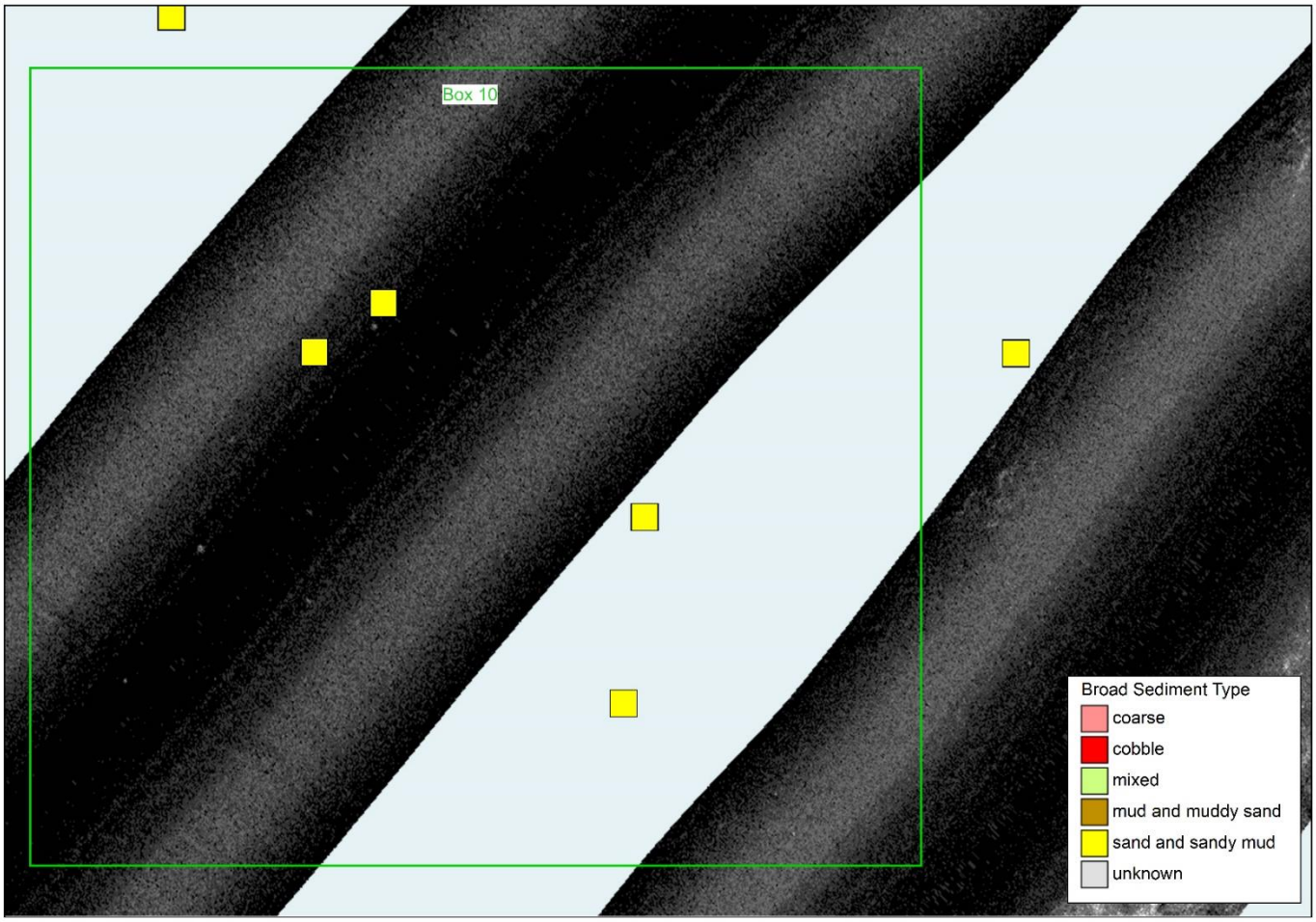

Figure 23 – Higher magnification of SSS from Box 10 and grab sample contents for ground-truthing

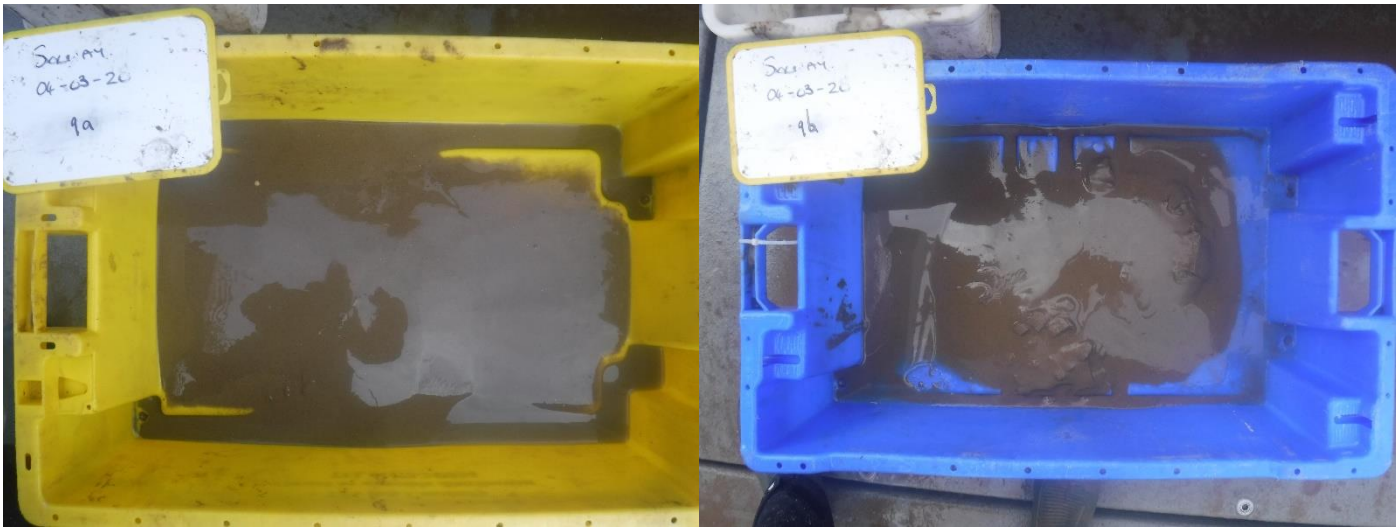

Figure 24 – Hamon Grab samples taken from Box 10

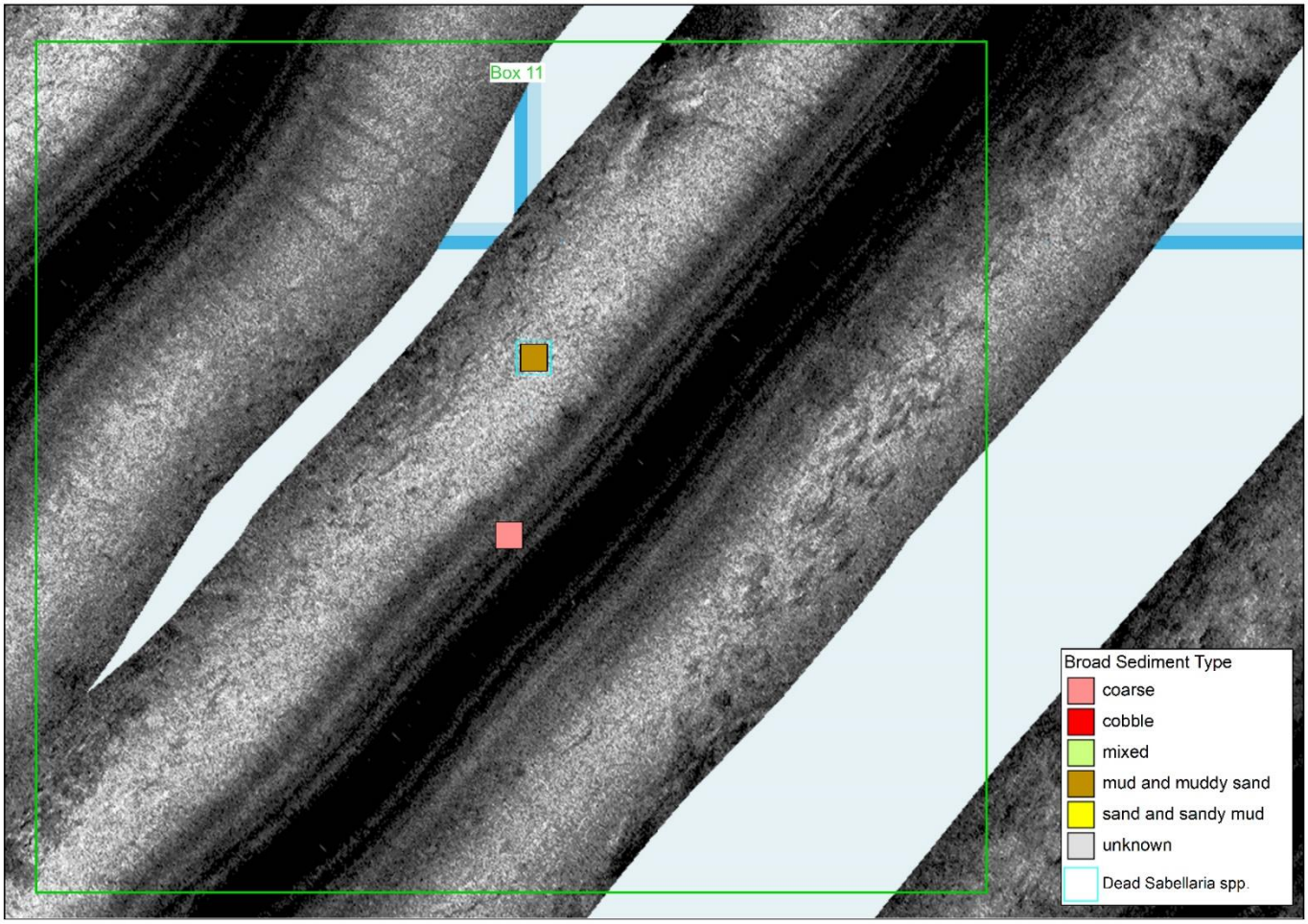

Figure 25 – Higher magnification of SSS from Box 11 and grab sample contents for ground-truthing

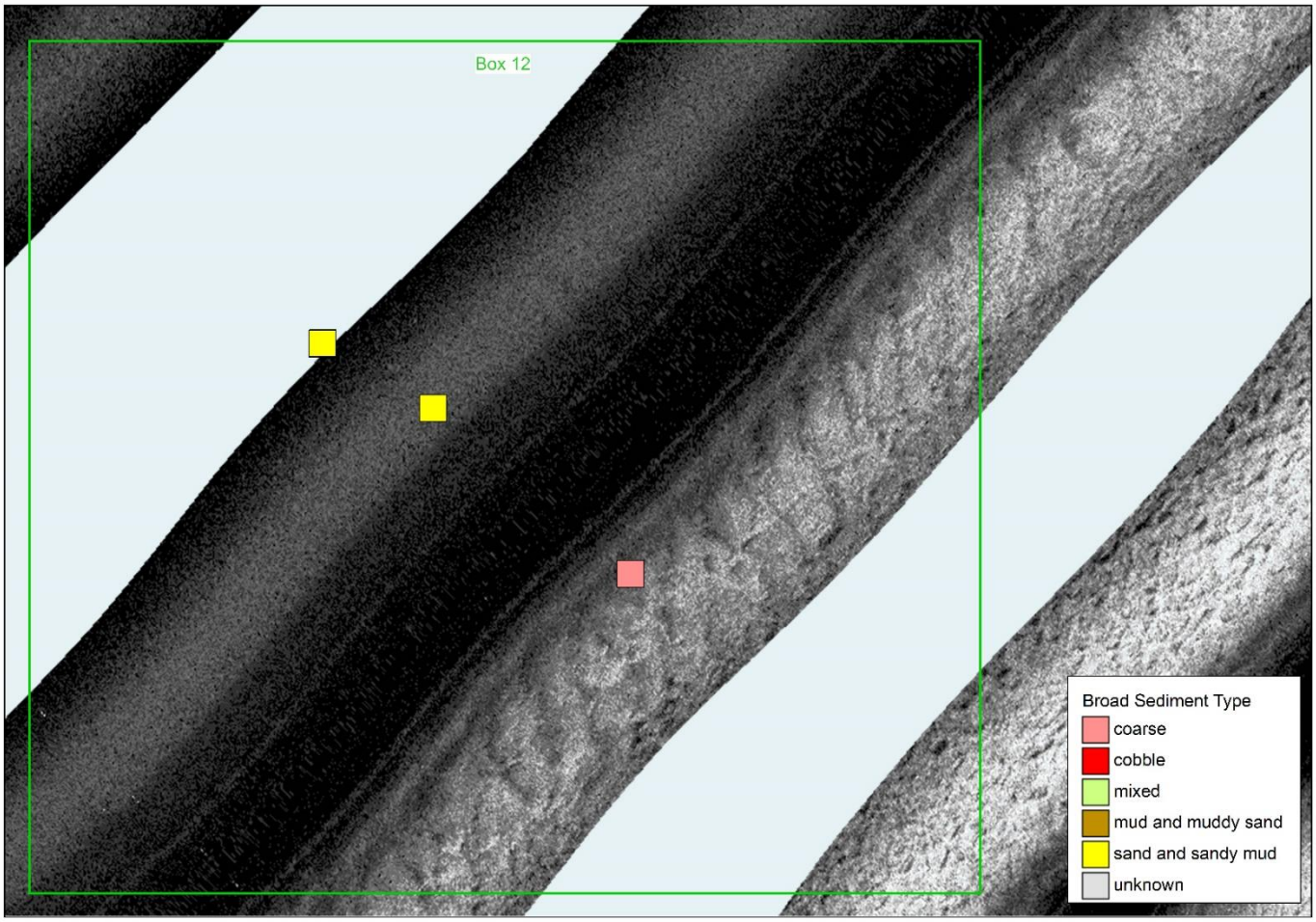

Figure 26 – Higher magnification of SSS from Box 12 and grab sample contents for ground-truthing

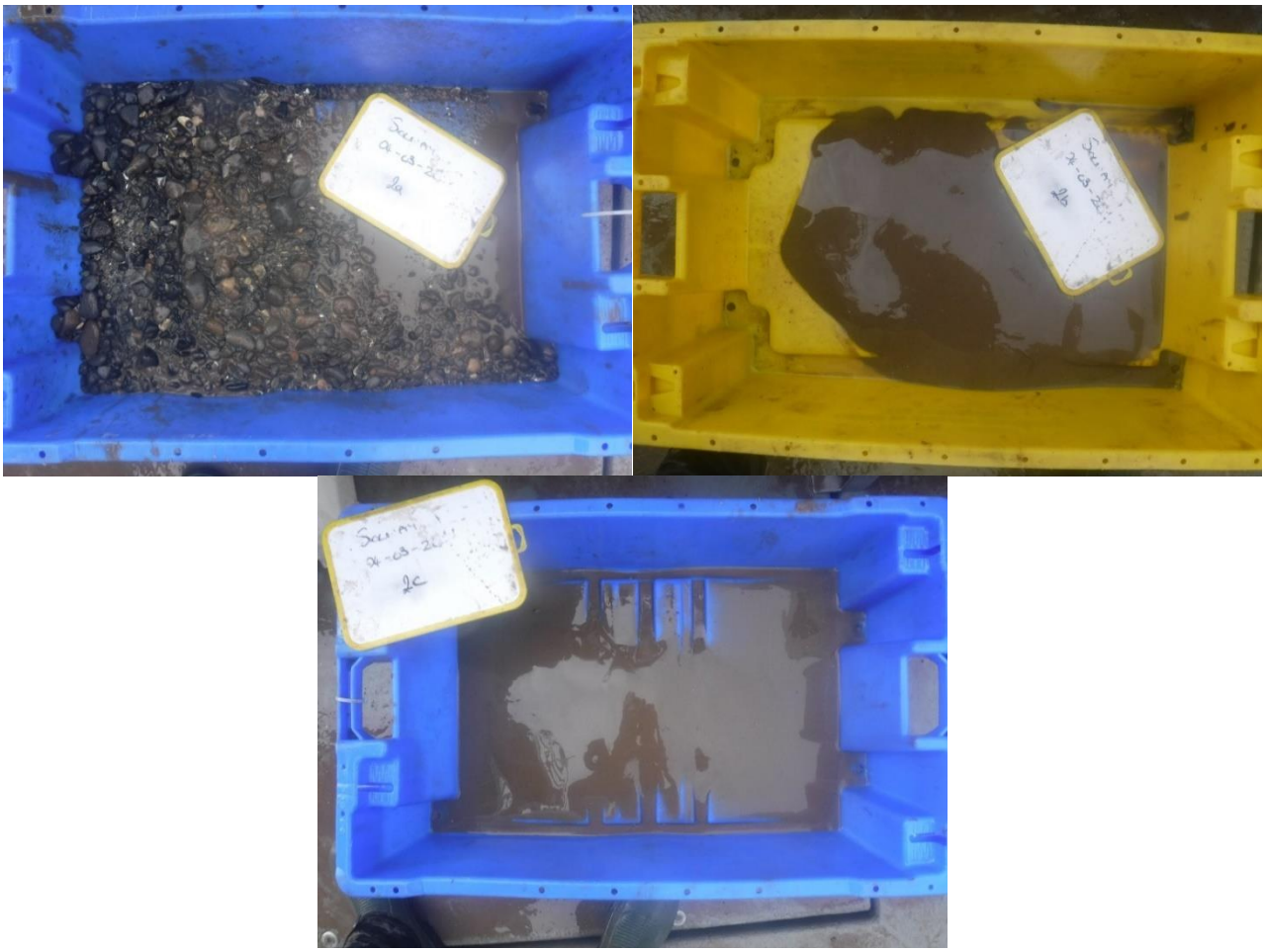

Figure 27 – Hamon Grab samples taken from Box 12

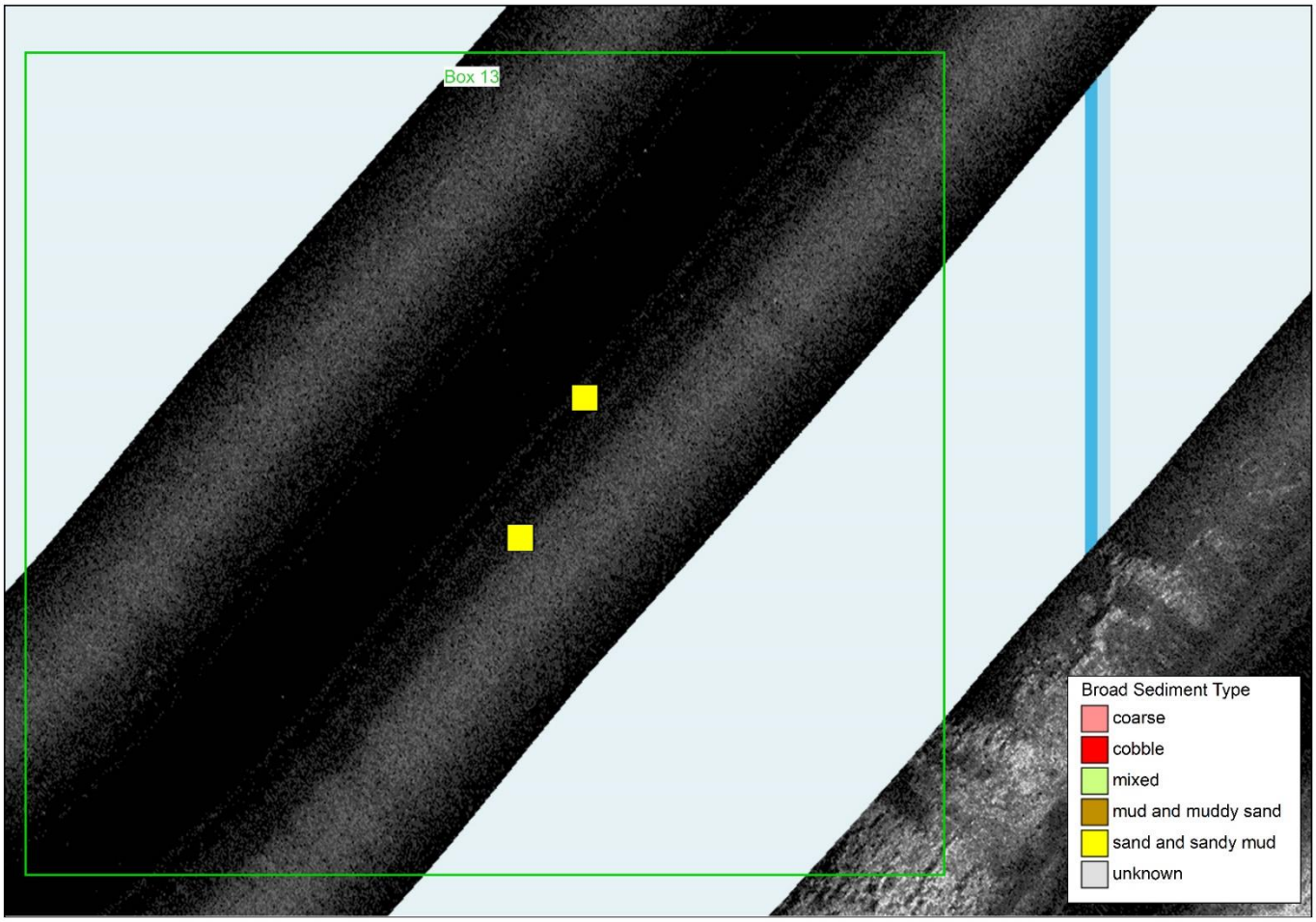

Figure 28 – Higher magnification of SSS from Box 13 and grab sample contents for ground-truthing

Figure 29 – Hamon Grab samples taken from Box 13

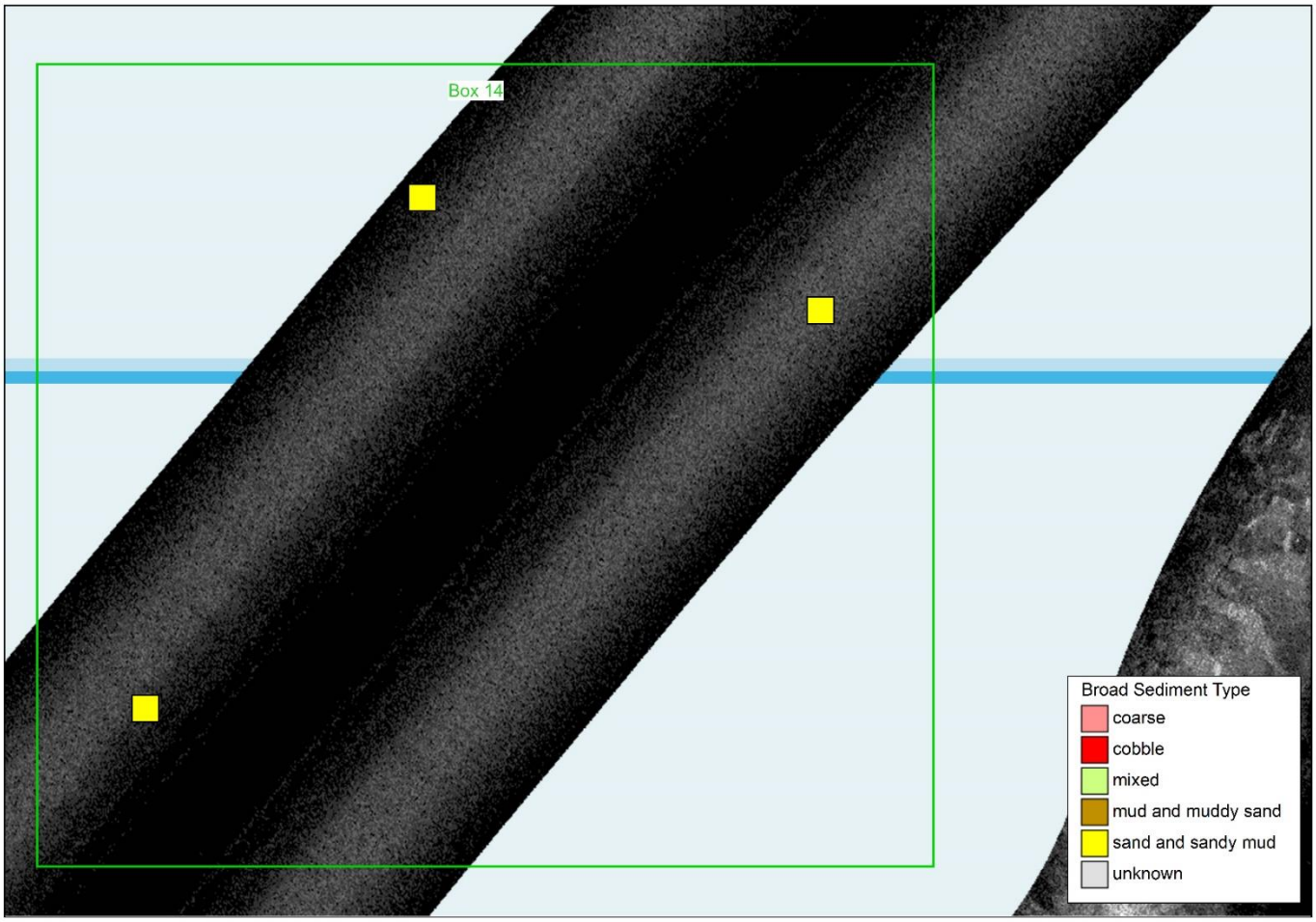

Figure 30 – Higher magnification of SSS from Box 14 and grab sample contents for ground-truthing

Figure 31 – Hamon Grab samples taken from Box 14

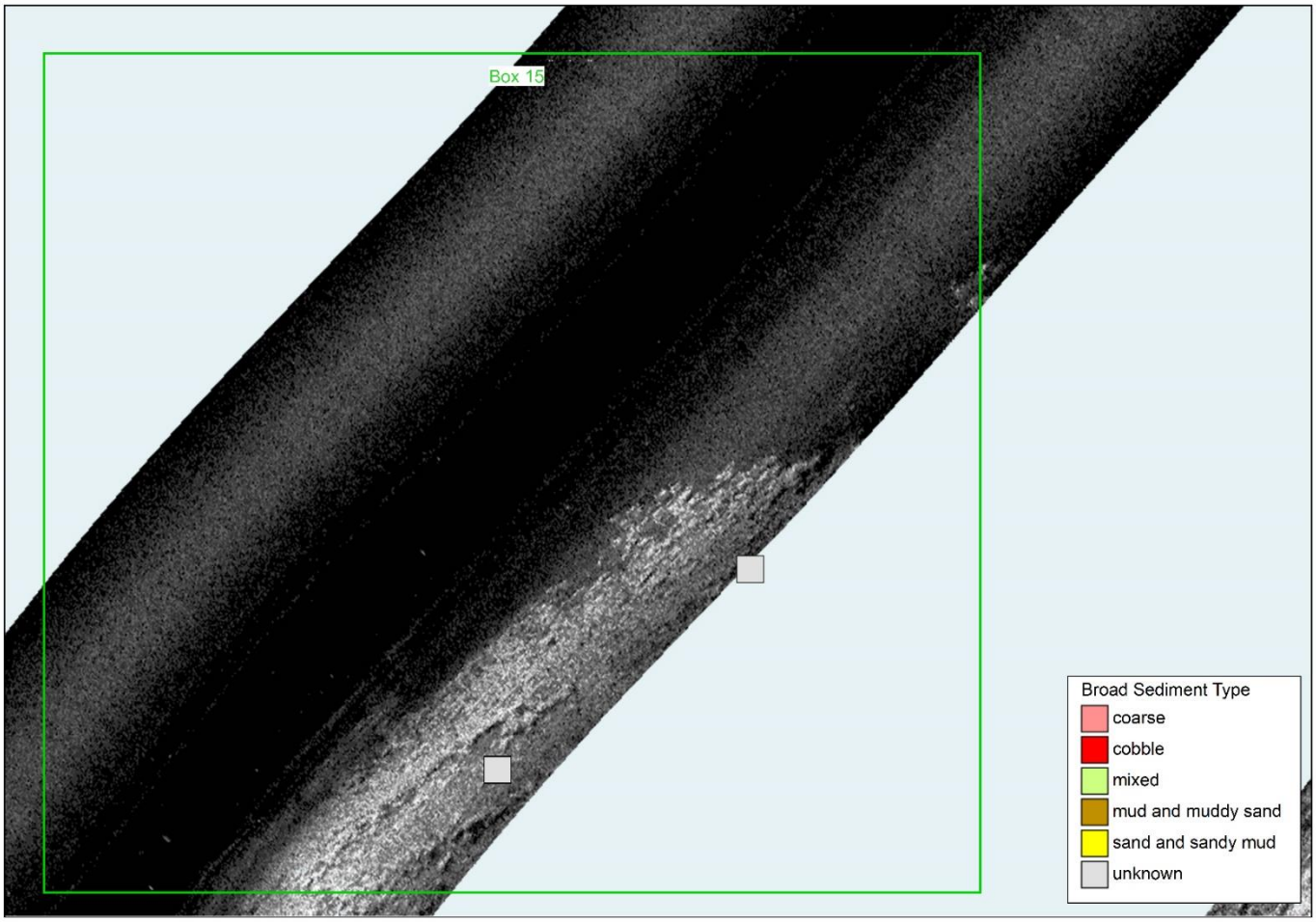

Figure 32 – Higher magnification of SSS from Box 15 and grab sample contents for ground-truthing

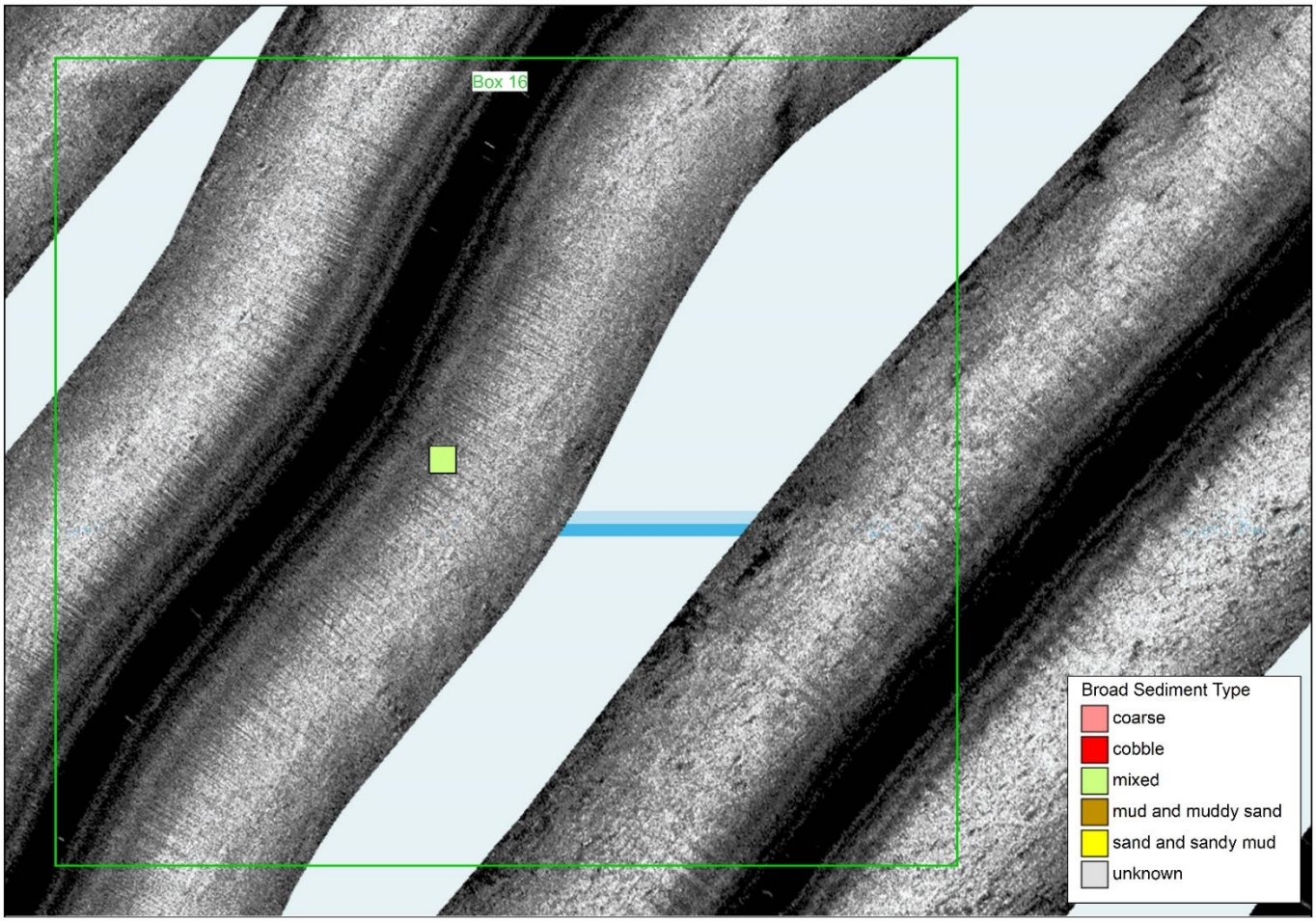

Figure 33– Higher magnification of SSS from Box 16 and grab sample contents for ground-truthing

Figure 34 – Hamon Grab samples taken from Box 16

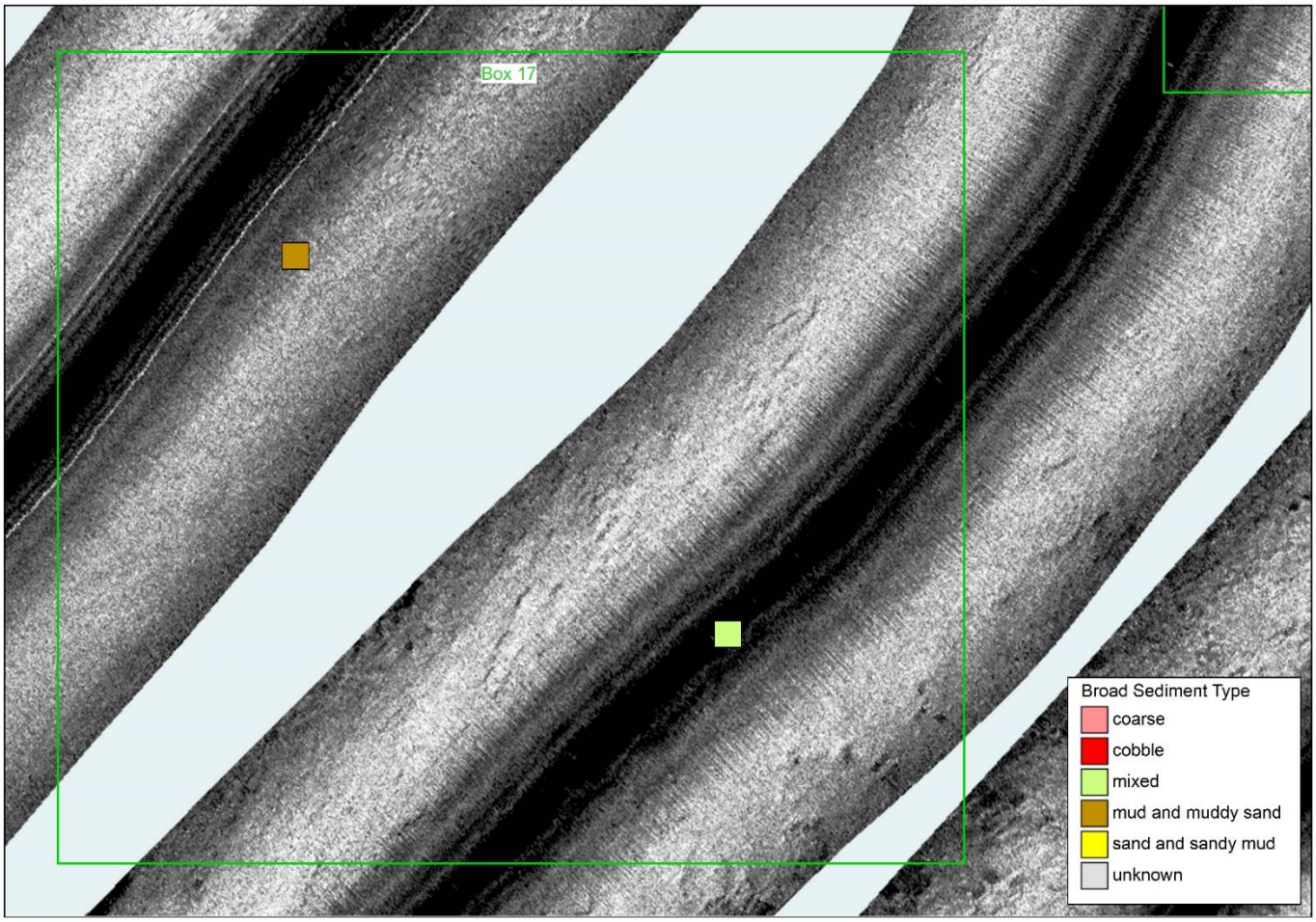

Figure 35 – Higher magnification of SSS from Box 17 and grab sample contents for ground-truthing

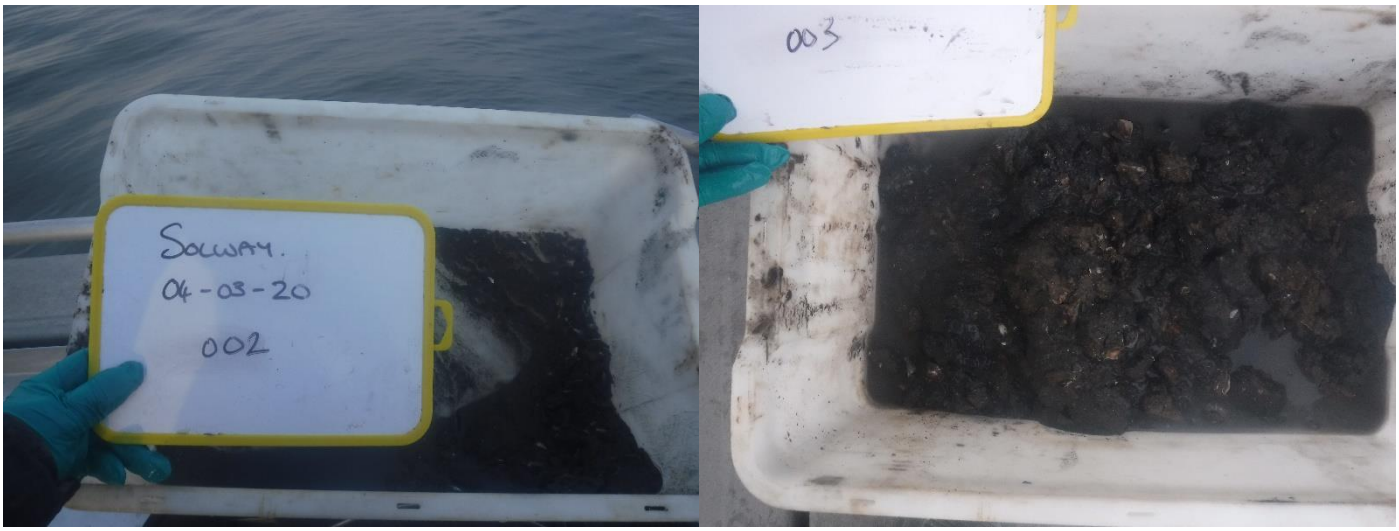

Figure 36 – Hamon Grab samples taken from Box 17

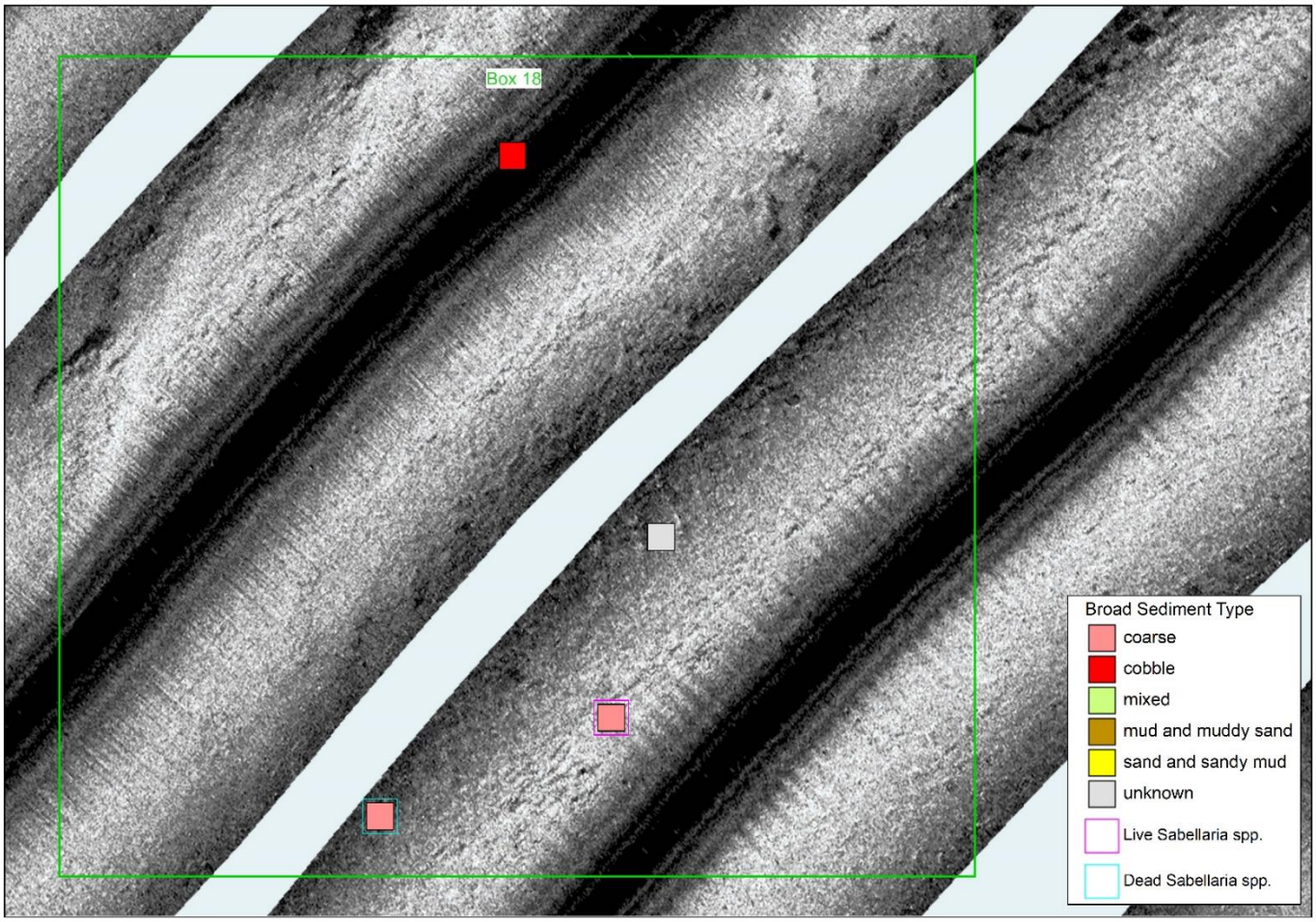

Figure 37 – Higher magnification of SSS from Box 18 and grab sample contents for ground-truthing

Figure 38 – Hamon Grab samples taken from Box 18

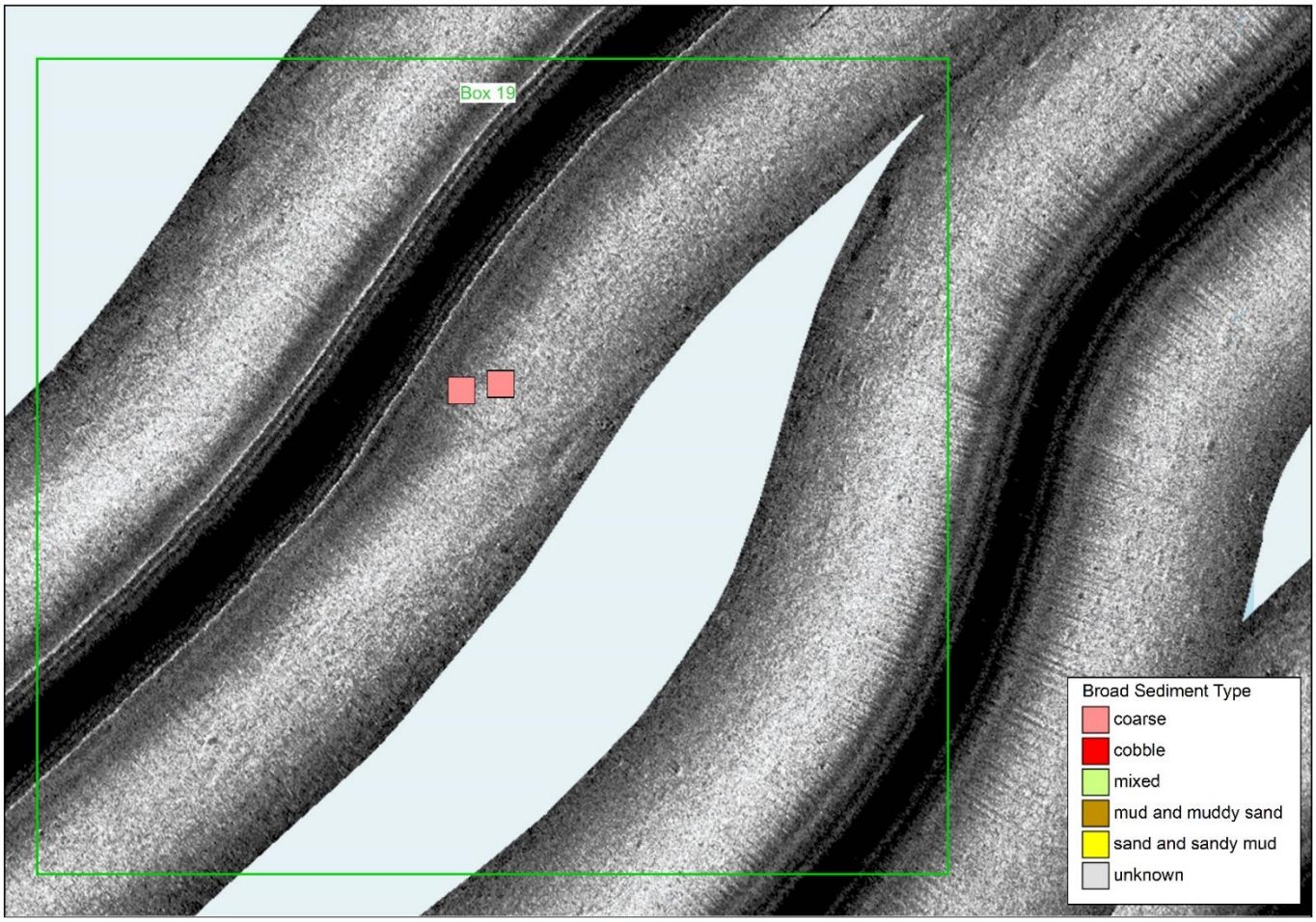

Figure 39 – Higher magnification of SSS from Box 19 and grab sample contents for ground-truthing

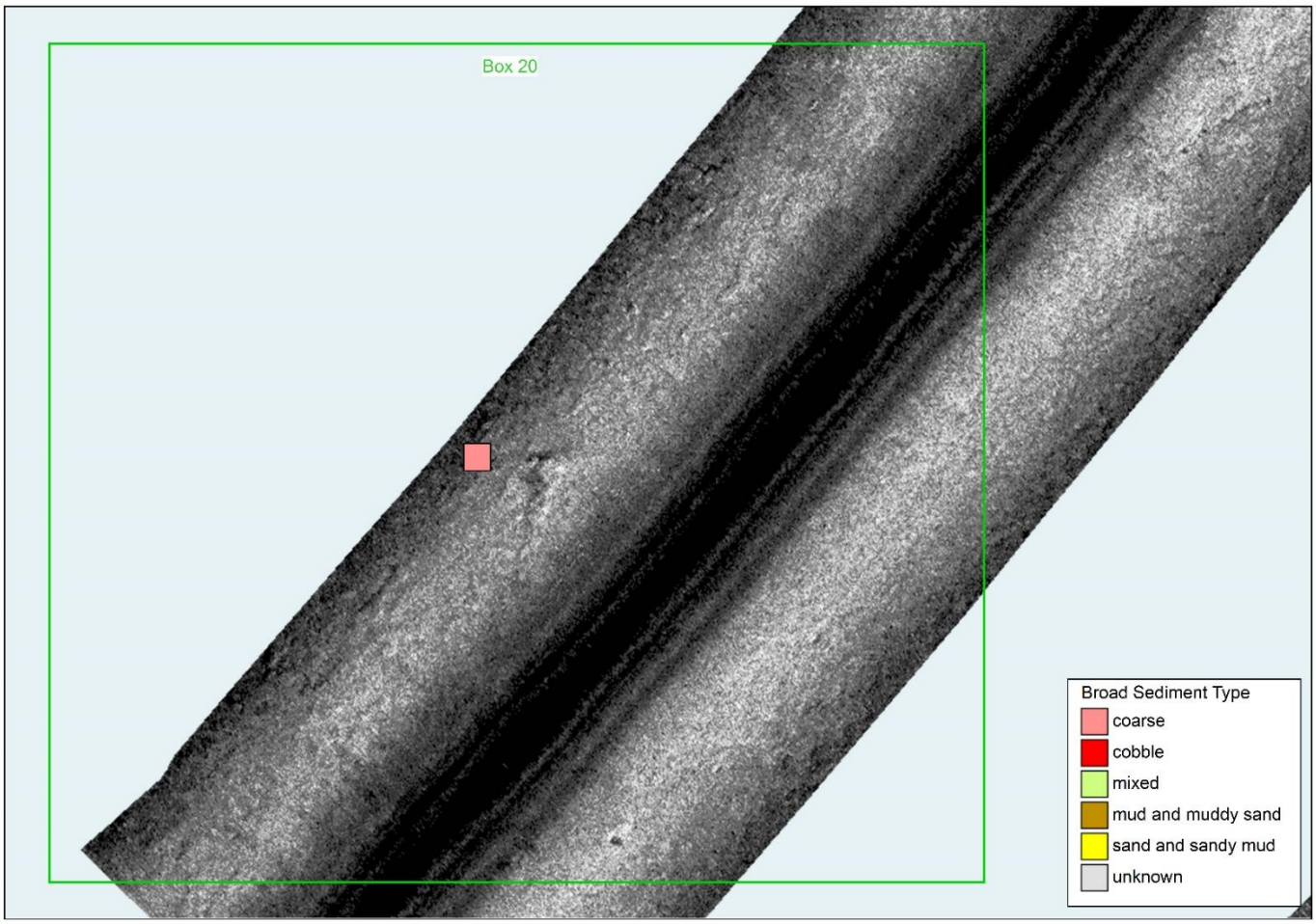

Figure 40 – Higher magnification of SSS from Box 20 and grab sample contents for ground-truthing

4. Discussion

Use of SSS data and grab samples in the target survey area enabled an illustration to be produced of how mixed the habitat is in this area of the Solway. There was also indication that large areas have the potential to be covered with mussel and that mussel can be found on a range of sediment types. As this is the first NWIFCA SSS survey which has been ground-truthed it is difficult to draw any firm conclusions from the data but it does allow NWIFCA to start building evidence of the area and habitats present. For this discussion the data has been split into two sections; samples that had no mussel present and samples with mussel.

Habitat

The grab samples indicated that Boxes 10, 12, 13 and 14 (Figures 23, 26, 28 and 30) 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 light image with varying degrees of texture and a strong return. To highlight some of the more interesting features Box 12 (Figure 26) showed ridges running perpendicular to the shore, Box 15 (Figure 26) showed hard ground meeting sand and Box 16 (Figure 37) showed large ridges creating shadows suggesting a more substantial feature.

Mussel

Boxes 4, 5, 7 (Figures 11, 13, and 17) and parts of Box 3 and 6 (Figures 9 and 15) all had similar imagery where there was a very 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 mud and muddy sand. Although some of the samples contained *Sabellaria spp.* it is unlikely this could be visible in the SSS imagery as the grab samples indicated that it was buried in the mud substrate.

Boxes 1, 2, 8, and 9 (Figures 5, 7, 19, and 21) and parts of Box 3 (Figure 9) 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 cobble. There was no clear similarity which can be drawn from the SSS images for each of the different sediment types.

From the grab samples the mussel ranged from 30 to 60mm with the majority being 45-60mm. The mussel was typically clean and free of any fouling and loose with no byssal threads, other than one sample in Box 8 (Figure 19) where the mussel was on cobble and had byssus threads and a small amount of barnacle fouling. When considering the condition of the mussel, it had persisted and grown through to size (larger than 45mm). Historically and from anecdotal evidence it is known that the mussel in the Solway can grow very quickly and reach size in a season. The mussel was very 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 of the samples contained mussel that was recently dead with meat still present in the shell. It is difficult to provide reasoning for this but prior to the survey there had been some storms and potentially this mussel may have died due to being displaced and smothering by mud and sand. 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 9 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	No. of Samples with Dead Mussel	No. of Samples with Empty Shell	Size Class of Mussel (mm) across all samples
Mud and muddy sand	14	56%	10	11	3	30 - 60
Sand and sandy mud	4	16%	4	0	0	50 - 60
Mixed	4	16%	3	1	0	50 - 60
Coarse	1	4%	1	0	0	55
Cobble	1	4%	1	0	0	50 - 60
Unknown	1	4%	1	0	0	45 - 60

Future Improvement to Survey Design

100% coverage was not achieved due to the size of the area and the limited number of suitable tides to complete SSS work. Reducing the swathe width from 160m to 100m also reduced coverage. For future surveys it is recommended to return to using the 160m swathe to get full coverage, with the acceptance that some data may be of lower quality at the edges of the swathe. Achieving 100% coverage would ensure that all grab samples coincide with areas of SSS and would significantly decrease the processing time in the mapping software.

Jon Haines

Deputy Senior Scientist
NWIFCA

October 2020

Annex A – Solway SSS Line and Transect Plan

Annex B - NWIFCA Sidescan Sonar Survey Transects Log Sheet March 2020

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	05/03/20	07:34	54º51.500N	003º25.361W	08:18	54º50.220N	003º27.232W	215	-	1.9-2.4	3	10	7
1B-4B	05/03/20	06:23	54º51.948N	003º24.890W	07:26	54º50.288N	003º27.365W	215	0.6	1.8-2.5	4	11	7
1C-4C	05/03/20	08:23	54º50.305N	003º27.449W	09:37	54º50.370N	003º27.345W	40	-	1.4-2.7	2	10	8
1D-2D	05/03/20	09:49	54º50.349N	003º27.537W	10:25	54º51.207N	003º26.251W	40	-	1.8-2.2	8	15	7
3D-4D	04/03/20	09:56	54º51.215N	003º26.215W	10:41	54º52.040N	003º25.026W	40	2.0	1.2-2.1	2	10	8
3E-4E	04/03/20	10:52	54º51.227N	003º26.344W	11:36	54º52.086N	003º25.071W	40	1.5	1.5-2.0	3	11	8
1F-2F	04/03/20	13:31	54º51.288N	003º26.447W	14:05	54º50.499N	003º27.575W	215	-	1.5-2.0	5	15	10
3F-4F	04/03/20	11:47	54º51.314N	003º26.404W	12:22	54º52.125N	003º25.191W	40	-	1.8-1.9	5	15	10
1G-4G	04/03/20	12:27	54º52.145N	003º25.345W	13:21	54º50.525N	003º27.732W	215	-	1.9-2.6	7	15	8