NIWA

Taihoro Nukurangi

record id: 2246
(4041897)

Marine farm survey for consent renewal – MF 320/196, Crail Bay, Marlborough Sounds

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Prepared for

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NIWA Client Report: NEL2004-020
October 2004

NIWA Project: SAN05403

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Executive Summary

NIWA Nelson has been requested by Sanford South Island Ltd to undertake a benthic survey of an existing marine farm, MF 320/196 in Crail Bay, Marlborough Sounds, to provide information as part of the resource consent renewal. This report presents the results of the survey, focussing on characterising benthic (seabed) habitats and epifauna (animals living on the surface of the seabed) within the existing farm.

The site is located in a relatively exposed position on the western side of the mouth of Crail Bay. Water depth at the site is 20-35 m. MF 320 and MF 196 form extensions at either end of the larger licence area Li 6. Sampling was done in September 2004 using sidescan sonar surveys, benthic video transects to ground-truth the sidescan images and characterise the epifauna, and grab sampling to characterise sediments.

Evidence from this study, and from studies of marine farm sites in the Marlborough Sounds generally, indicates that the footprint of the farms is limited to the vicinity of the area covered by mussel lines. Within this zone, there is some organic enrichment of the sediment, (although not to the extent that it becomes anoxic), and the accumulation of live and dead mussels on the seabed (and some items of other debris from the farm). The present study does not suggest that there has been any severe, adverse effect of the existing farm on the seabed beneath. Other than the continued accumulation of shell material and live mussels, and assuming that stocking densities remain similar, this situation is not likely to change significantly in the future. The longlines currently in place are unlikely to have an adverse effect on the areas of coarse sediment and low rocks present in or adjacent to MF 196 because of the distance between them, but this could change if the lines are moved to the west.

1. Introduction

NIWA Nelson has been requested by Sanford South Island Ltd to undertake a benthic survey of an existing marine farm, MF 320/196 in Crail Bay, Marlborough Sounds, to provide information as part of the resource consent renewal. This report presents the results of the survey, focussing on characterising benthic (seabed) habitats and epifauna (animals living on the surface of the seabed) within the existing farm.

The site is located in a relatively exposed position on the western side of the mouth of Crail Bay (Figure 1). Water depth at the site is 20-35 m. MF 320 and MF 196 form extensions at either end of the larger licence area Li 6 (see Figures 2 and 3). MF 320/196 were developed in 1996 and Li 6 ca 20 years ago (M. Mandeno, Sanford Havelock, pers. comm.).

2. Methods

Fieldwork was done on 2-3 September 2004 and included sidescan sonar surveys of the site, benthic video transects to ground-truth the sidescan images and characterise the epifauna, and grab sampling to characterise sediments. Locations of all sampling stations were determined using a Garmin handheld GPS.

Three sidescan sonar swaths of the site were made using a high-frequency (675 kHz) Tritech towfish, running along the outer and inner boundaries and through the middle of the 2 consent areas and parallel to the shore (Figure 2). The tracks also covered the adjoining licence area (Li 6). The beginning, end and intermediate positions of the tow were recorded using a handheld GPS. All sidescan transects were analysed by running the profiles back and recording the positions or boundaries of sediment types. In addition, each sidescan transect was saved as a series of bitmap files and stitched together to provide a visual record that could then be georeferenced and placed into GIS to depict their positions in relation to the adjacent farm boundaries or application site.

Grab samples were taken with a Van Veen grab (bite area ca 0.13 m^2, maximum bite depth 22 cm). A total of 6 samples was collected at haphazardly-chosen sites, 2 within MF 196 (1 on the edge of the area where longlines are currently installed), 2 within MF 320 (1 on the edge of the area where longlines are currently installed), 1 in the outer part of Li 6 (where longlines are currently installed), and 1 just outside the southern boundary of MF 320 but within the same distance from shore as the farm (Figure 2). Two cores of sediment (54 mm internal diameter, up to 15 cm deep – depth varied with the amount of sediment collected by the grab) were taken from each grab and frozen for subsequent analysis of grain size and organic matter content. The depth of the redox discontinuity layer was measured to the nearest mm on one of the cores, using a ruler, at the time of sampling.

The proportions of mud (particles smaller than 63 μm), sand (63-2000 μm) and gravel (>2000 μm) in the sediments were determined by oven drying a sample of sediment at 100 °C overnight and washing a weighed subsample through stacked 2000-μm and 63-μm sieves. The fraction retained on each sieve was dried and weighed and the weight of material passing the 63-μm sieve obtained by subtraction from the original weight. Dry weights for each fraction were expressed as percentages of the total dry weight. The amount of organic matter in the sediments was determined by freeze-drying each sample, grinding, combusting a known weight in a furnace at 500°C for 4 hours, and reweighing. The weight of organic matter was determined by subtracting the combusted weight from the original (freeze-dried) weight and expressed as a percentage of the dry weight.

Benthic video transects were made using a small remote-operated vehicle (ROV) attached to a sled. The sled was dragged for approximately 50 m along the seabed within each of the sidescan tracks at the site, sampling an area of ca 25 m^2 with each transect (Figure 2). A reasonably constant towing speed was achieved by hauling the ROV's tether with the winch on the support vessel. Numbers of biological features (including living and dead organisms, and holes) were recorded from each transect.

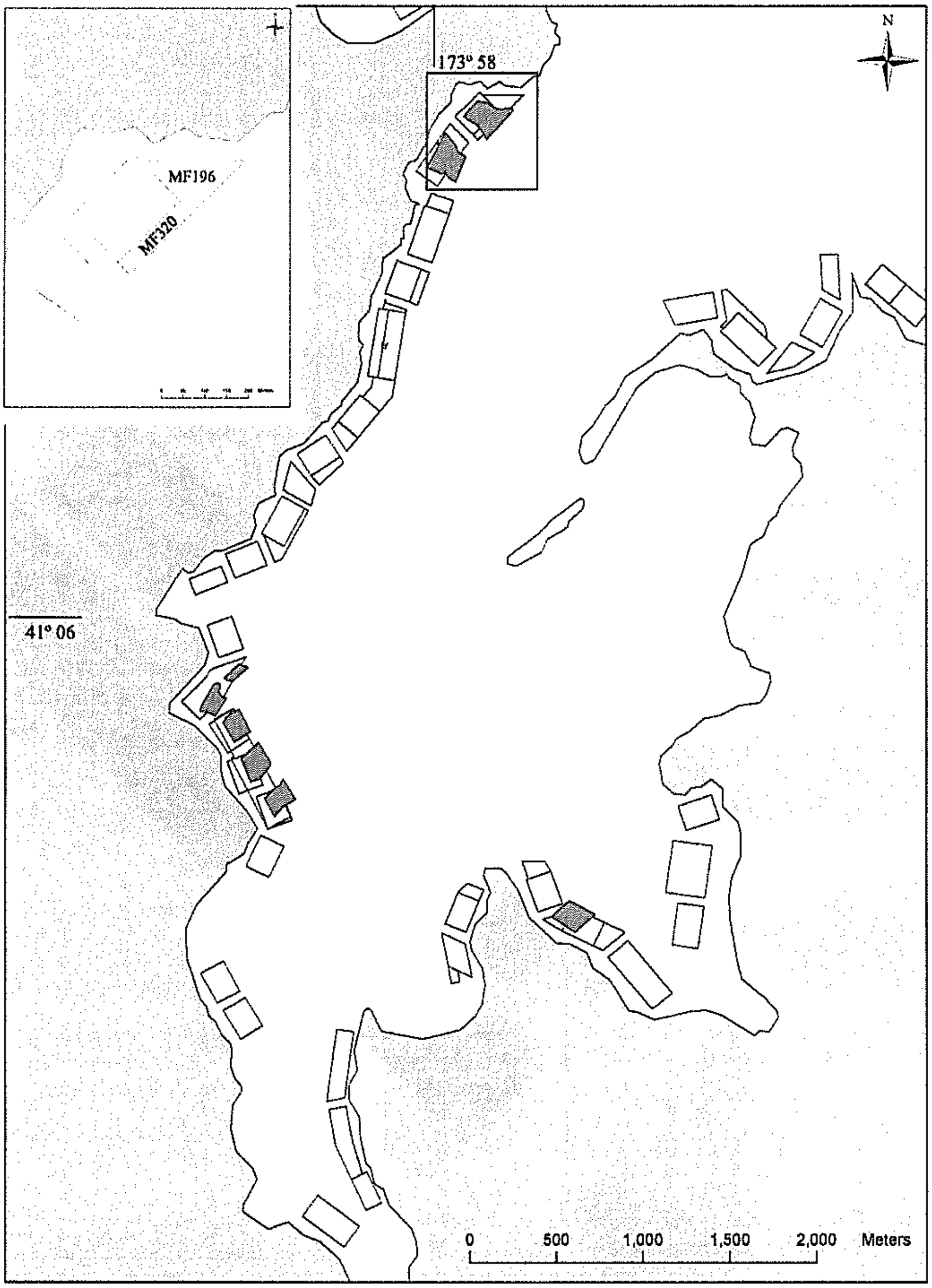

Figure 1 **Crail Bay, Marlborough Sounds, showing location of farm site MF 320/196 in box. Existing farm structures are shown in purple, proposed extensions in yellow and consent areas in white. The inset shows the positions of the original consent area (Li 6) and the extensions (MF 320/196).**

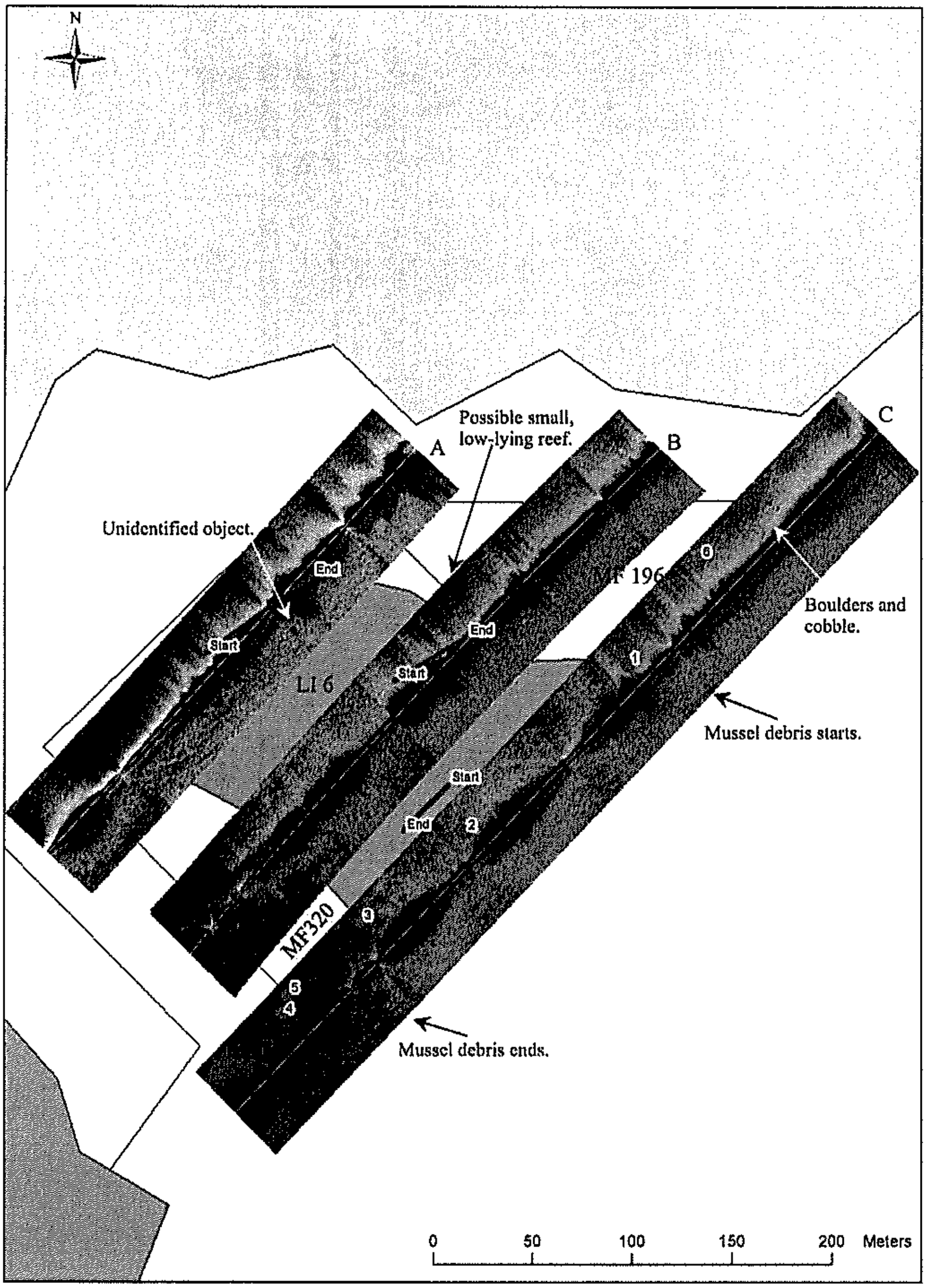

Figure 2 **Location of sonar tracks, grab samples (red dots) and video transects (blue lines) at MF 320/196, Crail Bay. Existing farm shown in purple. Selected features of interest, referred to in Table 1, are labelled.**

3. Results

3.1 Character of the seabed and sediments below and adjacent to the farm

3.1.1 Sidescan sonar

The sidescan surveys of the site show that the seabed consisted of muds, sands and gravels along the inshore boundary and mud/sand in the outer part of the consent area. Mussel shell debris was generally restricted to the area within the boundaries of the existing farmed area and occurred along all three transects but most abundantly on the middle and outer swaths (Figure 2, Table 1). There was an indication on the middle swath of low-lying rocks or reef in the western part of MF 196 (outside the area currently occupied by longlines). An area of boulders and cobbles occurred just outside the northeastern corner of MF 196, on the outer swath. Other areas of gravels or cobbles were present on the middle and inner swaths, close to the shore and just outside the northern boundary of MF 196. There also appear to be some items of other debris from the farm (possibly ropes and a drum) on the seabed below the farm.

3.1.2 Sediment texture, organic-matter content and redox depth

Most samples consisted predominantly of mud (Table 2), with smaller amounts of sand (1-8%) and shell gravel (0-16%). When the weight of shell gravel is removed from the total weight, all samples except for number 6 comprised more than 90% mud. Sample 6 (from MF 196, away from the area where longlines are currently installed) consisted predominantly of sand and shell gravel, the latter composed of species other than Greenshell mussels, presumably because it lay in shallower water nearer the shore, where wave action has more effect on the seabed. Of the other samples, only samples 1, from the edge of the farmed area, and 2, from inside the farmed area, contained more than trace amounts of shell material (Table 2).

The average organic matter content of the sediments (Table 2) was slightly higher inside the farm (9.2%, n=2) than outside (8.3%, n=3, excluding sample 6 because of its coarse texture). Sample 2, from the middle of the area currently occupied by longlines, contained the highest percentage of all (11%). The difference between the 2 groups of samples is likely to result from the input of organically-enriched material to the seabed beneath the farm in the form of faeces and pseudofaeces (material filtered from the water but not ingested) from the mussels and from fouling organisms dislodged from the lines. There was, however, overlap in the percentages of organic matter between the 2 groups (Table 2).

The redox depth of the sediment indicates how rapidly oxygen is used up in the process of microbial decomposition of organic matter. Above this depth, oxygen is replaced from the overlying water faster than it is used for decomposition. Below it, oxygen is no longer available and decomposition occurs by various anoxic biochemical processes, some of which produce grey and black sulphides that give anoxic sediment its characteristic colour and smell. Anoxic sediments generally contain relatively small abundances and diversities of organisms compared to oxic sediments. Redox depth therefore provides an indication of the relative ecological effect that organic enrichment has had on the sediment, with a shallow redox depth indicating a more severe adverse effect. At the present site, redox depths in the samples from inside the edge of the farmed area (samples 1 and 3, Table 2) were similar to those in samples from outside (samples 4 and 5). Sample 2, from the middle of the area currently occupied by longlines, had the shallowest redox layer. None of the samples, however, contained a particularly distinct redox discontinuity layer (i.e., a distinct transition from brown to black sediment), and the sediment below the redox depth was grey-brown rather than dark grey or black. This indicates that organic enrichment below the farm was probably not intense enough to have a severe adverse effect on the sediment environment or biota.

3.1.3 Video transects

In the parts of the sidescan swaths along the inshore margin of the consent areas that were ground-truthed with the video (Figure 2, Table 3), the seabed consisted of sand with shell gravel and moderate to abundant mussel debris (clumps and individual shells of live and dead mussels). The middle and offshore parts of the consent areas contained muddy sediments with abundant mussel debris (individuals and clumps).

3.2 Epifauna of the seabed below and adjacent to the farm

The conspicuous epifauna of the site, as identified from the video transects of the seabed, consisted of species typical of soft sediments in the Marlborough Sounds (Stenton-Dozey et al. 2003) (Table 3: note that image quality for the outer transect was too poor to distinguish organisms reliably). Clumps and individual living Greenshell mussels were abundant along all 3 transects and the starfish *Coscinasterias muricata* was present along the inner and middle transects, feeding on the fallen mussels. The cushion star *Patiriella regularis* was also abundant along the inner and middle transects. A single horse mussel (*Atrina zelandica*) was present on the inner transect.

Holes, presumably made by infauna, were moderately abundant along the inner transect but less so along the middle transect.

4. Discussion

4.1 Nature and extent of effects of the existing farm on the seabed

The presence of mussel farms might be expected to alter the underlying seabed through the input of live and dead mussels, fine-grained particulate matter in the form of faeces and pseudofaeces, and organic material in the form of faeces/pseudofaeces and fouling organisms dislodged from the lines. However, the degree to which this occurs can vary considerably among farms, depending on factors such as the hydrodynamic environment, the depth of water and the level of stocking of the farm.

The presence of shell material on and in the sediment is clearly shown in the sidescan images (Figure 2, Table 1). This material appears to be confined generally to the area immediately around the mussel lines, and is within the consent areas.

Other than the addition of shell and shell gravel, there is no indication that the presence of the farm has had a major effect on the texture of the sediment, with the percentage of fine particles (<63 µm) being similar, or larger, in the samples from outside the farmed area (even when differences in the amount of material >2 mm is taken into account). Proportion of fine material appears to relate more to water depth than the presence of farm structures. One sample (sample 6) had a much larger percentage of shell gravel than the others, probably because it came from shallower water nearer the shore (this sample came from a site away from existing farm structures). The amount of organic matter in the sediment was slightly higher in samples from inside the farm, but this did not cause a consistent reduction in the depth of the redox discontinuity layer, a measure of the degree of oxygenation of the sediment. The absence of a dark-grey or black layer of strongly reduced sediment suggests that effects on benthic organisms would be small.

The most obvious effect of the farm on the epifauna is the accumulation of clumps and individual mussels within the farm area. As with many farm sites (e.g. Inglis & Gust 2003), the starfish *Coscinasterias muricata* was also present, feeding on the mussels. The absence of large, sessile epifauna, such as sponges, bryozoans, horse mussels and sea-squirts under the existing farm is not surprising and cannot be interpreted as an effect of the farm. Such organisms are sparsely and patchily distributed in the Marlborough Sounds, as evidenced by work done recently for Fisheries Resources Impact Assessments (FRIAs: Stenton-Dozey et al. 2003).

5. Conclusions

Evidence from this study, and from studies of marine farm sites in the Marlborough Sounds generally, indicates that the footprint of the farms is limited to the vicinity of the area covered by mussel lines. Within this zone, there is some organic enrichment of the sediment, (although not to the extent that it becomes anoxic), and the accumulation of live and dead mussels on the seabed (and some items of other debris from the farm). The present study does not suggest that there has been any severe, adverse effect of the existing farm on the seabed beneath. Other than the continued accumulation of shell material and live mussels, and assuming that stocking densities remain similar, this situation is not likely to change significantly in the future. The longlines currently in place are unlikely to have an adverse effect on the areas of coarse sediment and low rocks present in or adjacent to MF 196 because of the distance between them, but this could change if the lines are moved to the west.

6. References

Inglis, G.J., Gust, N. (2003). Potential indirect effects of shellfish culture on the reproductive success of benthic predators. *Journal of Applied Ecology* 40: 1077-1089.

Stenton-Dozey, J., Ross, A., Stevens, C., Grange, K. (2003). Fisheries resource impact assessment for mussel farm permit applications in Forsyth and Orchard Bays, Marlborough Sounds. NIWA Client Report No. CHC2003-120 for Mussel Farmers' Consortium for Forsyth and Orchard Bays, Christchurch, December 2003.

Table 1 **Summary of information obtained from side-scan sonar records for MF 320/196. GPS coordinates for the central line of the side-scan swath (latitude/longitude) were taken at the beginning and end of each track. Additionally, coordinates were noted when features of interest were present.**

Track ID	Easting	Northing	Latitude	Longitude	Sediment Type	Seabed Class	Notes
Inshore	2591736	6012826	S 41 5.228	E 173 58.380	Sand/Mud/Gravel	Soft & Coarse Sediment	Coarser sediment inshore side of swath.
Boundary	2591671	6012757	S 41 5.266	E 173 58.334	Sand/Mud/Gravel	Soft & Coarse Sediment	Shell farm side.
	2591657	6012744	S 41 5.273	E 173 58.324	Sand/Mud/Gravel	Soft & Coarse Sediment	Unidentified object farm side, possibly farm refuse.
	2591596	6012678	S 41 5.309	E 173 58.281	Sand/Mud/Gravel	Soft & Coarse Sediment	
	2591555	6012627	S 41 5.337	E 173 58.252	Sand/Mud/Gravel	Soft & Coarse Sediment	
	2591550	6012621	S 41 5.340	E 173 58.249	Sand/Mud/Gravel	Soft & Coarse Sediment	
Middle of	2591852	6012821	S 41 5.230	E 173 58.463	Mud/Sand/Gravel	Soft & Coarse Sediment	Coarse sediment inshore side.
Farm	2591805	6012777	S 41 5.254	E 173 58.430	Mud/Sand	Soft Sediment	
	2591771	6012741	S 41 5.274	E 173 58.406	Mud/Sand/Reef	Soft Sediment/Reef	Possible small, low-lying reef inshore side.
	2591746	6012717	S 41 5.287	E 173 58.388	Mud/Sand/Shell	Soft Sediment/Shell	Debris visible both sides of swath.
	2591675	6012634	S 41 5.332	E 173 58.338	Mud/Sand/Shell	Soft Sediment/Shell	Debris visible both sides of swath.
	2591628	6012578	S 41 5.363	E 173 58.305	Mud/Sand some shell	Soft Sediment/Shell	Debris patchy, then ends.
	2591614	6012567	S 41 5.369	E 173 58.295	Mud/Sand	Soft Sediment	Anchor blocks visible.

Table 1 Continued.

Track ID	Easting	Northing	Latitude	Longitude	Sediment Type	Seabed Class	Notes
Offshore	2591956	6012815	S 41 5.233	E 173 58.537	Mud/Sand/Gravel	Soft & Coarse Sediment	Coarse sediment inshore side.
Boundary	2591905	6012774	S 41 5.255	E 173 58.501	Mud/Sand/Boulders/Cobble	Soft Sediment/Boulders/Cobble	Boulders and cobble on inshore side of swath.
	2591898	6012767	S 41 5.259	E 173 58.496	Mud/Sand some shell	Soft Sediment/Shell	Some debris.
	2591838	6012697	S 41 5.297	E 173 58.454	Mud/Sand/Shell	Soft Sediment/Shell	Debris visible both sides of swath.
	2591779	6012641	S 41 5.328	E 173 58.412	Mud/Sand/Shell	Soft Sediment/Shell	Debris visible both sides of swath.
	2591723	6012578	S 41 5.362	E 173 58.373	Mud/Sand/Shell	Soft Sediment/Shell	Debris visible both sides of swath.
	2591682	6012533	S 41 5.387	E 173 58.344	Mud/Sand some shell	Soft Sediment/Shell	Debris becomes patchy.
	2591677	6012527	S 41 5.390	E 173 58.340	Mud/Sand some shell	Soft Sediment/Shell	Debris ends.
	2591633	6012472	S 41 5.420	E 173 58.309	Mud/Sand	Soft Sediment	Anchor blocks and warps visible.

Table 2 **Grab sampling locations, water depth and sediment characteristics. 'Position' indicates location of sample relative to the existing farm ('I' inside, 'O' outside). Latitude and longitude are in degrees and decimal minutes and eastings and northings relate to New Zealand Map Grid. '% OM' indicates percentage of organic matter (measured as loss on ignition). '% fines', '% medium' and '% coarse' indicate percentages of sediment in the size classes <63 µm, 63-2000 µm and >2000 µm, respectively. 'n/a' indicates no distinct redox layer present.**

Sample	Position	Latitude	Longitude	Easting	Northing	Depth (m)	% OM	Redox depth (mm)	% fines	% medium	% coarse
1	I	S 41 5.283	E 173 58.461	2591848	6012723	34.4	8.1	50	84.6	7.9	7.6
2	I	S 41 5.329	E 173 58.403	2591766	6012639	33.1	11.0	20	78.6	5.4	16.0
3	I	S 41 5.354	E 173 58.366	2591714	6012593	32.0	8.6	65	98.2	1.1	0.8
4	O	S 41 5.379	E 173 58.338	2591674	6012547	32.5	8.3	65	99.4	0.8	0.1
5	O	S 41 5.374	E 173 58.340	2591677	6012557	32.5	8.3	50	98.0	1.7	0.3
6	O	S 41 5.254	E 173 58.486	2591884	6012776	21.4	3.1	N/A	8.5	65.1	26.4

Table 3 **Sediment characteristics and biological features identified from video transects of the seabed. The locations of the start and end of each transect, and the water depth, are shown. Sediment type was assessed visually. 'Mussel debris' refers to dead mussel shells and is on a relative scale, 'Mussel clumps' refers to numbers of clumps of live Greenshell mussels (*Perna canaliculus*) and the number in brackets indicates the range of numbers of mussels per clump. The relative abundances of holes in the seabed larger than 1 cm diameter (presumably made by infauna) are indicated. Empty cells in the table indicate that image quality was too poor to identify features reliably.**

	Inner Boundary		Middle		Outer Boundary	
	Start	End	Start	End	Start	End
Easting (NZMG)	2591635	2591689	2591731	2591767	2591758	6012663
Northing (NZMG)	6012729	6012768	6012715	6012737	2591735	6012639
Water depth (m)	25.7	23.3	32.7	30.6	33.4	33.1
Sediment type	Sand/Mussel Debris/Shell Gravel		Mud/Mussel Debris		Mud/Mussel Debris	
Mussel debris	Moderate/Abundant		Abundant		Moderate/Abundant	
Mussel clumps	107 (2-150)		5 (20-150)		1	
Coscinasterias muricata	10		2			
Stichopus mollis	1		4			
Patiriella regularis	16		11		1	
Atrina zelandica	1		0			
Triplefin	3		0			
Unid. bivalve	1		0			
Holes	Moderate		Low			
Notes	Image clarity good		Image clarity fair		Image clarity poor	