

Table 1: Description of the hard substrate habitat types found in this study. The degree to which a taxa contributes to the similarity of a habitat type is given as a percent of 100 (in brackets), for taxa contributing more than 5% to overall similarity.

Habitat Group	Number of samples	Depth range	Taxa important for defining habitat type
<i>Ecklonia</i> forest	26	8.8-20.8m	Crustose Coralline (15.8) <i>Ecklonia radiata</i> (15.3) Juvenile <i>Ecklonia</i> (8.9) Crimson Coralline Sponge (7.1) Algal Turf (5.6)
Encrusting Invertebrates	14	15.1-48.6	Encrusting fauna (36.0) Crustose Coralline (21.5) White Encrusting Sponge (14.3) Orange Encrusting Sponge (8.1) Unidentified Red/Brown Algae (5.3)
Mixed Algae	11	3.8-18.1	Crustose Coralline (25.4) <i>Ecklonia radiata</i> (11.8) Crimson Coralline sponge (11.1) <i>Zonaria angustata</i> (10.8) <i>Landsburgia quercifolia</i> (10.0) Juvenile <i>Ecklonia</i> (9.9) <i>Carpophyllum maschalocarpum</i> (6.6)
Shallow <i>Carpophyllum</i>	3	3.7-5.3	<i>Carpophyllum maschalocarpum</i> (26.7) Crustose Coralline (22.0) Crimson Coralline sponge (20.2) <i>Lessonia variegata</i> (12.0)
Sponge Flat	17	16.5-34.7	Soft Bryozoan (23.1) Encrusting fauna (16.6) Orange encrusting sponge (10.9) Crustose Coralline (10.2) Small Yellow/Orange sponge (9.5) Small White sponge (6.4) Finer sponge (6.2)

Average linkage cluster analysis of the video data shows a high degree of dissimilarity between sites (Fig. 6). At 50% similarity of communities, there were five major group splits that contained at least 7 video samples each. There were numerous minor groupings as well: six groups consisted of 2-4 video locations and nine were isolated video locations. The points 1 to 4 on the cluster diagram indicate where habitat classes

based on the Shears et al. classification were separated out. Point #1, in general, indicates a split between the Encrusting invertebrate/Sponge flat class (to the left) and habitats based on algae species. Point #2 splits Ecklonia forest (to the right) from other algae classes and Point #3 separates Carpophyllum and mixed algae classes. A second occurrence of Encrusting invertebrates/Sponge flat occurs to the right of point #4, and separates it from Ecklonia forest. This second occurrence is due to a small amount of Ecklonia present in the samples, but note that the high dissimilarity at the split at point #4 indicates that it is not very similar to the Ecklonia forest habitat. Encrusting invertebrate and Sponge flat habitats could not be distinguished by average linkage cluster analysis and were therefore combined. For a few samples (shown by the asterisks) there was a poor relationship between the cluster analysis and the Shears groupings. While groupings generally related well to the Shears classification it does illustrate how variable the taxa found within habitat types are.

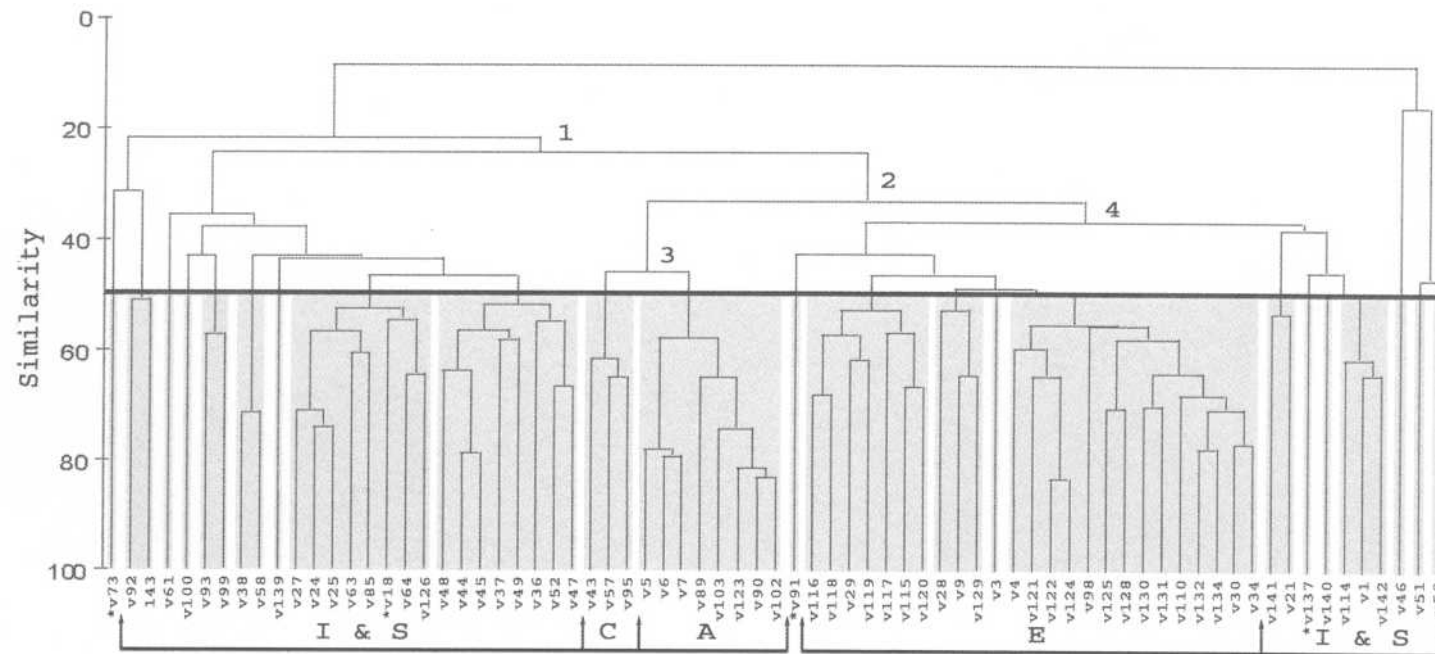


Figure 6: Average linkage cluster analysis of hard-substrate video data. Habitat classifications (based on Shears et al. 2004) are shown along the bottom axis (I = Incrusting invertebrates; S = Sponge flat; C = Carpophyllum; A = Mixed algae; E = Ecklonia forest).

3.3.2 Soft-substrata

Little structure and very few organisms were observed in the soft sediments found in this area. Sediment type was primarily sand, although some areas of finer sand/mud were observed, and an occasional sample had rock, boulders or cobbles. Ripples covered the sand surface at all but three sites; these were predominantly medium in size (1-3cm high, wavelength -10 cm). The occasional gastropod was observed; but there were no signs of bioturbation, worm tubes or casts or shell aggregations.

Cluster analysis of the soft-sediment data shows, unlike the hard substrata, a high degree of similarity between sites (Fig. 7). Three major groups were observed with greater than 80% similarity. Except for the two samples to the far left of the classification tree, which were in areas containing rock or boulders, the groups are distinguished by the amount and size of ripples.

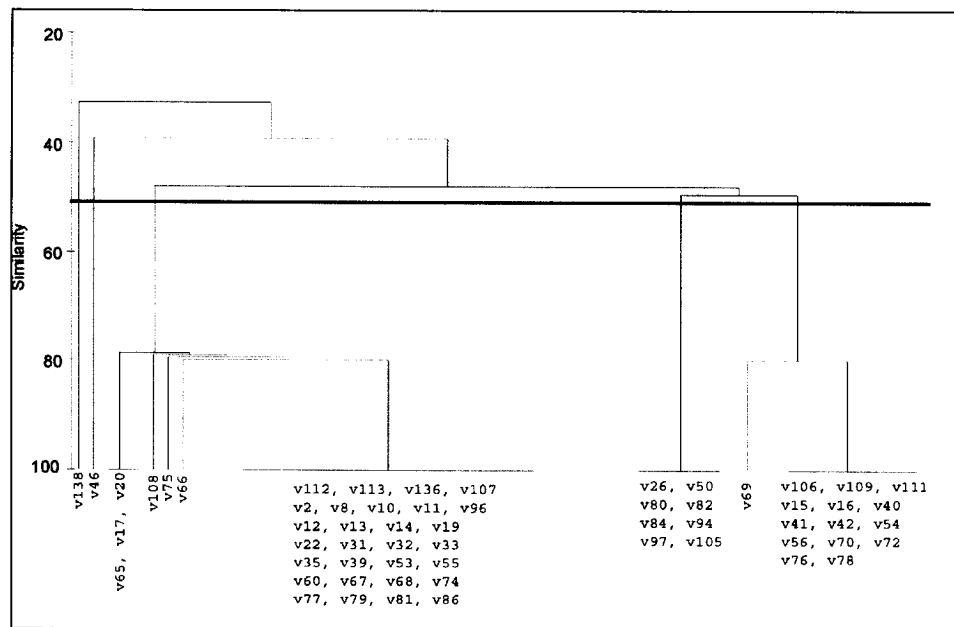


Figure 7: Average linkage cluster analysis of soft-sediment video data.

4. Discussion

4.1 Habitat maps

In general, the video survey identified broad habitat types that were concordant with visible changes in the side-scan printout. Note, however, that the Sponge flat and Encrusting invertebrate habitats are presented as one habitat type in the interpolated map (Fig. 8), because they were not well separated statistically. An isolated point off Aramoana indicates that there is a patch of 'Mixed algae' habitat further offshore than other video samples classified into this group. This is likely due to the raised elevation of the reef at this point compared to the other video locations the same distance from the shore (the depth is approximately 19.5m at this point).

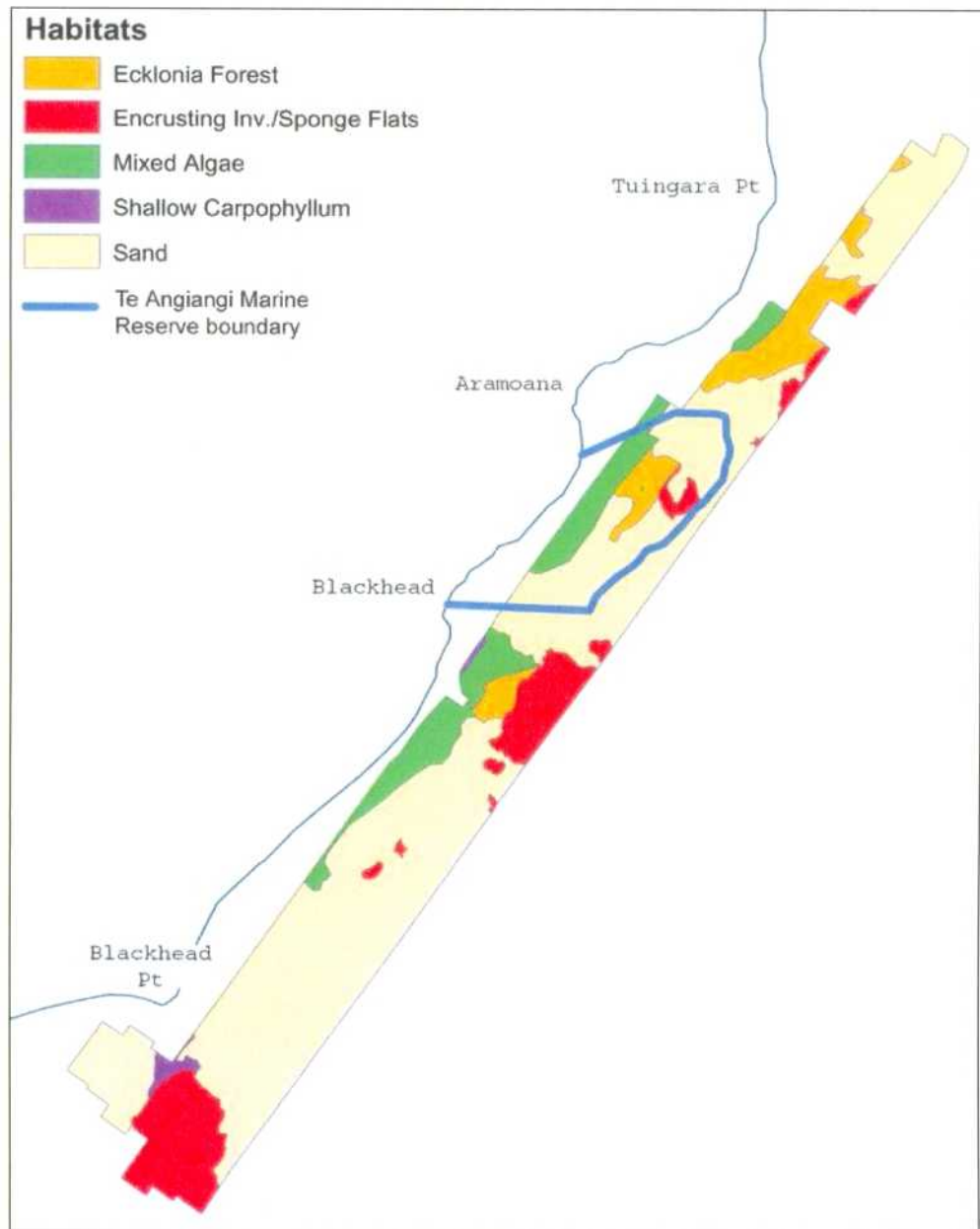


Figure 8: Subtidal reef habitats based on side-scan sonar and video information.

The most common reef habitat encountered in this survey was Encrusting Invertebrates/Sponge flat, with a total area of 303 hectares, making up 40% of the entire reef surveyed in this report. The other major habitat types were Mixed algae and *Ecklonia* forest with 226 hectares and 185 hectares respectively. The Shallow *Carpophyllum* habitat is likely under represented (at only 19 hectares) as it occurs in shallow water where the vessel was unable to survey due to safety concerns.

While no habitat classification scheme yet exists for soft sediments, we find the soft sediments in this area to be remarkably simple. They are comprised mainly of well-sorted medium sand, which is predominantly covered in ripples. There is a lack of epiflora and fauna, or any form of biogenic structure. At this stage, this sediment type is best treated as forming a single habitat type.

4.2 Caveats

It is important to note that, due to the sea conditions in the area of the survey, much of the very shallow habitat was not able to be surveyed.

It should also be noted that all video taxa identifications and cover estimates were conducted using a drop video camera system. No diving was undertaken to collect token species for accurate identification and therefore any species or taxa names included in the report should be used with caution. While remote survey technique involve an inherent lack of certainty, they do provide identification of broad habitat classifications, which was the contract objective.

The general agreement between the habitat types and the side-scan imagery provides a basis for interpolating the habitat extents based primarily on the side-scan results. However, the overlap of two main habitat types confirms that large-scale ground truthing continues to be necessary. Nesting the video within the acoustic survey has enabled a large area to be surveyed with a reasonable degree of accuracy.

The habitat types used by Shears et al. (2004) were appropriate for the majority of the survey area. This is important as it will allow the results to be easily compared with other surveys. However, it should be noted that there were sites that were not easily classified into the Shears et al. (2004) classification scheme and considerable variation was noted within habitats. Any classification scheme is specific to the data used to generate it and, even though the Shears classification was built on samples from a large geographical extent, it should be updated as more data from different areas become available. It is possible that in a few more years, analysis of combined datasets will allow more detailed classification. Although detail is desirable to a point, over-classification can be problematic. The goal to classification is to provide meaningful groups of species, with distinctive characteristics and functions, that provide different ecosystem services and affect habitat usage in different ways. When shifts occur to such groupings, they will reflect major changes to the ecosystem.

4.3 Addenda

In addition to the written report, this information is presented in a digitised format for incorporation into the ARC GIS system. Also, segments of the actual video footage have been produced in MPEG video format and included on a CD for viewing on a PC. The resolution of these MPEG's are comparatively low due to file size constraints, however they will provide the viewer an overview of the video site. The raw footage is provided in full resolution on Mini Digital Video Cassette format as a permanent record of the survey.

5. References

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Hewitt, J.E.; Thrush, S.F.; Legendre, P.; Cummings, V.J. & Norkko, A. (2002). Integrating heterogeneity across spatial scales: interactions between *Atrina zelandica* and benthic macrofauna. *Marine Ecology Progress Series* 239: 115-128.

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6. Appendices

6.1 Drop camera positions in New Zealand Map Grid, including depth and habitat group.

Video sample label	Shears et al. (2204) Groups (plus soft sediments)	Depth	Easting	Northing
v110	<i>Ecklonia forest</i>	16.7	2836541.06	6106670.67
v115	<i>Ecklonia forest</i>	17.1	2840746.09	6112203.47
v116	<i>Ecklonia forest</i>	17.1	2840738.52	6112196.2
v117	<i>Ecklonia forest</i>	12.2	2840504.74	6112303.68
v118	<i>Ecklonia forest</i>	13.5	2840393.79	6112039.35
v119	<i>Ecklonia forest</i>	13	2840393.22	6112029.55
v120	<i>Ecklonia forest</i>	12.5	2840556.32	6111879.78
v121	<i>Ecklonia forest</i>	15.5	2840390.43	6111575.05
v122	<i>Ecklonia forest</i>	15.5	2840368.41	6111568.97
v124	<i>Ecklonia forest</i>	19.6	2840354.19	6111383.41
v125	<i>Ecklonia forest</i>	19.6	2840362.63	6111361.73
v128	<i>Ecklonia forest</i>	17.3	2840090.98	6111197.23
v129	<i>Ecklonia forest</i>	17.3	2840107.09	6111172.07
v130	<i>Ecklonia forest</i>	11.3	2839881.54	6111301.4
v131	<i>Ecklonia forest</i>	8.8	2839648.85	6111240.96
v132	<i>Ecklonia forest</i>	15	2839832.47	6111079.19
O34	<i>Ecklonia forest</i>	15	2839866.26	6111006.39
v18	<i>Ecklonia forest</i>	20.8	2838338.683	6109244.748
v28	<i>Ecklonia forest</i>	14.1	2838043.648	6109504.876
v29	<i>Ecklonia forest</i>	14.1	2838052.281	6109490.978
O	<i>Ecklonia forest</i>	19.5	2838612.178	6109728.987
v30	<i>Ecklonia forest</i>	13.1	2838052.836	6109477.43
v34	<i>Ecklonia forest</i>	14.9	2838459.37	6110056.494
v4	<i>Ecklonia forest</i>	17.1	2838453.103	6109732.194
v9	<i>Ecklonia forest</i>	16	2837955.423	6108909.766
v98	<i>Ecklonia forest</i>	13.8	2836507.04	6107054.14
v1	Encrusting Invertebrates	24.6	2838765.177	6109743.084
v114	Encrusting Invertebrates	24.4	2841095.85	6112013.84
v137	Encrusting Invertebrates	24.1	2840282.19	6110851.33
O41	Encrusting Invertebrates	19.5	2837334.6	6107161.54
v142	Encrusting Invertebrates	17	2835214.16	6104871.45
v143	Encrusting Invertebrates	17	2835216.38	6104850.42
v24	Encrusting Invertebrates	27.4	2838678.483	6109315.201
v25	Encrusting Invertebrates	30.6	2838702.757	6109249.12
v27	Encrusting Invertebrates	32.5	2838738.201	6109184.776
v44	Encrusting Invertebrates	15.1	2832387.054	6101760.56
v45	Encrusting Invertebrates	21	2832518.597	6101452.787
v48	Encrusting Invertebrates	22.2	2832652.503	6101170.846

Video sample label	Shears et al. (2204) Groups (plus soft sediments)	Depth	Easting	Northing
v52	Encrusting Invertebrates	33.5	2832776.465	6100905.629
v61	Encrusting Invertebrates	48.6	2832863.68	6099960.98
v92	Encrusting Invertebrates	25.5	2838595.99	6109497.19
v102	Mixed Algae	7.3	2835950.16	6106655.8
v103	Mixed Algae	8.6	2835502.7	6106055.23
v123	Mixed Algae	6.1	2840128.48	6111802.31
v140	Mixed Algae	19.5	2837339.98	6107180.76
v5	Mixed Algae	10.1	2838221.207	6109842.49
v6	Mixed Algae	7.8	2837906.432	6109615.314
v7	Mixed Algae	8.1	2837682.06	6109230.26
v73	Mixed Algae	5	2833035.1	6103621.52
v89	Mixed Algae	6.7	2837268.08	6108759.3
v90	Mixed Algae	3.8	2837510.11	6109106.55
v91	Mixed Algae	18.1	2838369.03	6109550.77
v43	Shallow <i>Carpophyllum</i>	3.7	2832241.126	6102087.283
v57	Shallow <i>Carpophyllum</i>	5.3	2832551.324	6102384.703
v95	Shallow <i>Carpophyllum</i>	4.5	2836298.89	6107719.31
v100	Sponge flat	30.4	2836875.15	6105981.7
v126	Sponge flat	28.7	2840536.05	6111181.68
v139	Sponge flat	33.4	2837787.54	6107401.82
v21	Sponge flat	31.5	2838975.789	6109460.666
v36	Sponge flat	27.1	2832402.454	6101263.603
v37	Sponge flat	18.8	2832201.073	6101292.399
v38	Sponge flat	25	2832196.224	6101262.038
v47	Sponge flat	23.3	2832533.237	6101416.593
v49	Sponge flat	22.2	2832656.733	6101153.621
v51	Sponge flat	23.1	2832678.734	6101106.923
v58	S on e flat	20.5	2832612.827	6101631.051
v59	Sponge flat	16.5	2832616.017	6101622.578
v63	Sponge flat	31	2832626.95	6100503.53
v64	Sponge flat	24.7	2832425.68	6100773.72
v85	Sponge flat	34.7	2840311.51	6110311.87
v93	Sponge flat	25.5	2838609.29	6109495.87
v99	Sponge flat	26.7	2836974.14	6106696.59
v10	Soft sediments	16	2837961.385	6108889.87
v101	Soft sediments	18	2836332.1	6106399.22
v104	Soft sediments	18	2835889.22	6105766.97
v105	Soft sediments	8.8	2835025.21	6105425.54
v106	Soft sediments	24.9	2835730.12	6104901.09
v107	Soft sediments	25.1	2835362.68	6104164.23
v108	Soft sediments	13.6	2834648.83	6104628.08
v109	Soft sediments	14.1	2835967.56	6106166.71
v11	Soft sediments	26.1	2838258.125	6108597.62
v111	Soft sediments	15.4	2840816.26	6112575.74
v112	Soft sediments	10.4	2841015.07	6112494.6

Video sample label	Shears et al. (2204) Groups (plus soft sediments)	Depth	Easting	Northing
v113	Soft sediments	27.4	2841300.61	6112315.56
O2	Soft sediments	26.5	2838030.434	6107998.375
v127	Soft sediments	23.9	2840361.59	6111083.89
v13	Soft sediments	33	2838194.154	6107838.058
v133	Soft sediments	15	2839847.84	6111043.69
v135	Soft sediments	22.6	2840075.84	6110931.67
v136	Soft sediments	24.1	2840274.35	6110870.39
v138	Soft sediments	12.7	2839101.3	6110763.69
v14	Soft sediments	17	2837484.172	6107966.673
O5	Soft sediments	11.4	2837166.825	6108137.516
v16	Soft sediments	7.5	2836917.043	6108362.483
v17	Soft sediments	33	2838785.596	6109146.96
v19	Soft sediments	14.5	2838065.669	6109259.01
v2	Soft sediments	24.6	2838775.687	6109729.844
v20	Soft sediments	38	2839436.854	6109377.601
v22	Soft sediments	32.7	2838977.455	6109407.609
v23	Soft sediments	26.8	2838632.637	6109372.402
v26	Soft sediments	32.2	2838733.022	6109196.487
v31	Soft sediments	15.5	2838074.224	6109449.455
v32	Soft sediments	21.6	2839516.659	6110491.238
v33	Soft sediments	16.5	2838563.653	6110077.899
v35	Soft sediments	16	2838475.273	6110033.016
v39	Soft sediments	13.7	2831873.058	6101704.51
v40	Soft sediments	9	2831599.515	6102189.312
v41	Soft sediments	10.8	2831641.792	6102078.396
v42	Soft sediments	7.7	2832007.293	6102151.545
v46	Soft sediments	23.5	2832526.049	6101441.168
v50	Soft sediments	23.6	2832662.871	6101137.797
v53	Soft sediments	31.9	2833335.544	6101318.897
v54	Soft sediments	19.6	2833070.529	6101678.716
v55	Soft sediments	14.9	2832964.116	6101819.99
v56	Soft sediments	10.2	2832729.77	6102137.54
v60	Soft sediments	48.6	2832867.62	6099973.41
v62	Soft sediments	48.6	2832859.3	6099945.05
v65	Soft sediments	17.4	2831917.73	6101350.44
v66	Soft sediments	45	2833225.84	6100524.77
v67	Soft sediments	41	2833283.59	6100825.38
v68	Soft sediments	32.2	2833884.75	6101510.43
v69	Soft sediments	24.8	2833642.71	6101720.33
v70	Soft sediments	15.3	2833318.51	6102018.23
v71	Soft sediments	10.3	2832879.21	6102437.56
v72	Soft sediments	6.3	2832590.58	6102711.67
v74	Soft sediments	10.5	2833389.94	6103357.35
v75	Soft sediments	21	2834250.22	6102590.9
v76	Soft sediments	25.5	2834913.53	6103187.25

Video sample label	Shears et al. (2204) Groups (plus soft sediments)	Depth	Easting	Northing
v77	Soft sediments	15.2	2834157.99	6103690.66
v78	Soft sediments	4.8	2833556.83	6104229.05
v79	Soft sediments	44.6	2839785.29	6109045.8
v8	Soft sediments	16	2837961.043	6108931.197
v80	Soft sediments	40.6	2839475.71	6109120.99
v81	Soft sediments	36.7	2839052.27	6109055.88
v82	Soft sediments	29.4	2839206.41	6109772.05
v83	Soft sediments	37.3	2839790.78	6109748.62
v84	Soft sediments	22.3	2839272.42	6110213.99
v86	Soft sediments	27.8	2838411.19	6108839.4
v87	Soft sediments	43	2838934.77	6108315.51
v88	Soft sediments	20.6	2837877.12	6108343.31
v94	Soft sediments	27.4	2838854.16	6109586.19
v96	Soft sediments	12.5	2836741.53	6107541.05
v97	Soft sediments	13.8	2836507.95	6107065.22