Geophysics - Marine habitat mapping

Introduction

Our marine habitat mapping was done on the vessel 'Echo Explorer Plymouth' operated by Sonardyne. We used a combination of side scan sonar, video footage, and grabs of the sea bed to map the different sediment types of our study area. Using a Tow Fish **(Figure 1)** we could create a trace map of the sea bed and then analyse it to find out what sediment types are present. Our analysis could then be backed up by video footage and grabs of the sea bed to help confirm the sediments types seen.

Plymouth Sound is a Special area of conservation (SAC) **(Figure 2)** under the EU Habitats Directive meaning it is a highly protected area designated to "protect habitat types and species considered to be most in need of conservation at a European level (excluding birds)." Plymouth sound has been a SAC since 1st of October 1996 and covers almost 64km^2 (MSCUK). Plymouth sound has lots of recreational boating as well as large military activity including aircraft carriers and submarines. We decided to survey the West of the mouth of the estuary in Cawsand Bay as it had not been surveyed by any other groups yet and according to charts has a mixture of sand, shells and gravel sediments.

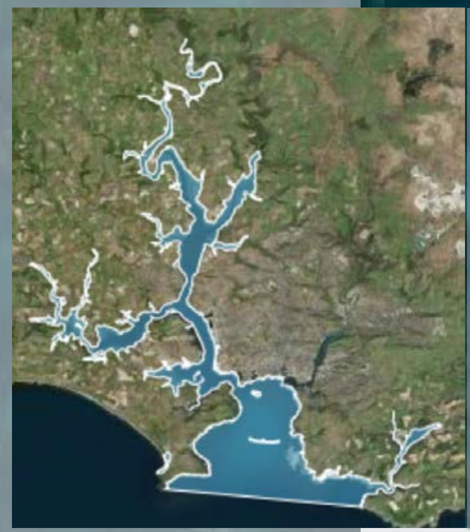


Figure 1 (*Right*) The Side scan Sonar Tow Fish used.
Figure 2 (*Left*) A map of the Special Area of Conservation surrounding Plymouth sound and surrounding estuary.

Instruments

Tow fish with acoustic transmitter (100KHz) **(Figure 1)** – Within the tow fish is a transceiver unit that transmits and acoustic pulse at 100KHz as well as receiving the returning pulse after it has been retransmitted from the sea bed. The unit relies on reflection and backscatter to formulate an image of the sea floor and objects in the water column.

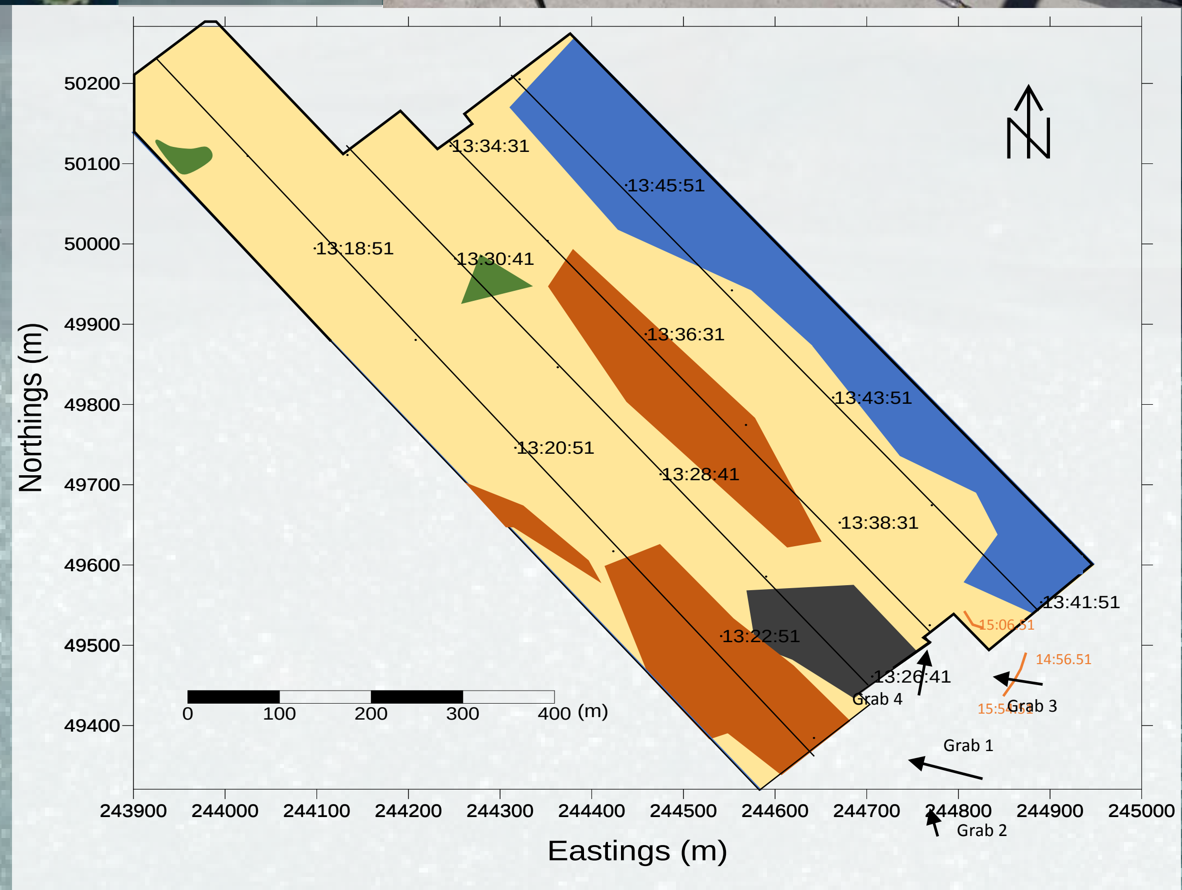
Video camera – As Plymouth sound is a special area of conservation. Using a camera allows a less intrusive view at the sea floor before using the Van Veer grab to sample the bottom.

Van Veer Grab **(Figure 3)** – After the bottom is viewed with the camera and is seen to be suitable to sample, the Van Veer grab is lower to retrieve physical samples that can be viewed on the deck on the ship and sediments can be looked at closely.

Figure 3 (*Left*) The Van Veer Grab used, resting in a bucket.
Figure 5 (*Right*) One of our grabs with a tape measure for reference and the time and location written next to the sample.

Issues and Limitations

- During the transects, the speed of the vessel was not kept constant creating distortion objects and bed forms seen in the side scan image
- After the initial waypoints for the first transect were plotted on the GPS, we surveyed the transect line before deploying the tow fish and discovered there were moorings along the track. As a result, the first track was moved 200m northeast **(Figure 4)**.
- Mid way trough the 1st and 2nd transect, the gain on the transmitter was reduced to produce a lighter image allowing finer details to be seen. This meant that there is a significant colour change that does not correspond to a change in bottom structure.
- Cable on the camera was limited to 20m.
- When the grab and video camera were lowered to the seabed simultaneously, we observed coarse sediment however the grab only retrieved a rock suggesting the grab was held open slightly by the rock, losing all the finer sediments as the grab was retrieved.
- Video footage of the seabed was recorded at waypoints after interesting features were seen on the side scan sonar scroll. The video system crashed while recording the final waypoint and therefore we lost all the footage.



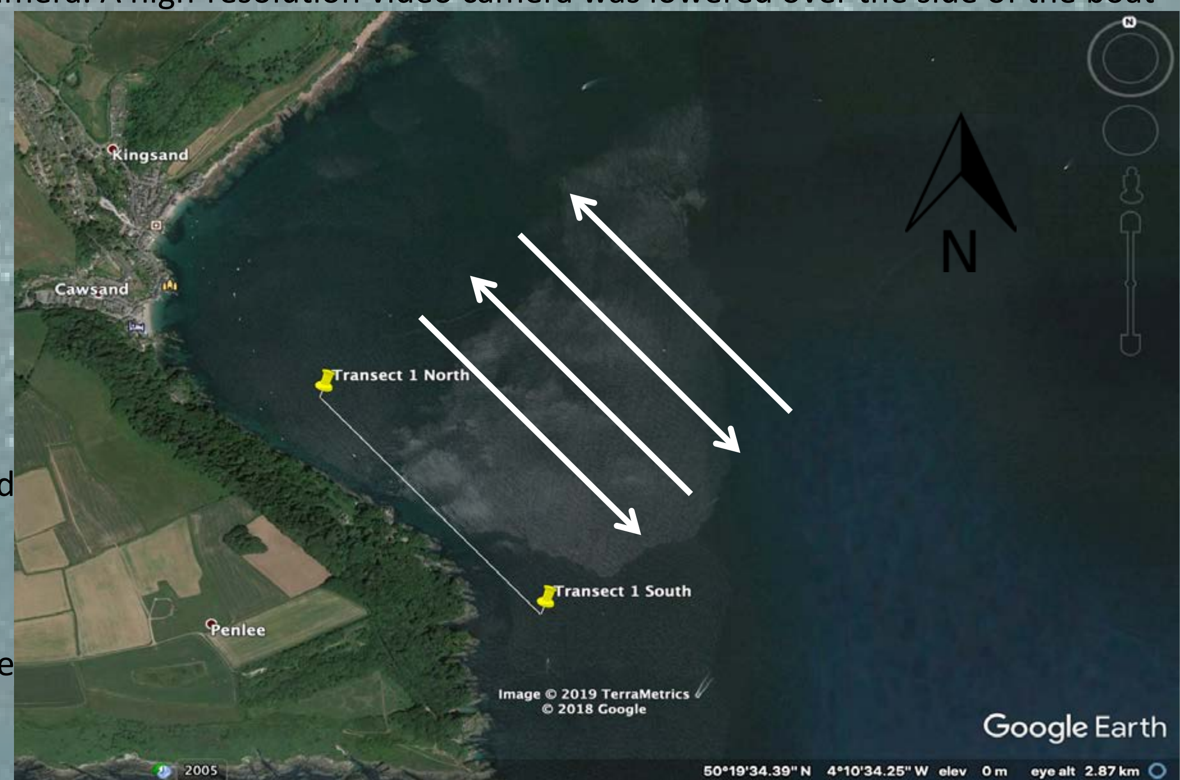
= Zone 1
= Zone 2
= Zone 3
= Zone 4
= Zone 5
= Camera Track

Figure 7 (*Left*) A diagram of the different sediment/habi-tat types seen in our trace map as well as the location of our camera footage and grab locations.

Methodology

A side scan sonar with an acoustic frequency of 100Khz and a swath width of 150m was towed behind the Sonardyne vessel at a speed of 5knots over 4 parallel lines in Cawsand bay. The initial transect line was mapped with a start point at 50° 19.333N 004° 11.133W and a stop point at 30°19.710N 004° 11.679W ordnance survey Great Britain 1936. 4 parallel lines, 200m from each other, derived from the first transect line were plotted on the GPS as illustrated in the image below (**Figure 4**). Backscatter from the seabed was recorded on a trace map, which will be used in the lab to create a mosaic of the seabed in the survey area.

Along the transect lines, areas of interest were marked with a waypoint on the GPS for further examination using a video camera. A high-resolution video camera was lowered over the side of the boat and allowed to drift over the waypoints placed along the transect lines. The live feed from the camera allowed a direct view of the seafloor structure and possible areas from grab samples using the Van Veer grab.
At all waypoints plotted, the Van Veer grab was lowered over the stern of the ship and samples were retrieved for closer analysis of the substrates and organism living in the sediments on the back deck of the ship (**Figure 5**).



The trace map (**Figure 6**) was stitched together in the lab to create a physical map of the seafloor on which the various habitats could be identified and outlined. Different habitats were indicated by the amount of backscatter transmitted, which is a function of the sediment structure.

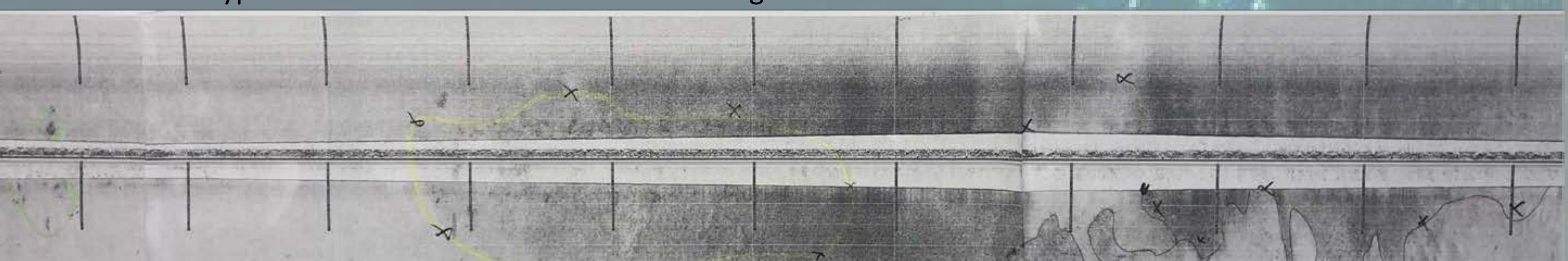


Figure 6 (*Bottom left*) A section of the trace plot produced with possible sediment types highlighted.

Figure 4 (*Right*) The location of our 4 transect lines based off of our original line to the South West

Habitats

We found what appears to be 4 distinct habitat zones on the sea floor over the course of our 4 transects as well as the base sediment. It is not possible to say with 100% certainty what each habitat was as we are only able to measure the strength of the reflected sonar signal meaning our measurements are indirect. Dark areas on the trace map indicate areas where more signal has been reflected which corelates to areas of hard sediment or rocks/metal. Softer sediments absorb and dissipate the sonar signal more and therefore return less signal creating lighter areas of the plot. Using the physical trace map as a reference we created a digital diagram to better show the different habitats present in our survey area **(Figure 7)**. Each habitat zone mentioned can be seen on the **Figure 7** diagram.

Zone 1 we believe could have been areas of Sea Grass due to cluster of patches of higher sonar reflection, and as on the ship chart it was shown that Sea Grass was found in that area. Furthermore, earlier in the week we were told Sea Grass had been found in a grab taken near that area.

Zone 2 had a stronger return than the background sediment and we have therefore classed these areas as a separate habitat zone. The darker trace shows more signal was reflected suggesting this is an area of coarser sediment such as broken rock or shell. This is supported by charts of this area showing a mixture of sand, broken shell and gravel.

Zone 3 returned by far the strongest signal and showed bulges and some striation strongly suggesting that this zone is rock. This zone is likely protruding bedrock and is likely high in biodiversity due to the stability of the seabed here.

Zone 4 is a large zone of weaker signal return at the far North East side of our transects. The weaker return of the sonar is due to the sediment being either sand/fine gravel or muds.

Zone 5 is the base sediment which is likely a mixture of broken shell and gravel as its return signal is smaller than that of zone 2 yet greater than that of zone 4 suggesting a coarser sediment than sand while not as hard as broken rock and shell. After our side scan sonar transects, we returned and deployed an underwater camera to just above the sea bed and recorded a coarse sediment of sand, broken shell and some gravel in the South East corner of Zone 5. As such we can be fairly confident that the habitat type for Zone 5 is coarse sand, broken shell and gravel.

Observations

Using the recorded footage from the underwater camera we identified all the species we could at each location as shown in **Figure 8**. While on the boat we recorded each species found in the each of the grabs and photographed each grab to help identify sediment type. This did not help to identify habitat type in the end as the grabs did not overlap with our transects.

	VIDEOS	WAYPOINT 9	WAYPOINT 11
LOCATION			
TIME	Start at 15:49	Start at 15:53	Start at 16:05
OBSERVATIONS	Sea stars	Sea stars	Asterias rubens (23)
	Broken shells	Broken shells	Marthasterias glacialis (12)
	Unidentifiable fish	Old rope	Terete gracilariaceae (24)
	Sponge	Macro algae	Suberites ficus (3)
		Sea grass	Polyides rotunda
			Vertebrata nigra
			Echinus esculentus (1)

Figure 8 (*Left*) A table of observed species from the recorded video footage.
Figure 9 (*Below*) A table of the observed species from the sea bed grabs.

	GRAB 1	GRAB 2	GRAB 3	GRAB 4.1	GRAB4.2
LOCATION	N 50 19.398 W 004 10.913	N 50 19.386 W 004 10.886	N 50 19.477 W 004 10.848	N 50 19.510 W 004 10.886	N 50 19.512 W 004 10.893
TIME	14:36	14:48	14:54	15:03	15:06
OBSERVATIONS	2 pea crabs	6 mason worms alive (Lanice conchilega)	Sea squirts (Corella eumyota)	1 rock	Coords: N 50 19.512 W 004 10.893
	13 pieces of mason worms (lanice conchilega)	7 pieces of mason worm (Lanice conhilega)	14 calcareous tube worms (Pomatoceros *triqueter*)		Time: 15:06
	Unidentified algae on shell		2 pink sea squirts		2 calcareous tube worms (Pomatoceros *triqueter*)
	Calcareous tube worm		3 bryozoans		3 encrusting algae (Lithophyllum incrustans)
	3 unidentified bryozoans		2 crabs (1 pea crab, 1 Carcinus maenas)		24 bryozoans (Membranipora tuberculata)
			1 mason worm (Lanice conchilega)		9 mason worms (Lanice conchilega)
					Sponge/larvae
					White tentacle organism on top of shell