Rocky Shore Extra Transects: Monitoring for Project Next Generation

Prepared by

Ryder Consulting

June 2015

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environment + planning + project management

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Cover ptograph: Channel at Quarantine Island – Murray Robertson.

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1. Introduction

A condition of the resource consent granted to carry out dredging as part of Project Next Generation work specifies that POL must carry out appropriate biological monitoring to determine baseline conditions before the commencement of dredging. Additional monitoring must also be carried out during and after the completion of capital works to gauge any effects that might be attributable to the works. Should adverse effects be found modifications may be made to the dredging regime if necessary. To this end, POL engaged Ryder Consulting Ltd (RCL) to carry out the baseline assessment with a report detailing findings being produced in October 2013.

At a subsequent Technical Group meeting, during which the findings of the baseline survey were discussed, it was decided that it would be of benefit to gather additional data on rocky subsubstrates in areas where sediment was likely to settle. i.e. in areas of lower current speed than those surveyed in the initial baseline survey. As a result an additional subtidal transect was surveyed close to each of the three original rocky shore sites, but in a location more sheltered from prevailing currents.

2. Methods

All methods for this survey are widely used in the assessment of intertidal and subtidal marine habitats and provide a robust baseline against which future changes may be compared (Kingsford and Batttershill 1998; Robertson *et al*. 2002). It is believed that the sampling intensity used throughout this survey will be adequate to determine whether of not there are any changes in community structure when compared with future surveys.

2.1 Rocky Shore

An additional shore-normal transect was surveyed in areas close to those surveyed by Ryder Consulting in 2013, which, in turn, were located close to those surveyed by Paavo (2009). The sites are Pudding Island, due to this area being a recorded refuge of the small brachiopod, *Pumilus antiquatus* (Robinson 2010), at Quarantine Island, and at Pulling Point (Figures 2.1.1a-c).

Sampling utilised five ~0.25 m^2 photo quadrats randomly placed at each 1m depth interval where possible, or at roughly even intervals across obvious subtidal habitat along transects. Photographs were then viewed by experienced personnel and obvious flora and fauna identified and counted, or percentage cover estimated, as appropriate. As pointed out by Paavo (2009), algae typically form multi-species aggregations and it is not feasible to identify most individual algal taxa in some quadrats. Consequently, only large, well-

documented taxa were identified individually. Similarly, colonial or cryptic animal species (particularly sponges, colonial tunicates, and bryozoans) cannot be reliably identified in the field and a best guess based on form and colour was made. Infauna were not counted unless they were clearly identifiable as individuals.

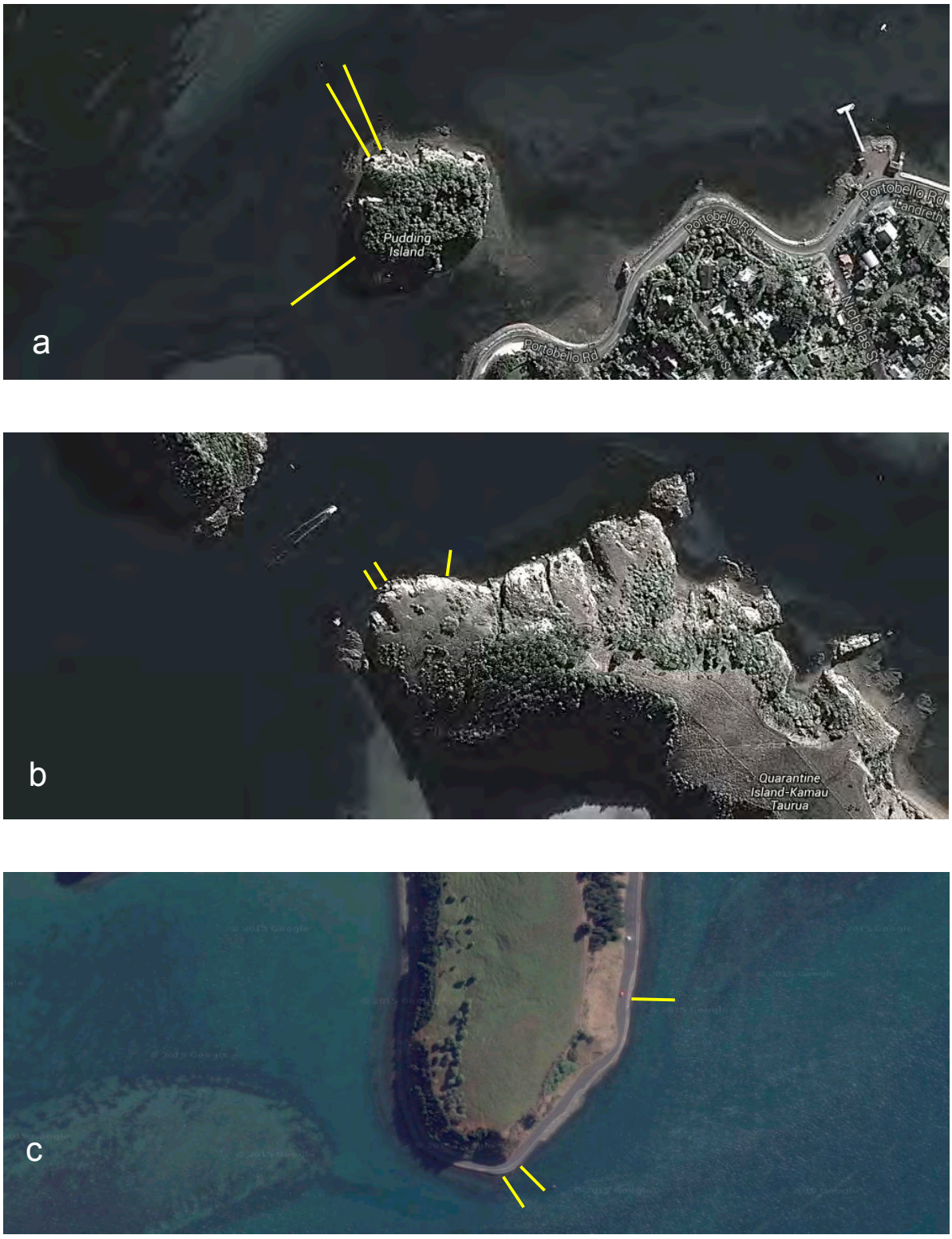

Figure 2.1.1. *Location of rocky shore transects at (a) Pudding Island; (b) Quarantine Island and (c) Pulling Point, Otago Harbour.*

Transects were re-swum and video recorded to assess the distribution and abundance of different invertebrate species and semi-quantitative observations were made of macro-algal distribution. Transect start locations were recorded using hand help GPS to facilitate repeat surveys when necessary.

3. Results

3.1 Rocky Shores

Rocky shore sites were revisited on 2nd June 2015. GPS co-ordinates were recorded for the high tide point for each Transect 1 surveyed (Table 3.1.1). At each site Transect 2 was located 3m up-harbour from Transect 1. Transect 3 was located at a site considered to be more sheltered from currents than either Transects 1 or 2. Representative photographs of quadrats are presented in Appendix 1.

Table 3.1.1. *GPS locations of rocky shore assessment sites. Co-ordinates are expressed as NZMG.*

Rocky Shore	T1	T2	T3
Pulling point	E2327669	3m up-harbour	E2327766
	N5487610		N5487767
Quarantine island	T1	T2	T3
	E2325618	3m up-harbour	E2325662
	N5484136		N5484130
Pudding Island	T1	T2	T3
	E2326480	3m up-harbour	E2326510
	N5482982		N5482809

The 5 m water depth target was easily achieved at Pulling Point and Quarantine Island, but at Pudding Island the maximum water depth available at the time of the survey (MLW) was 4 m.

Quadrats along transects are labelled a-e with 'a' being shallowest and 'e' being deepest. Divers observed a good deal of diversity for flora but less so for fauna (Tables 3.1.2 and 3.1.3). In addition to the still photographs a video recording (available on request) was made for each transect.

Over both surveys a total of 16 algal taxa were encountered along the rocky shore transects, with Pudding Island having the highest diversity (14 taxa). Algal cover in quadrats was variable, ranging from 0 - 97%, with the highest total cover being at Quadrats c and e on the third transect at Pudding Island. In video recordings *Undaria pinnatifida* was also visually significant, especially off Pulling Point and Quarantine Island, with other large foliose species (*Carpohyllum* and *Cystophora*) also moderately common.

Table 3.1.2. *Percentage algal cover within 0.25 m^2 quadrats along subtidal transects at Pudding Island, Quarantine Island and Pulling Point, Otago Harbour.*

	PudT1a	PudT1b	PudT1c	PudT1d	PudT1e	PudT2a	PudT2b	PudT2c	PudT2d	PudT2e	PudT3a	PudT3b	PudT3c	PudT3d	PudT3e	QT1a	QT1b	QT1c	QT1d	QT1e	QT2a	QT2b	QT2c	QT2d	QT2e	QT3a	QT3b	QT3c	QT3d	QT3e	PullT1a	PullT1b	PullT1c	PullT1d	PullT1e	PullT2a	PullT2b	PullT2c	PullT2d	PullT2e	PullT3a	PullT3b	PullT3c	PullT3d	PullT3e
Green Algae																																														
Codium fragile														7																																
Enteromorpha spp																																3													
Ulva lactuca	1									2							5			2	2	1	5	5		4	6							6	5			17	6		8	1			
Zostera capricorni																												15	1																
Red Algae																																													
Callophyllis spp.			2		2	8		5	5	6								6	6	10	9	13		10	3						10		2	9	3						8			
Ceramium uncinatum											2		77	70	85												3		2					9					3			9	5		
Coralina spp.											2		3	3		15										5	5						1								8			
Euptilota formosissima													8		12																													
Lenormandia spp.					15								9	13			2												2	5					5	4	18		16	4		16	15		
Lithothamnion spp.	5	10			1						15	8				2		4				8				6				8	3	4	1	2	6		4	1	2			6		
Brown Algae																																													
Carpophyllum flexuosum	8								2							3										10																			
Cystophora torulosa											10					13																2									2			
Hormosira banksii											10															5																		
Macrocystis pyrifera											3							3								5								1			5							
Petalonia fascia	1					2																																						
Undaria pinnatifida	18	15																	20				5	8	2										2	7			8				6		

Table 3.1.3. *Animals encountered within 0.25 m^2 quadrats along subtidal transects at Pudding Island, Quarantine Island and Pulling Point, Otago Harbour.*

	PudT1a	PudT1b	PudT1c	PudT1d	PudT1e	PudT2a	PudT2b	PudT2c	PudT2d	PudT2e	PudT3a	PudT3b	PudT3c	PudT3d	PudT3e	QT1a	QT1b	QT1c	QT1d	QT1e	QT2a	QT2b	QT2c	QT2d	QT2e	QT3a	QT3b	QT3c	QT3d	QT3e	PullT1a	PullT1b	PullT1c	PullT1d	PullT1e	PullT2a	PullT2b	PullT2c	PullT2d	PullT2e	PullT3a	PullT3b	PullT3c	PullT3d	PullT3e
Molluscs																																													
Dendrodoris citrina													1																								2				1					
Cellana ornata												2																													2				
Melagraphia aethiops																											1														2				
Ostrea heffordi												6																																	
Scutus breviculus	4	3							1							2	2	3	1					1								1				2						1			
Sypharochiton pelliserpentis												11							1																									
Turbo smaragdus											1																																		
Anemones																																													
Habrosanthus bathamae																	7	6				1		1																					
Isactinia olivacea																										1																			
Sponges																																													
Brown *Mycale* (%)																				4		7	5	5	3									1		10								
Dactylia palmata																								4	9																				
Orange *Mycale* (%)																		6	4			5		2	5																			1	
White *Mycale* (%)											1							2						2	1	2																	1	1		
Yellow *Mycale* (%)																			11	2			3														1							
Tethya spp.	5										2										2																								
Crabs																																													
Macrophthalmus hirtipes			1				2																																			3	2
Barnacles																																													
Chamaesipho columna (%)												3																																	
Polychaete worms																																													
Pomatoceros caerulus											4	23																								1						1			
Echinoderms																																													
Allostichaster insignis																			1																										
Evechinus chloroticus																																				1									
Ophiomyxa brevirima													1																																
Tunicates																																													
Orange *Didemnum*																								2																					
Pyura pachydermatina																	1								1																				
Fish																																													
Variable triplefin																				1																										
Number of taxa	2	1	1	0	0	0	1	0	1	0	4	5	2	0	0	1	3	4	5	3	1	3	2	6	6	1	1	1	0	0	0	0	1	1	0	4	2	0	0	1	2	3	1	2	1
Abundance per m^{-2}	36	12	4	0	0	0	8	0	4	0	32	180	8	0	0	8	40	68	72	28	8	52	32	64	80	8	4	4	0	0	0	0	4	4	0	56	12	0	0	4	16	8	4	16	8

Animals were less abundant than algal species, with relatively low abundance and diversity at both Pudding Island and Pulling Point (Table 3.1.3). In total, 24 taxa were encountered, with 15 of those being represented at Quarantine Island. Community composition (abundance and diversity of algal and animal species) at each of the quadrats along all transects display a great deal of commonality, as shown by the intermingling of symbols in the ordination (Figure 3.1.1). Just Pulling Point Quadrate 3e is markedly separated from other quadrats, this quadrat containing just two burrowing crabs and no other species (Figure 3.1.1). Other quadrats that are separate (e.g. Pud T2b and Quar T3e) also have very low diversity but slightly higher abundance. Note that quadrats that contain no organisms at all do not appear in the ordination.

Video recordings echo the observations of the still photographs and also emphasise the presence of numerous burrows belonging to polychaetes and various crustaceans, and siphons, generally of cockles (*Austrovenus stutchburyi*). Areas of dead shell feature prominently in video recordings of transects at Pudding Island (*Maoricolpus roseus roseus*) and Quarantine Island (*Austrovenus stutchburyi*).

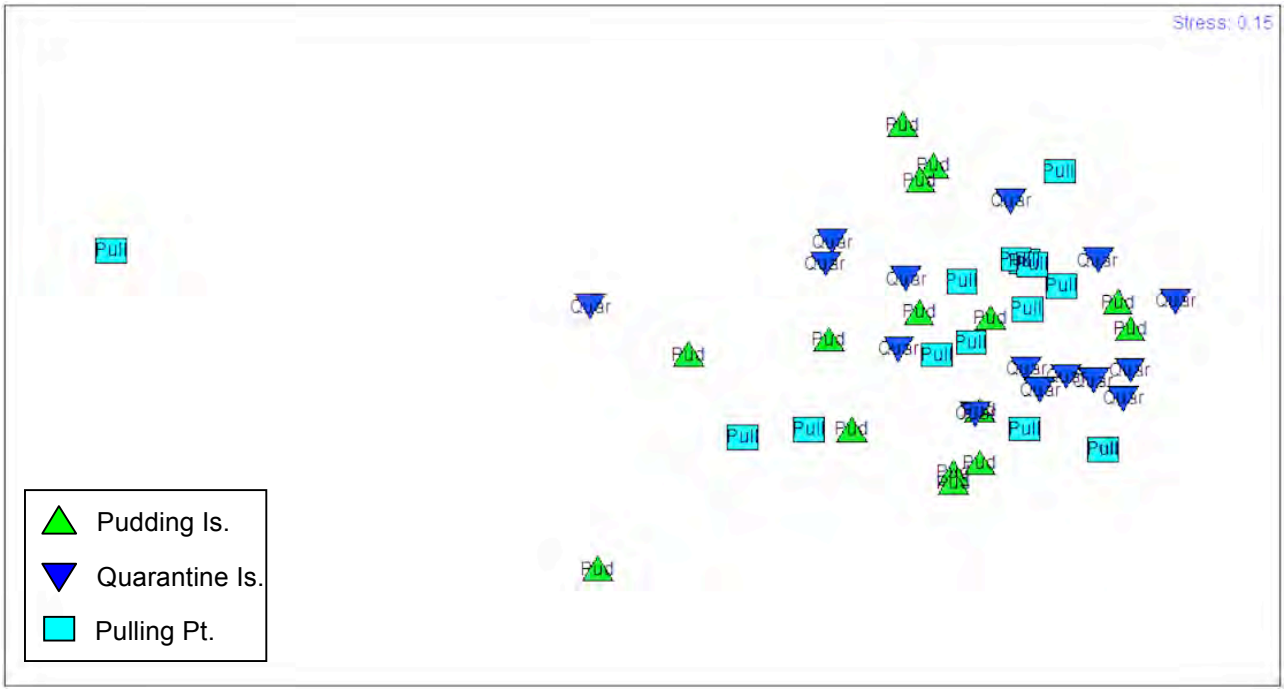

Figure 3.1.1. *Ordination plot for subtidal rocky shore communities within quadrats at different rocky shore intertidal sites. Pud = Pudding Island; Quar = Quarantine Island; Pull = Pulling Point.*

The dendrogram for multidimensional scaling emphasises the lack of difference in community structure along the subtidal rocky shore transects, with QuarT1 and T2 forming the only relatively discrete grouping (Figure 3.1.2). The lack of compactness (i.e. how similar to one another the elements of a cluster are) is also quite marked.

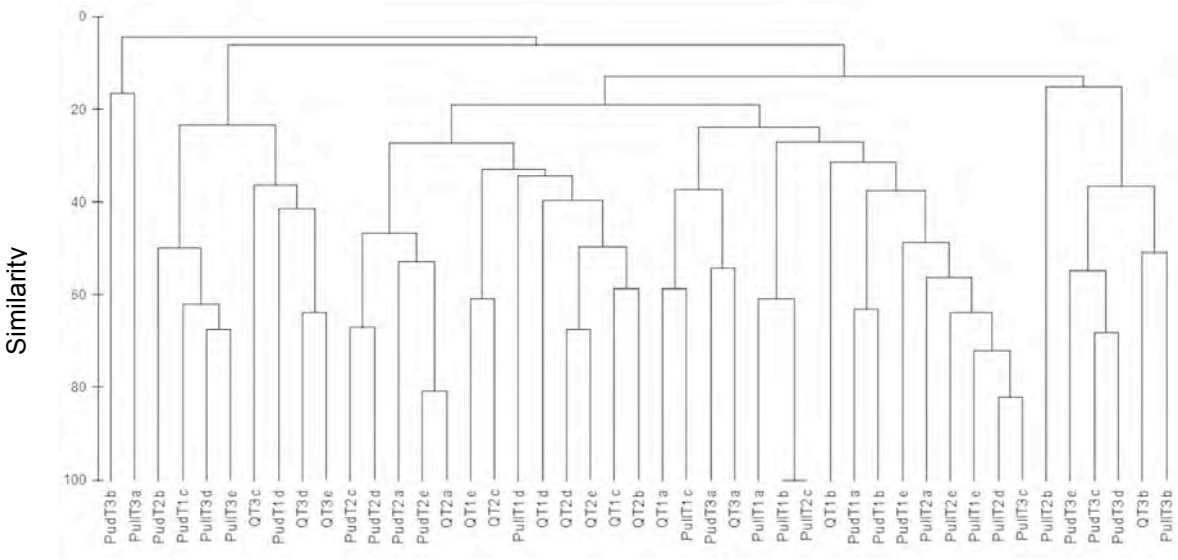

Figure 3.1.2. *Dendrogram showing the relationship among communities in different quadrats at subtidal rocky shore sites, Otago Harbour.*

Analysis of similarities (ANOSIM) among transects at different sites also suggest that differences are not significant ($R = 0.016$, $p = 0.293$).

However, similarity percentages for subtidal rocky shore sites show that similarities, both within sites and among sites, are quite low (Table 3.1.4).

Table 3.1.4. *Similarity percentages calculated for different subtidal rocky shore assessment site sites, Otago Harbour. A value of 100% would indicate that the communities at two locations are identical in terms of species present and the number of animals in each species.*

	Pudding	Quarantine	Pulling
Pudding	12.65		
Quarantine	13.59	19.4	
Pulling	16.36	18.04	22.22

It can be seen from values for the indices of multivariate dispersion that the highest variability was encountered at Pudding Island and the lowest at Pulling Point (Table 3.1.5).

Table 3.1.5. *Indices of multivariate dispersion calculated for different quadrats at subtidal rocky shore assessment sites, Otago Harbour.*

	IMD
Pudding	1.158
Quarantine	0.933
Pulling	0.908

Diversity indices calculated for each quadrat show a high degree of variability with a range of 0.0 (no or just one animal species encountered) to 0.862 at Quadrat T2 D, Quarantine Island (Table 3.1.6).

Table 3.1.6. *Diversity indices calculated for each quadrat at subtidal rocky shore assessment sites, Otago Harbour.*

H' (log_{10})	Pudding Island			Quarantine Island			Pulling Point		
Quadrat	T1	T2	T3	T1	T2	T3	T1	T2	T3
A	0.689	0.217	0.833	0.591	0.361	0.807	0.298	0.804	0.301
B	0.409	0	0.654	0.666	0.655	0.536	0	0.388	0.784
C	0.451	0.196	0.354	0.814	0.593	0.192	0.726	0	0.635
D	0	0.499	0.345	0.631	0.862	0.577	0.504	0.568	0.413
E	0.242	0.244	0.162	0.562	0.776	0.195	0.655	0.523	0.452

4. Discussion

Sheltered rocky shores within Otago are quite rare, with the majority of rocky substrate being on exposed coasts and other inlets having practically none (e.g. Stewart 2007). However, rocky shores within Otago Harbour have been extensively studied. The existence of the Portobello Marine Laboratory directly across the harbour from Port Chalmers ensures a steady flow of both amateur and professional scientists keen to document what lives on the shore.

The baseline survey was designed to establish robust baseline data for different habitat types within Otago Harbour against which future surveys may be compared. It also serves as a comparator for surveys undertaken as part of the Port Otago Ltd consenting process.

The current survey focuses on subtidal rocky shore habitat and extends our knowledge of these sites. Some differences from the baseline survey and the results presented here are immediately obvious, such as the lack of significant difference among some transects that was apparent in the baseline survey. Such differences are largely due to algal abundance and diversity being considered alongside animal abundance and diversity in the current analyses. In the original baseline survey animal abundance and diversity was considered separately. It is felt that the new approah gives a much more realistic picture of community composition and a broader base against which change may be gauged.

The communities encountered during this survey are flourishing and typical of those one would expect to find on sheltered rocky shores in southern New Zealand (Batham 1956, Morton and Miller 1973). The assemblages are very similar to those observed by Paavo (2009) and comprise largely foliose red and brown algae, sponges, ascidians, crabs and gastropod molluscs. As one would expect, there is a gradient of both diversity and abundance moving from the subtidal zone up to extreme high water. This is almost universal among rocky shores and well

recognized (Clayton 1982, Raffaelli and Hawkins 1996, Ricketts 1997). What is not tested is the up-harbour gradient noticeable as one moves from Taiaroa Head to Vauxhall. However, it is believed that focus on rocky shores closest to the proposed dredging activity is most appropriate.

Organisms living on rocky substrate are particularly prone to smothering by fine material (Brosnan 1999, Stewart 2001). Consequently, the risk to such communities from any activity that generates fine sediments in the water column needs to be monitored. That being said, it also needs to be recognized that dredging activity is unlikely to be the only source of such sediments, nor the most significant source. Ongoing road improvements, property development, heavy rain events, the Water of Leith and land subsidence all contribute varying, and sometimes considerable, amounts of sediment to the harbour. The choice of widely separated sites, including intertidal and subtidal sites, and the use of control sites in the case of seagrass beds will assist in differentiating sources of sedimentation.

In previous studies marine benthic communities have been found to re-establish within relatively short time frames of 30 days to 2 years (Brosnan 1996). It is expected that the organisms at rocky shore Otago Harbour sites will do similar. Certainly the fact that a moderately diverse community has established on relatively newly laid rock retaining walls along the Harington Point Road is an indication of how quickly re-colonisation may take place (Stewart 2011).

5. Conclusions

The level of sampling carried out during this survey is believed to be adequate to provide a robust baseline against which future surveys may be compared and any significant changes in community structure identified. The infaunal communities encountered during this baseline survey are typical of infaunal sandy communities in sheltered inlets and harbours around most of New Zealand (Morton and Miller 1973). Likewise, rocky shore communities are as one would expect for sheltered harbours in southern New Zealand (Morton and Miller 1973, Batham 1956). The invertebrate and macroflora assemblages encountered show considerable similarity to those observed in previous studies within Otago Harbour with minor differences attributable to differences in sampling techniques and taxonomic rigor (e.g. Ralph and Yaldwyn 1956, Rainer 1980, Paavo and Probert 2005, Paavo *et al.* 2008, Paavo 2009, Stewart 2013).

It is reasonable to expect that these assemblages will remain essentially unchanged for the next survey, unless dredging, or some other extrinsic factor, has some discernible impact on the communities. The same applies to substrate. Ultimately, indices of multidimensional scaling, similarity percentages and diversity indices calculated for seagrass, saltmarsh, cockle bed, rocky

shore and soft bottom communities will provide ready indicators of community health. Similar metrics for similarly conducted surveys in the future may be compared using a number of uni- and multivariate statistical tests that will reveal any changes in community structure.

It is acknowledged that any changes will be dependent on many factors, including scale and intensity of dredging, the type of substrate being dredged, time of year, and state of the tide and weather.

6. Acknowledgements

Ryder Consulting Limited would like to acknowledge the assistance of Murray Robertson and the team at New Zealand Diving and Salvage.

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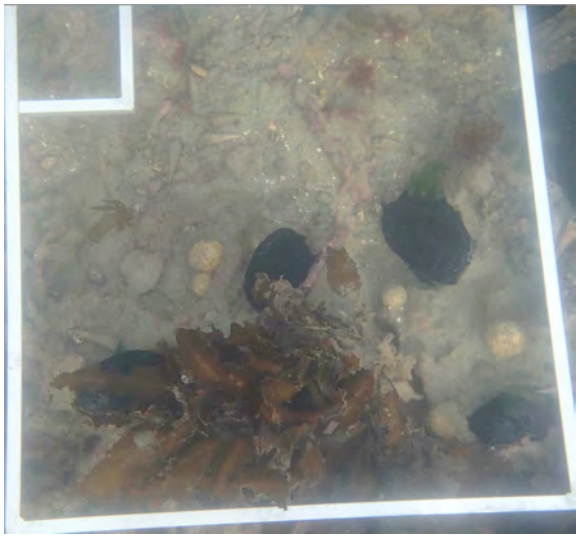
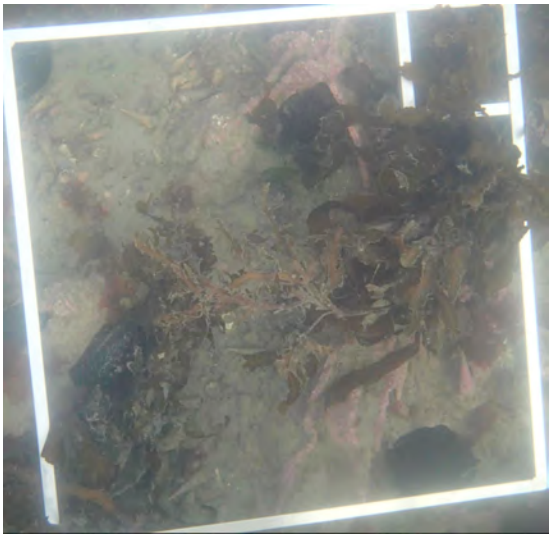
Appendix 1 – Rocky Shore Subtidal Sites

Pudding Island Sites (Quadrats are 0.5 m x 0.5 m. Small square is 10 cm x 10 cm)



Transect 1Qa



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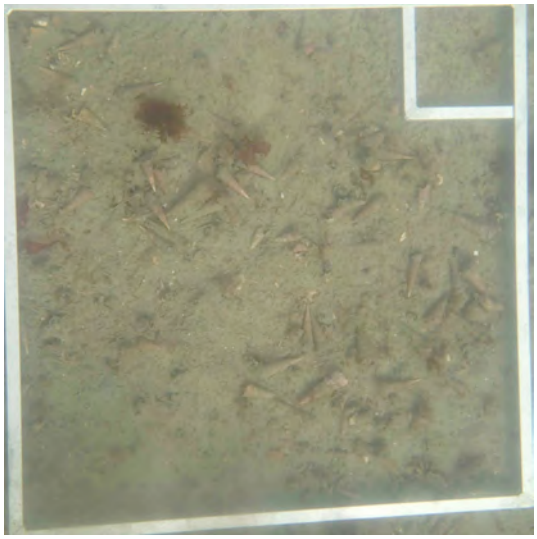

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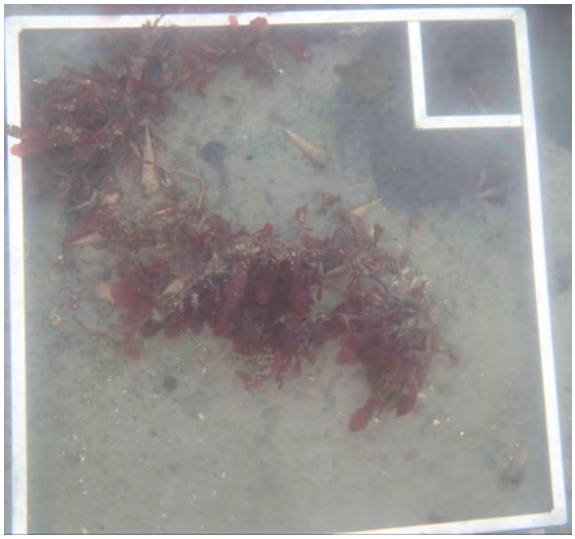

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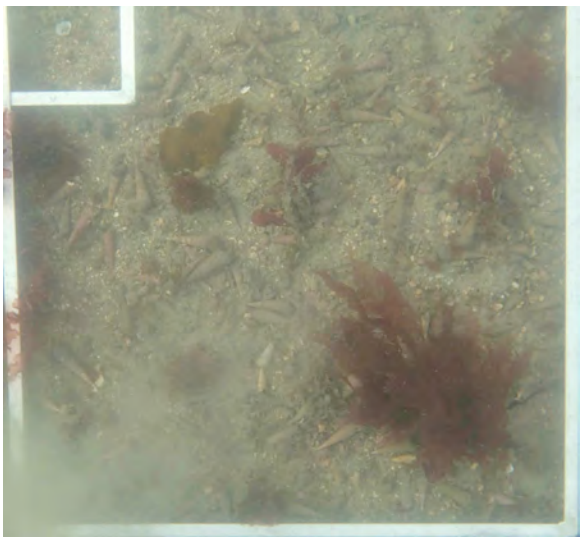

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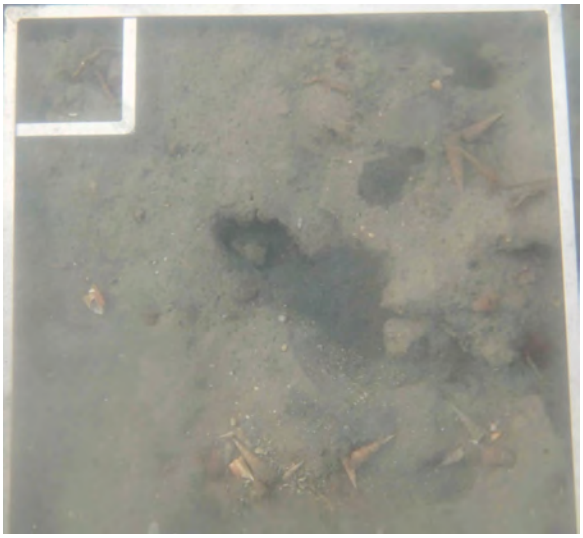

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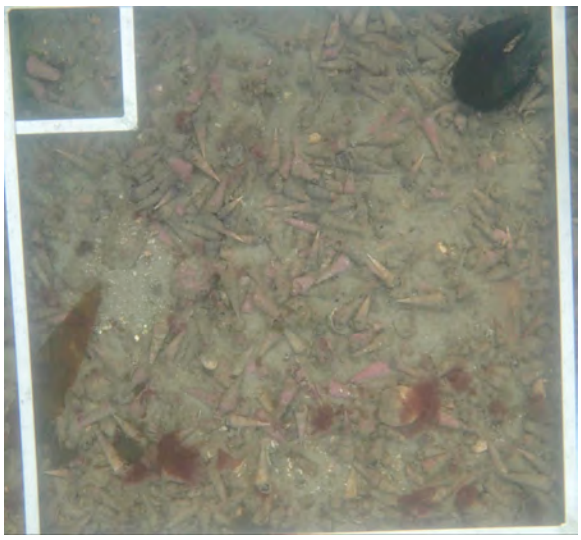

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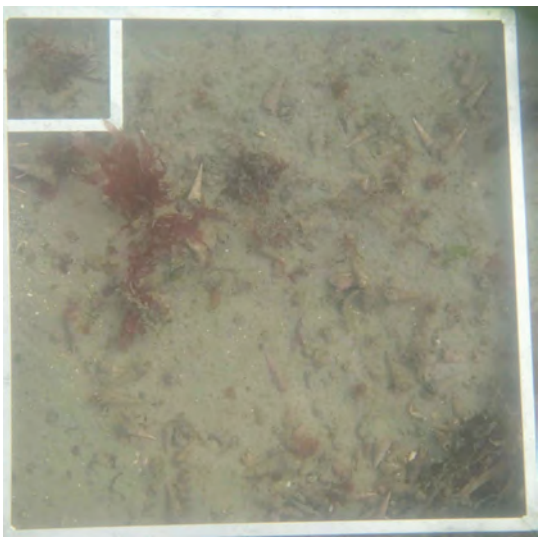

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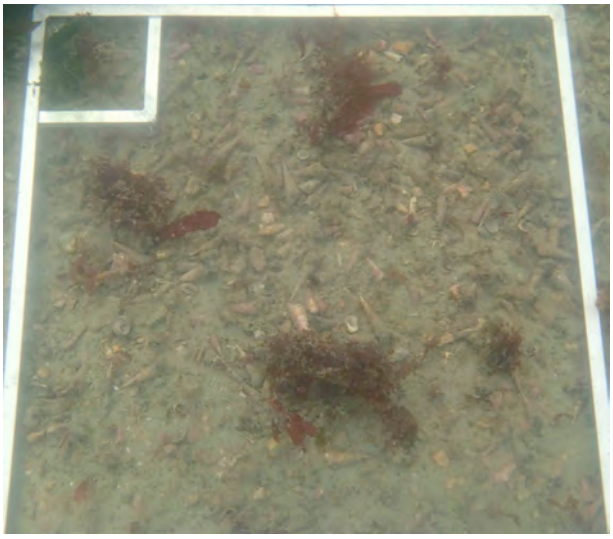

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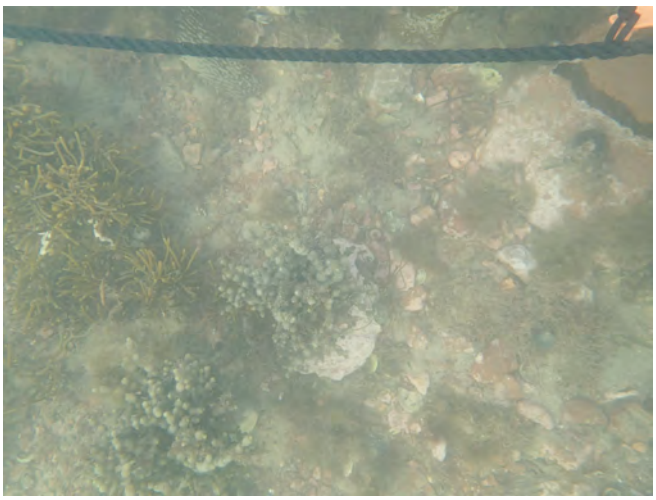

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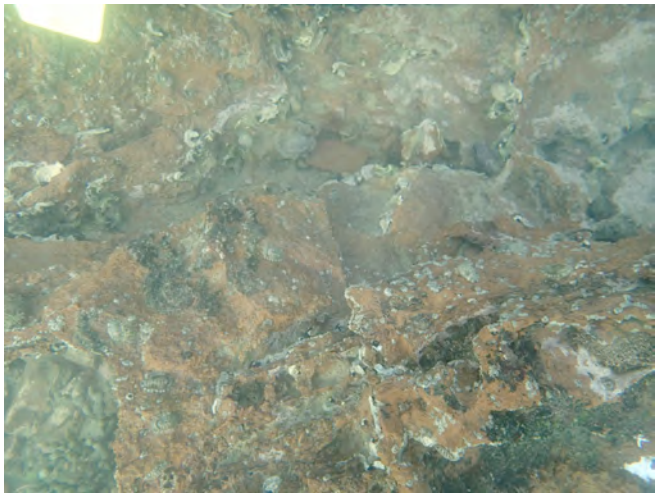

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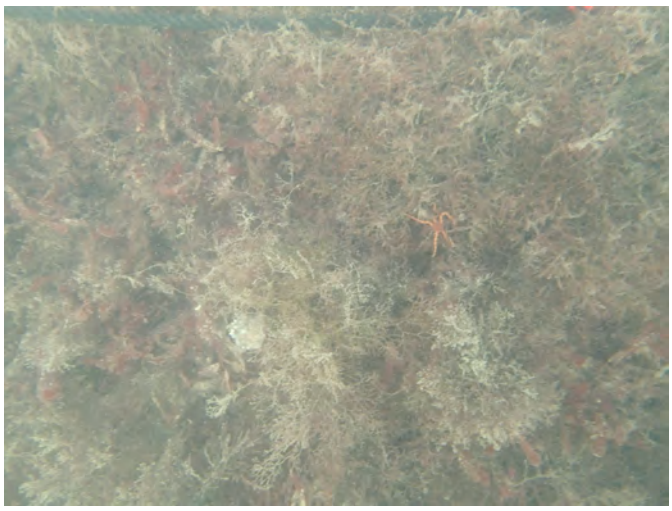
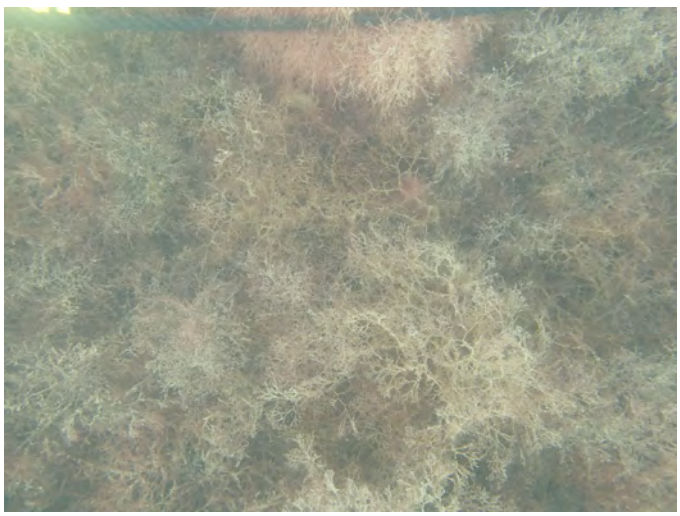


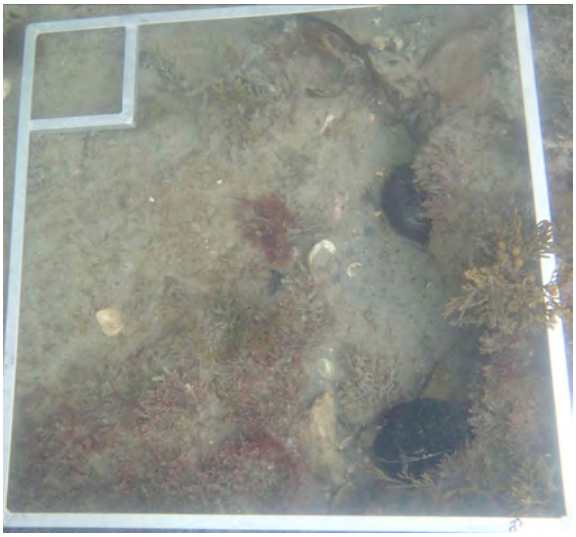
Transect 3Qc

Transect 3Qd

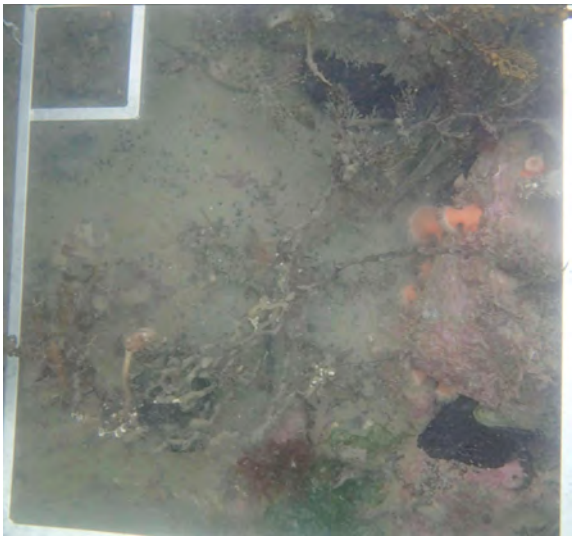


Transect 3Qe

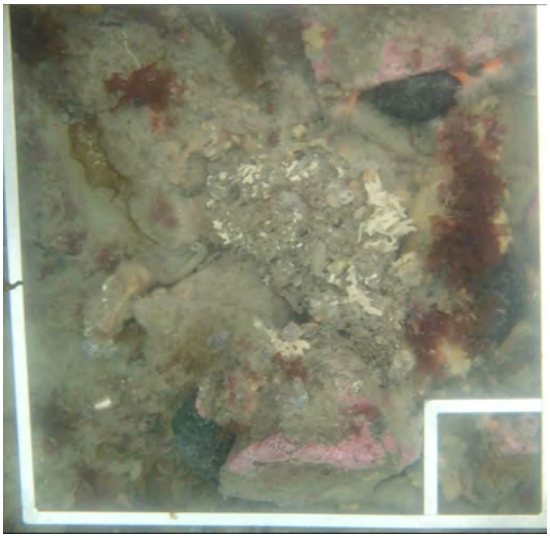
Quarantine Island Sites (Quadrats are 0.5m x 0.5m. Small square is 10cm x 10cm)



Transect 1Qa

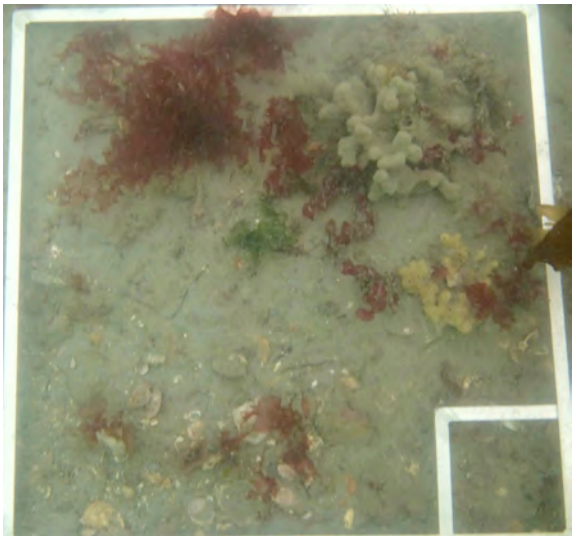


Transect 1Qb

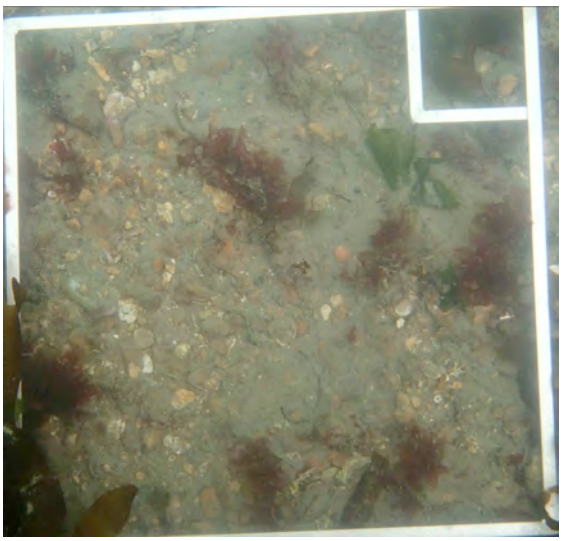


Transect 1Qc

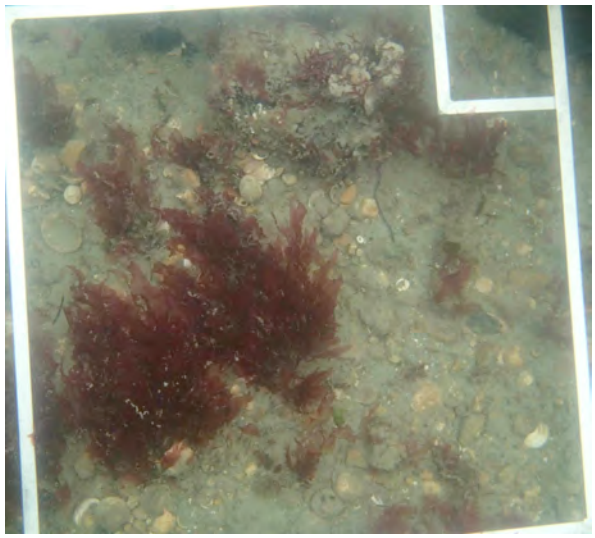
Transect 1Qd



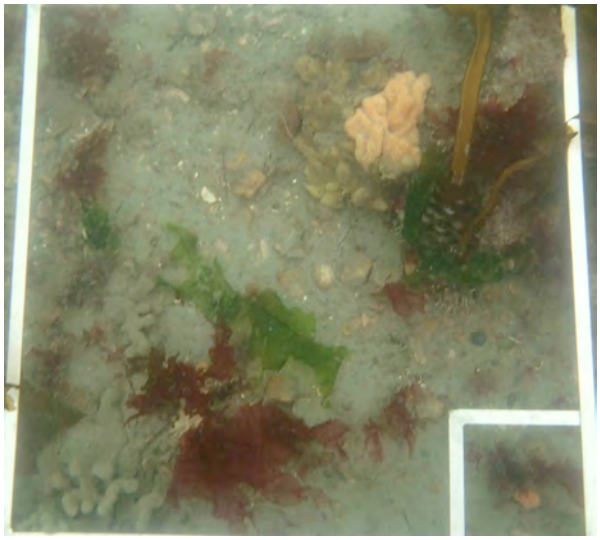
Transect 1Qe



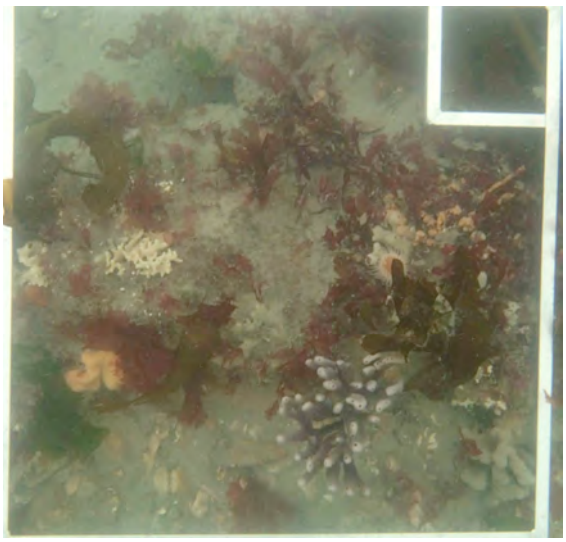
Transect 2Qa



Transect 2Qb



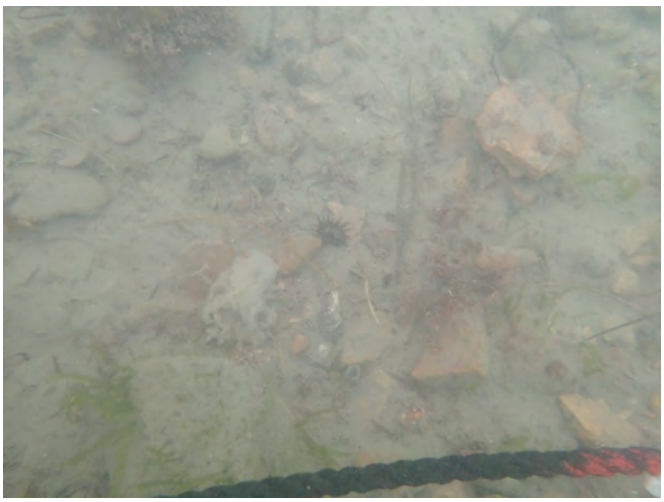
Transect 2Qc



Transect 2Qd

Transect 2Qe

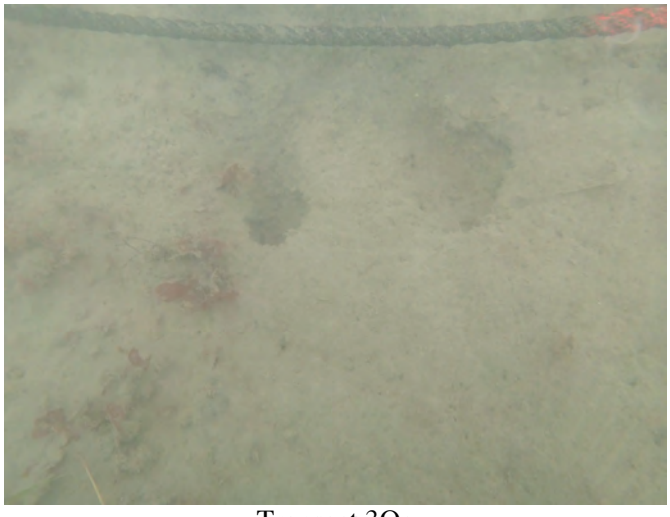
Transect 3Qa



Transect 3Qb

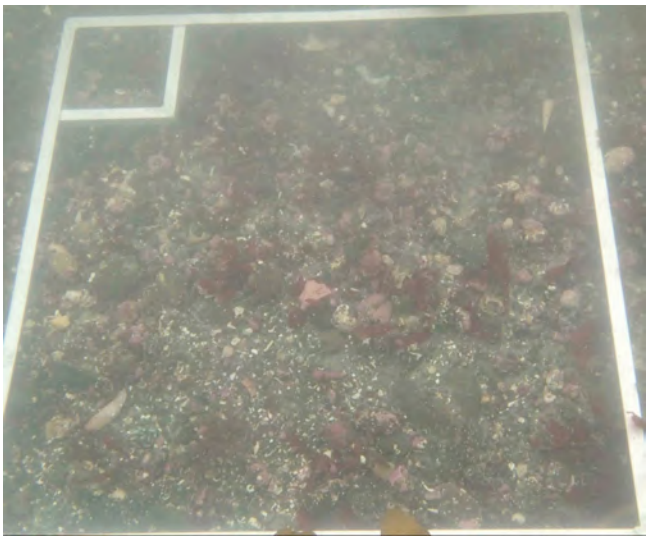
Transect 3Qc

Transect 3Qd

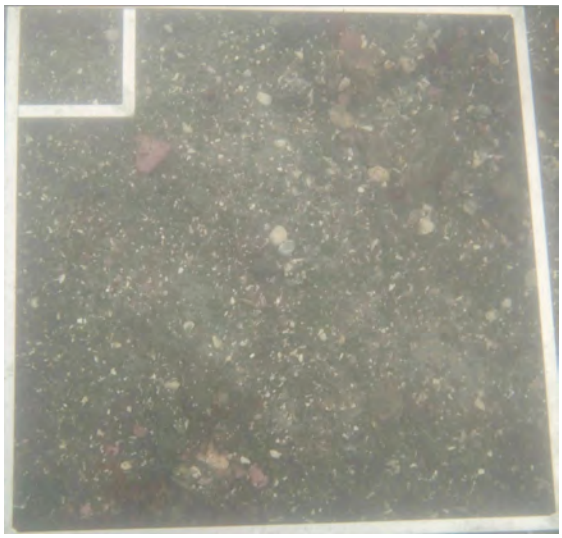


Transect 3Qe

Pulling Point Sites (Quadrats are 0.5 m x 0.5 m. Small square is 10 cm x 10 cm)

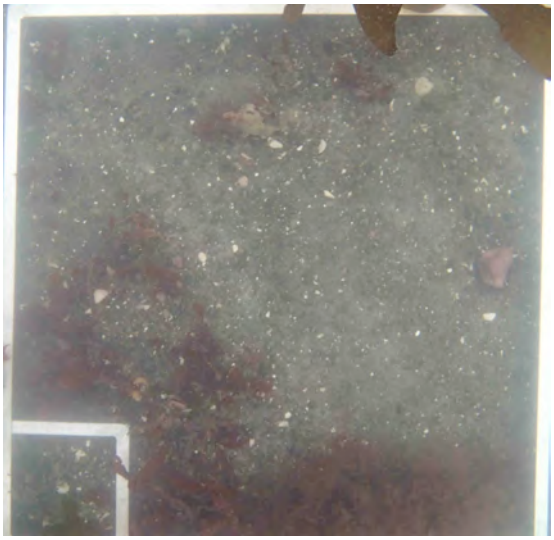


Transect 1Qa

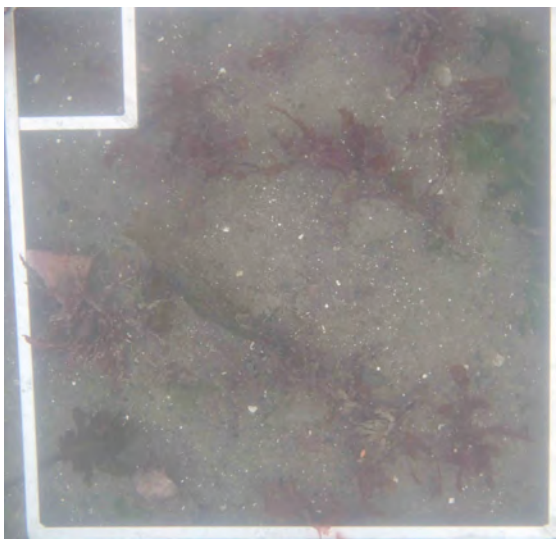


Transect 1Qb

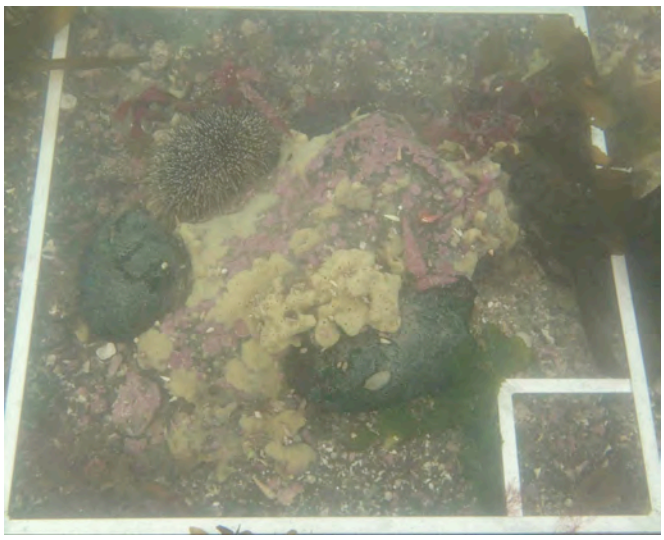
Transect 1Qc



Transect 1Qd

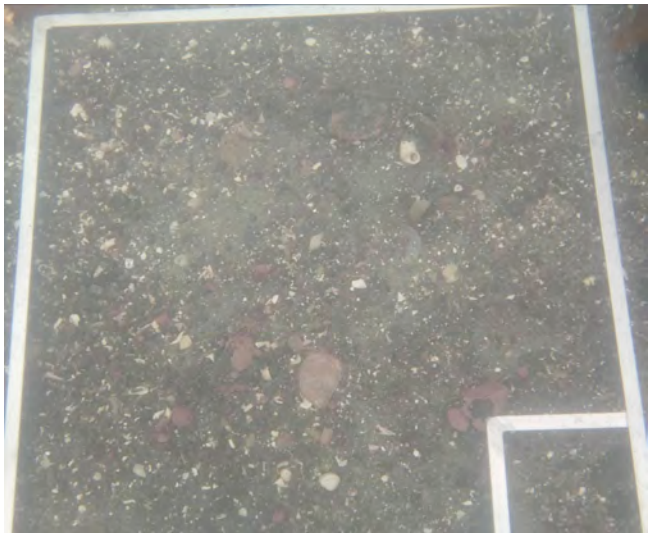


Transect 1Qe

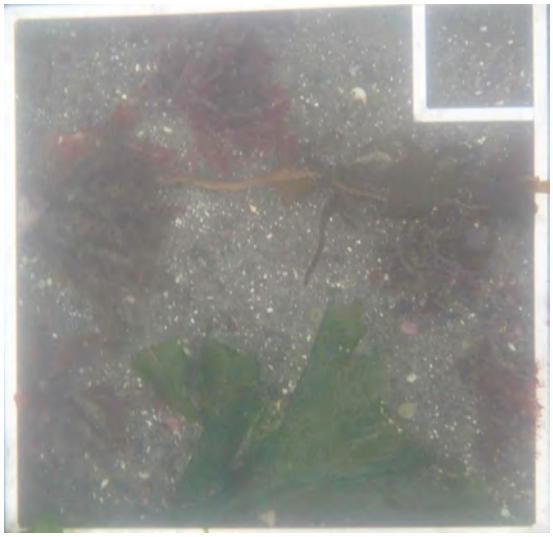


Transect 2Qa

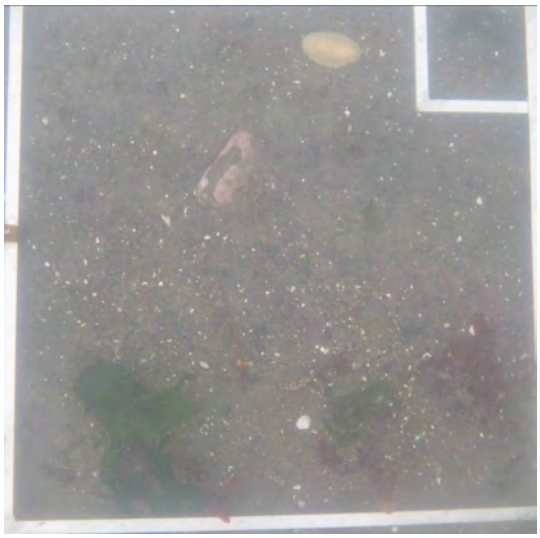
Transect 1Qb



Transect 2Qc

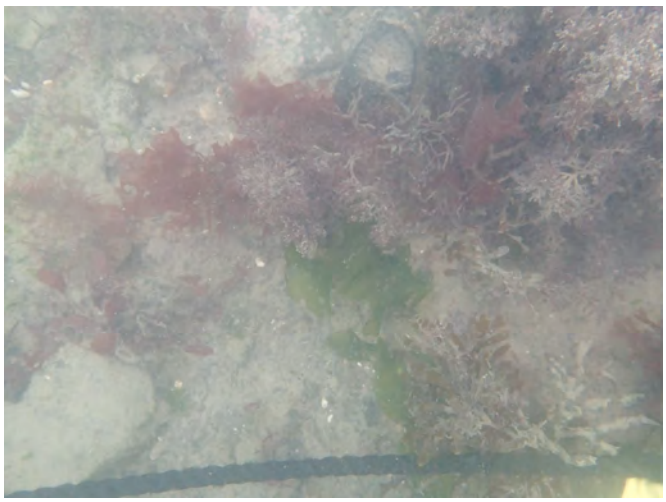


Transect 2Qd

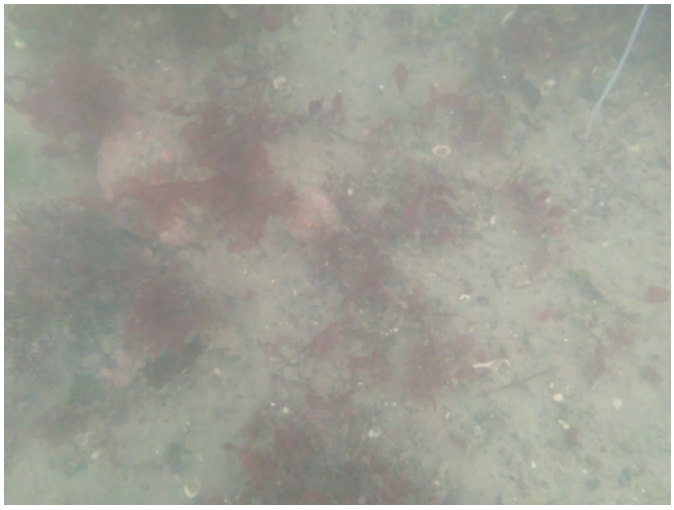


Transect 2Qe

Transect 3Qa



Transect 3Qb



Transect 3Qc

Transect 3Qd

Transect 3Qe