NIWA

Taihoro Nukurangi

Resource Consent Application -U044310

# Marine farm survey for consent renewal – MF 127, Port Gore, Marlborough Sounds

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# Executive Summary

NIWA Nelson has been requested by Sanford South Island Ltd to undertake benthic surveys of 4 existing marine farms to provide information to support renewal of the resource consents. This report presents the results and conclusions from the survey for MF 127 in Port Gore, Marlborough Sounds. It focuses on characterising benthic (seabed) habitats and epifauna (animals living on the surface of the seabed) within the existing farm.

The site is located in the inner part of the eastern side of Port Gore. Sanford have farmed site MF 127 since it was purchased in 1998. We have no information on the history of the site prior to Sanford's purchase. Water depth at the site is 15-28 m. Sampling was done in July 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 immediate vicinity of the area covered by mussel lines. Within this zone, there is some organic enrichment of the sediment, (though not to the extent that it becomes anoxic), and the accumulation of live and dead mussels on the seabed. 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.

# 1. Introduction

NIWA Nelson has been requested by Sanford South Island Ltd to undertake benthic surveys of 4 existing marine farms to provide information to support renewal of the resource consents. This report presents the results and conclusions from the survey for MF 127 in Port Gore, Marlborough Sounds. It focuses on characterising benthic (seabed) habitats and epifauna (animals living on the surface of the seabed) within the existing farm.

The site is located in the inner part of the eastern side of Port Gore (Figure 1). Sanfords have farmed site MF 127 since it was purchased in 1998 (Mike Mandeno, Sanford South Island Ltd, pers. comm.). We have no information on the history of the site prior to Sanford's purchase. Water depth at the site is 15-28 m.

# 2. Methods

Field work was done on 8 July 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 through the outer boundary, middle and inner boundaries of the farm along its long axis (parallel to the shore: Figure 2). 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, which were then coded and used to produce GIS maps. 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 placed into GIS along with the adjacent farm boundaries or application site.

Grab samples were taken with a Van Veen grab (bite area ca 0.13 $m^2$, max bite depth 22 cm). Samples were collected at 3 haphazardly-chosen sites within the farm and at 2 locations just outside the farm 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.

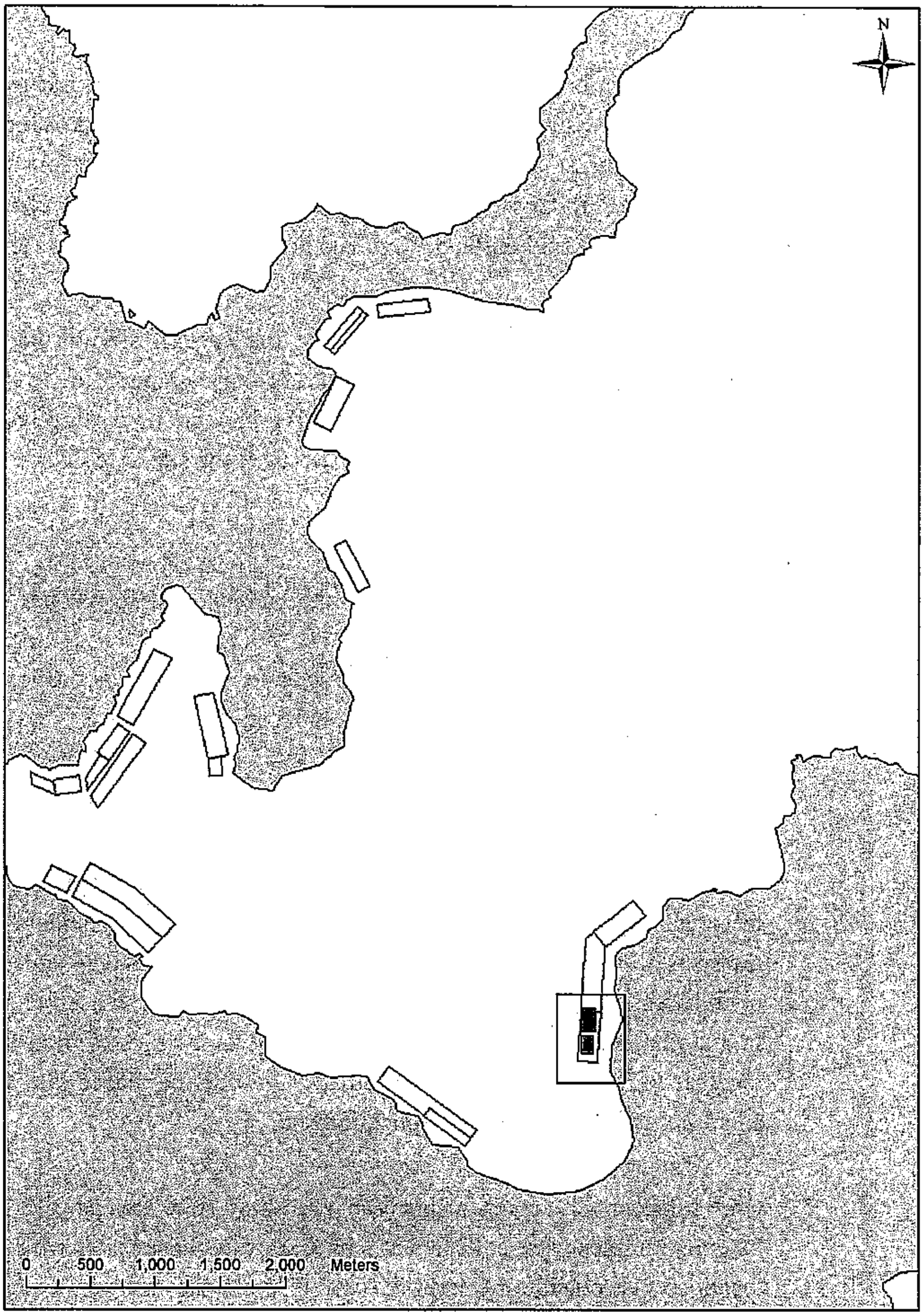


**Figure 1** **Port Gore, Marlborough Sounds, showing location of farm site MF 127. Existing farm structures are shown in purple, proposed extensions are shown in yellow and white are the consent areas.**

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 (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.

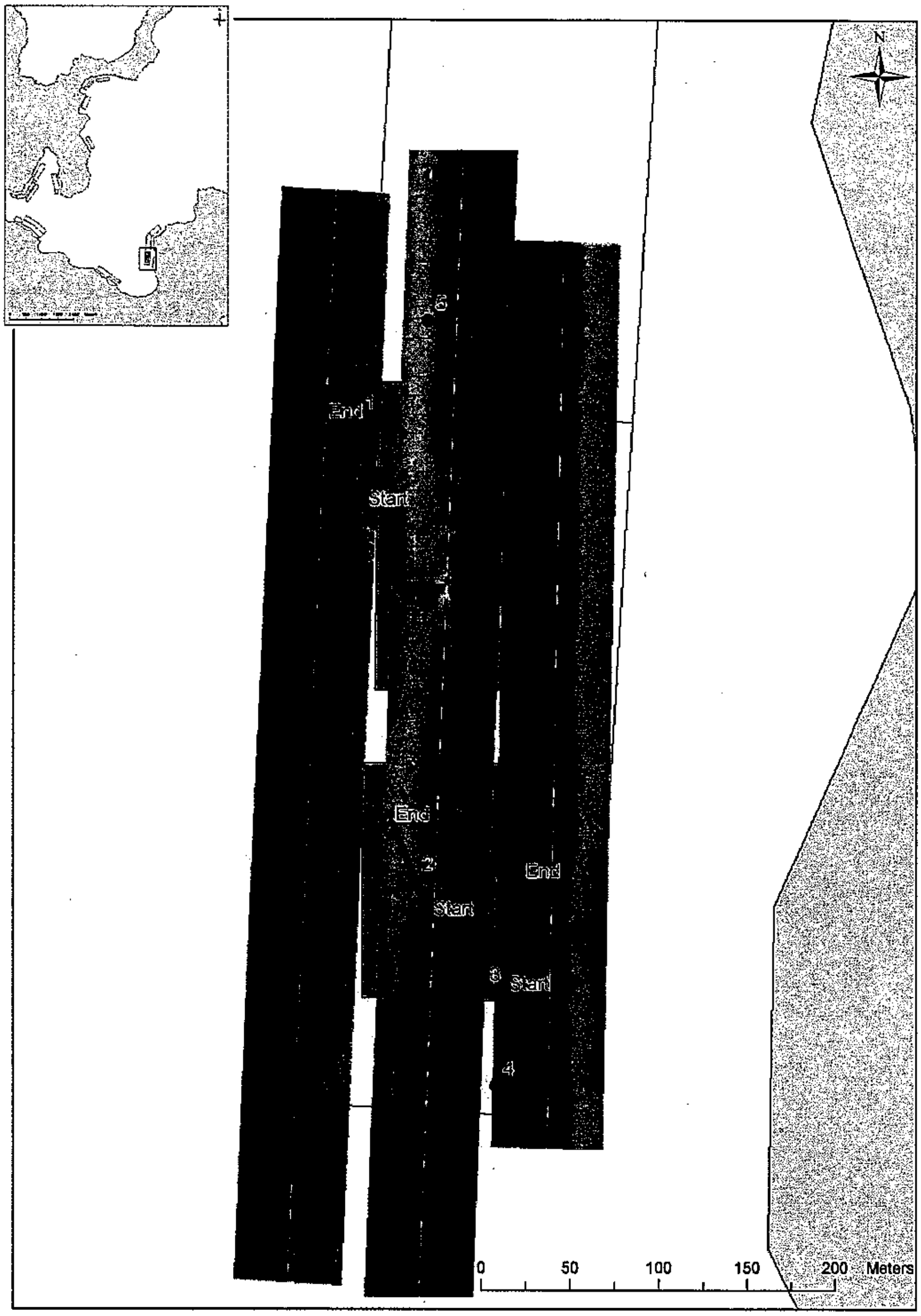


**Figure 2** **Location of sonar tracks, grab samples (red dots) and video transects (blue lines) at MF 127, Port Gore. Existing farm shown in purple.**

# 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 consists of soft sediment (sand or mud), with shell debris present inside the farm boundaries and very little outside (Figure 2, Table 1). There is no evidence of reef or cobble within the consent area.

### 3.1.2 Sediment texture, organic-matter content and redox depth

The sediments at this site were relatively sandy (24-80% sand: Table 2). Sand content decreased with distance from shore apart from in sample 5, which was the sandiest but occurred near the offshore boundary of the existing farm (Figure 2). There were no consistent differences in the percentage of fine sediment between samples inside and outside the farm. Sample 3 (inside) and 4 (outside) were located a similar distance offshore and, apart from more shell gravel in the former, had very similar textures. The percentages of shell gravel were consistently higher inside the farm.

The average organic matter content of the sediments (Table 2) was higher inside the farm (4.4%, $n$=3) than outside (2.3, $n$=2), but the values for all samples were relatively low. This difference 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.

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 different 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 were consistently shallower inside than outside the farm and in one sample the grey layer came right to the surface of the sediment (Table 2). Samples from inside the farm were grey with black mottling, but there was no clearly defined black layer. Although variation in redox depth between samples from inside and outside the farm matched the relative concentrations of organic matter, it is surprising that redox differences were so pronounced given the low percentage values of organic matter (4% would not be considered a particularly high concentration for muddy sediments).

#### 3.1.3 Video transects

In all parts of the sidescan swaths ground-truthed with the ROV, the seabed consisted of soft sediment (Table 3).

### 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 (Table 3), was very limited in its diversity along all 3 transects. Numerous clumps of living Greenshell mussels occurred along all transects but were most abundant in the middle of the farm. Dead mussel shells were abundant along the inshore and middle transects but less so along the outer boundary of the farm. This difference may represent inshore transport of the shells by ocean swells, either as they fall from the lines or after they have reached the bed. Surprisingly, and in contrast to many other sites in the Marlborough Sounds (e.g. Inglis & Gust 2003), the starfish *Coscinasterias muricata* was represented by only one individual among the 3 transects. The cushion star *Patiriella regularis* and the sea-cucumber *Stichopus mollis* were abundant on the transects along the middle of the farm and the offshore boundary. Holes, presumably made by infaunal organisms, were also more abundant in these deeper areas. Isolated individual horse mussels (*Atrina zelandica*) occurred inside the farm and along the inshore boundary. Triplefins were most abundant along the inshore and middle transects, presumably because these areas were closest to the shallow subtidal areas typically inhabited by these fish. The greater abundance of drift algae along the transect through the middle of the farm may have been due to its entrapment among the clumps of mussels.

## 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 to the area immediately around the mussel lines, and is within the consent area.

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 ranges of percentage of fine particles overlapping between samples from inside and outside the farm. Sediment texture appears to relate mainly to water depth. The amount of organic matter in the sediment was higher inside the farm, and the redox depth correspondingly shallower. However, the absolute amounts of organic matter in the sediments inside the farm were relatively low, and there was no clearly defined anoxic, black horizon in the sediment.

The most obvious effect of the farm on the epifauna is the accumulation of clumps of mussels within the farm area. 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). Furthermore, the bay is dredged and trawled by commercial fishers, which is likely to reduce the abundance and diversity of epifauna (e.g., Kaiser & Spencer 1996).

## 5. Conclusion

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 immediate vicinity of the area covered by mussel lines. Within this zone, there is some organic enrichment of the sediment, but not to the extent that it becomes anoxic, and the accumulation of live and dead mussels on the seabed. 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.

# 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.

Kaiser, M.J., Spencer, B.E. (1996). The effects of beam-trawl disturbance on infaunal communities in different habitats. *Journal of Animal Ecology* 65: 348-358.

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 sidescan sonar records. GPS coordinates (latitude/longitude) were taken at the beginning and end of each track. Additionally, coordinates were noted when features of interest were present. Coordinates refer to the central line of the sidescan swath.**

| Track ID | Latitude | Longitude | Sediment Type | Seabed Class | Notes |
|---|---|---|---|---|---|
| PGMF127_IS | 41° 03.463 | 173°13.375 | Soft sediment | Sand/Mud | Start |
| (Inshore | 41° 03.472 | 173°13.376 | Soft sediment | Sand/Mud | Anchor warp and block (or possibly screw anchor) |
| boundary) | 41° 03.495 | 173°13.380 | Soft sediment | Sand/Mud/Shell debris | Mussel line starts, shell debris starts on farm side |
| | 41° 03.576 | 173°13.383 | Soft sediment | Sand/Mud/Shell debris | Mussel line ends, shell debris ends |
| | 41° 03.608 | 173°13.379 | Soft sediment | Sand/Mud | Anchor block and warp |
| | 41° 03.609 | 173°13.380 | Soft sediment | Sand/Mud | Anchor block and warp (next farm) |
| | 41° 03.644 | 173°13.371 | Soft sediment | Sand/Mud/Shell debris | Mussel line and shell debris start farm side |
| | 41° 03.645 | 173°13.372 | Soft sediment | Sand/Mud/Shell debris | Mussel line and shell debrisend |
| | 41° 03.742 | 173°13.374 | Soft sediment | Sand/Mud | Anchor block and warp |
| | 41° 03.753 | 173°13.374 | Soft sediment | Sand/Mud | Finish |
| | | | | | |
| PGMF127_M | 41° 03.797 | 173°13.325 | Soft sediment | Sand/Mud | Start |
| (Middle of | 41° 03.695 | 173°13.326 | Soft sediment | Sand/Mud | Anchor block and warp western side |
| farm) | 41° 03.659 | 173°13.326 | Soft sediment | Sand/Mud | Anchor block and warp eastern side |
| | 41° 03.660 | 173°13.327 | Soft sediment | Sand/Mud/shell | Shell debris on both sides |
| | 41° 03.560 | 173°13.334 | Soft sediment | Sand/Mud | Shell debris ends |
| | 41° 03.561 | 173°13.335 | Soft sediment | Sand/Mud | Anchor block and warp western side |
| | 41° 03.562 | 173°13.336 | Soft sediment | Sand/Mud | Anchor block and warp eastern side |

**Table 1** **Continued.**

| Track ID | Latitude | Longitude | Sediment Type | Seabed Class | Notes |
|---|---|---|---|---|---|
| PGMF127_M | 41° 03.563 | 173°13.337 | Soft sediment | Sand/Mud | Anchor block and warp eastern side |
| (Middle of | 41° 03.539 | 173°13.336 | Soft sediment | Sand/Mud/Shell | Shell debris starts |
| farm) | 41° 03.481 | 173°13.336 | Soft sediment | Sand/Mud | Shell debris ends |
| | 41° 03.447 | 173°13.337 | Soft sediment | Sand/Mud | Anchor block and warp eastern side |
| | 41° 03.448 | 173°13.338 | Soft sediment | Sand/Mud | Anchor block and warp western side |
| | 41° 03.425 | 173°13.336 | Soft sediment | Sand/Mud | Anchor block and warp eastern side |
| | 41° 03.426 | 173°13.337 | Soft sediment | Sand/Mud | Finish |
| | | | | | |
| PGMF127_OS | 41°03.447 | 173°13.287 | Soft sediment | Sand/Mud/Shell | Shell debris on eastern (farm) side |
| (Offshore | 41°03.447 | 173°13.287 | Soft sediment | Sand/Mud | No debris on western side |
| boundary) | 41°03.542 | 173°13.278 | Soft sediment | Sand/Mud/Shell debris | Shell debris farm side |
| | 41°03.542 | 173°13.278 | Soft sediment | Sand/Mud | No debris western side |
| | 41°03.613 | 173°13.275 | Soft sediment | Sand/Mud/Shell | Shell debris farm side |
| | 41°03.652 | 173°13.278 | Soft sediment | Sand/Mud/Shell | Anchor block and warp eastern |
| | 41°03.681 | 173°13.273 | Soft sediment | Sand/Mud/Shell debris | Shell debris farm side |
| | 41°03.769 | 173°13.271 | Soft sediment | Sand/Mud/Shell | Anchor warp starts eastern |
| | 41°03.783 | 173°13.274 | Soft sediment | Sand/Mud/Shell debris | Shell debris finishes on farm side |
| | 41°03.784 | 173°13.275 | Soft sediment | Sand/Mud | Western side, finish |

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.

| Sample | Position | Latitude | Longitude | Easting | Northing | Depth (m) | % OM | Redox depth (mm) | % fines | % medium | % coarse |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I | S 41 3.512 | E 174 13.294 | 2612662.170 | 6015739.180 | 26.9 | 5.8 | 6 | 74.95 | 23.52 | 1.53 |
| 2 | I | S 41 3.654 | E 174 13.32 | 2612694.910 | 6015475.900 | 26.1 | 4.2 | 0 | 53.67 | 30.31 | 16.02 |
| 3 | I | S 41 3.688 | E 174 13.348 | 2612733.247 | 6015412.430 | 21.2 | 3.2 | 26 | 24.55 | 73.47 | 1.98 |
| 4 | O | S 41 3.717 | E 174 13.354 | 2612740.900 | 6015358.650 | 19.2 | 2.3 | >90 | 25.33 | 74.41 | 0.26 |
| 5 | O | S 41 3.481 | E 174 13.322 | 2612702.193 | 6015796.000 | 22.6 | 2.2 | >85 | 19.76 | 79.51 | 0.72 |

**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 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.**

| | Inner Boundary | | Middle | | Outer Boundary | |
|---|---|---|---|---|---|---|
| | Start | End | Start | End | Start | End |
| Latitude | S 41 3.689 | S 41 3.654 | S 41 3.666 | S 41 3.637 | S 41 3.54 | S 41 3.513 |
| Longitude | E 174 13.358 | E 174 13.364 | E 174 13.327 | E 174 13.311 | E 174 13.298 | E 174 13.296 |
| Water depth (m) | 17.8 | 15.3 | 24.7 | 25.6 | 27.2 | 26.9 |
| Sediment type | Sand/mud | | Sand/mud | | Sand/mud | |
| Mussel debris | High | | Moderate/high | | Low/moderate | |
| Mussel clumps | 59 (10-100) | | 69 (5-50) | | 42 (5-30) | |
| *Coscinasterias muricata* | 1 | | 0 | | 0 | |
| *Stichopus mollis* | 2 | | 4 | | 4 | |
| *Patiriella regularis* | 0 | | 11 | | 21 | |
| *Atrina zelandica* | 1 | | 1 | | 0 | |
| *Pagurus* sp. | 0 | | 1 | | 0 | |
| Triplefins | 16 | | 16 | | 4 | |
| Unident. fish | 1 | | 0 | | 0 | |
| *Ulva lactuca* | 0 | | 10 | | 3 | |
| Red alga | 0 | | 10 | | 2 | |
| *Undaria* drift | 0 | | 0 | | 4 | |
| Unident. alga | 3 | | 0 | | 0 | |
| Holes | Low | | Abundant | | Abundant | |
| | | | | | | |
| Notes | Image clarity high | | Image clarity high | | Image clarity variable | |