BEFORE THE VARIATIONS 1 AND 1A PROPOSED MARLBOROUGH ENVIRONMENT PLAN HEARINGS PANEL
AT BLENHEIM

UNDER	the Resource Management Act 1991 (the Act)
IN THE MATTER	of proposed variations to the publicly notified proposed Marlborough Environment Plan under the First Schedule to the Act

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STATEMENT OF EVIDENCE OF ROBERT JAMES DAVIDSON IN SUPPORT OF THE SUBMISSIONS OF CLEARWATER MUSSELS LTD AND TALLEY'S GROUP LTD IN RESPECT OF TWO PROPOSED AMAS AT HAPUKU ROCK, ADMIRALTY BAY

Dated 1 November 2021

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Education

1. My full name is Robert James Davidson. I am a marine biologist and hold the qualification of Master of Science in Zoology (First Class Honours) obtained from Canterbury University (1986). I have worked for the Ministry of Fisheries (1986-87), and the Department of Conservation (DOC) (1987-95). During my time at DOC, I was based at Nelson and employed as the coordinator of marine biological surveys throughout the Nelson Marlborough Conservancy. I was the principal author of several large-scale ecological reports and biological resource documents for marine areas in the DOC Nelson-Marlborough Conservancy. While at DOC I also coordinated resource inventory reports used by the Marlborough District Council, Nelson City Council, Tasman District Council and Canterbury Regional Council outlining ecologically important marine areas for inclusion in their respective coastal plans (Davidson *et al.* 1993; 1995).

Private consultancy and experience

2. In 1995, I left DOC and established my own practice, "Davidson Environmental Limited", which specializes in ecological research, survey and monitoring. To date, I have produced over 1,000 reports most of which have been associated with Resource Consent applications. Most of these RMA related reports have been for marine farm applications, farm impact assessments, farm revalidations and renewals and marine farm monitoring.
3. I have also coordinated up to 29 consecutive years of monitoring for each of three Marine Reserves located at the top of the South Island. Another long-term monitoring programme was the impact monitoring of ferries travelling through the Marlborough Sounds including Tory Channel (1995-2015). Recently I have coordinated a three-year programme updating and reassessing the biological value of sites in the Marlborough Sounds (Davidson *et al*. 2011). This programme was extended from 2015 onwards with sites being revisited and new data collected to confirm their location and biological values (e.g. Davidson and Richards, 2015).
4. I have also been involved in several reviews and advisory roles including the Ecological Advisory Group for reviewing monitoring of the Tasman Bay Marine Farm Ring Road development, as a member of the MDC marine focus group, Top of the South Biosecurity Partnership, MAF *Undaria* Expert Advisory Group, Tasman and Golden Bay marine farm EAG group, and Mapua FCC contaminant clean-up programme.
5. I am the author or co-author of 19 conference papers in New Zealand and overseas. I have published 12 papers in international peer-reviewed scientific journals including papers on marine reserves, subtidal soft bottom and reef communities. Based on a wide range of long-term studies combined with over 4000 working dives in the Marlborough Sounds, I have a very good understanding of the subtidal environment of the Marlborough Sounds.

Summary of experience

- **Working in Marlborough Sounds: 1988-2021 (31 years)**
- **Working dives: >4000**
- **Long term monitoring programmes: 29 years**

- **Resource Consent reports: 950**
- **Published papers: 12**
- **Conference presentations: 18**
- **Boating: SRL skippers ticket, 29 years navigating in the Marlborough Sounds**
- **Conflict of interest declarations**

6. I am part owner of several marine farm consent areas in the Marlborough Sounds. Water space is leased out or is managed by a variety of marine farming companies on contract. I have no shareholding or other beneficial interest in the present marine farm application.
7. I conduct contract work for a variety of organisations some of whom regularly submit or are involved with the process of marine farm applications (e.g. Department of Conservation (DOC), Marlborough District Council (MDC), Ministry for the Environment (MFE), Ministry of Primary Industries (MPI), Marine Farming Association (MFA)). I contract to the MDC and have or presently coordinate science-based studies (i.e. marine farm recovery study in East Bay, ferry impact study in Queen Charlotte Sound and Tory Channel, significant site survey and monitoring).
8. I take care to ensure that my investment in marine farms and my role as a consultant for a variety of clients does not influence my role as an independent consultant. My relationship with clients and standing as an expert witness has been based on my responsibilities as a scientist, my expertise and my experience. My evidence today is therefore consistent with the best principles of scientific inquiry and any opinions and conclusions are based on my experience and understanding of biological theory, integrated with data collected during fieldwork throughout the Sounds and New Zealand.

Code of practice

9. I have read and agree to be bound by the Environment Court Code of Conduct for Expert Witnesses and confirm that I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express in the following evidence. The evidence I give is within my expertise, save where the context indicates otherwise.
10. I confirm that to the best of my ability I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

1.0 Summary

11. This evidence provides a summary of biological information for two proposed AMA sites southwest of Hapuku Rock, Admiralty Bay. The sites are proposed by Clearwater Mussels Ltd and Talley's Group Ltd, in their submissions on Variation 1, as alternative space for any existing maring farms that need to relocate.

12. The two proposed AMA's are located either side of existing marine farm 8057 (see teal areas in Figure 1).

13. The sites are in deep water in an area influenced by regular tidal currents and wave action. Benthic impacts from shellfish farming are therefore likely to be at the lower end of the range known for mussel farms in the Marlborough Sounds (see Keeley et al. 2019 for review of impacts).

14. Davidson et al. (2021) (**attached** to this evidence as **Appendix RJD1**) produced a range of quantitative and qualitative data collected in 2014 and 2021 from the AMA's and adjacent areas. These data included sonar, drop camera photos, sulphide levels, infauna and water movement (ADCP).

15. Davidson et al. (2021) identified an area in the northern proposed AMA that supports cobbles, natural shell and mud. The authors recommended that no production backbones be positioned in this area.

16. The remainder of the AMA areas were regarded suitable for shellfish farming, being characterised by a relatively flat bottom composed of silt and clay. The offshore flat mud areas had a low percentage cover of shell. The authors described the epifauna from this area as typical of mud bottoms in the Marlborough Sounds.

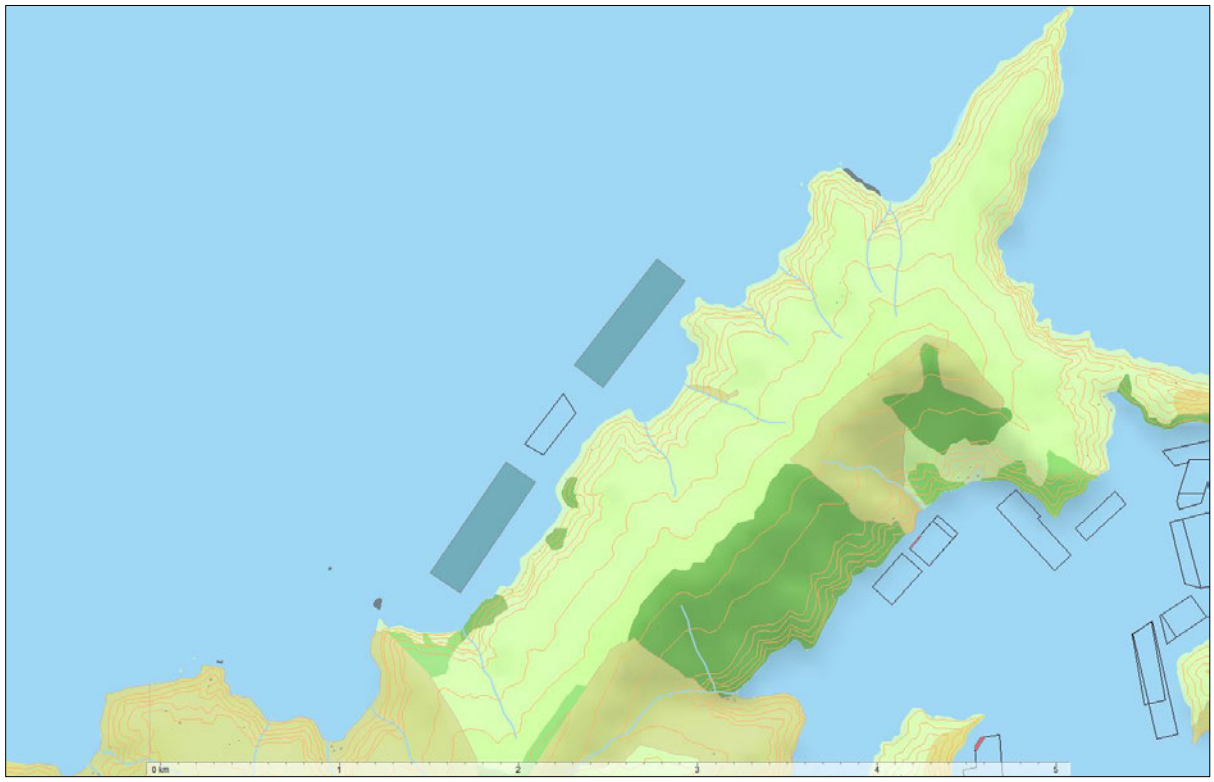


Figure 1. Location of the proposed AMAs (teal) and farm 8057 in outer Admiralty Bay.

2.0 Summary of data

17. The survey of the AMA's and the adjacent area included collection of the following:
    - Water current data (ADCP).
    - Quantitative benthic infauna data.
    - Qualitative epifauna communities.
    - Depth and habitat from drop camera photographs.
    - Side imaging sonar.
    - Sediment sulphides.
    - Mussel shell debris observations.
18. Depths along the inshore edges of the AMA's ranged from 30.8m to 40 m, while offshore corner depths ranged from 37.8m to 46m.
19. The proposed AMA's were dominated by a deep and relatively flat benthos comprised of silt and clay sized particles. The exception was the north-western inshore corner of the northern AMA. This area was characterised by silt, clay with a strong component of natural dead whole and broken shell. Cobbles were also observed at one site along the inshore-most edge of the proposed northern AMA.
20. Mud or mud/shell substrata found within the proposed AMA's supported a lower diversity of surface dwelling (epibenthic) species compared to inshore areas. Occasional lampshells (*T. sanguinea*) were observed from the northern AMA on the shore slope where natural shell was present.
21. A total of nine infaunal samples were collected in 2014, two from within the existing marine farm (samples 5 and 6), five from areas with no farm in the wider area. Sites located under farm droppers supported more species compared to deep mud from the proposed AMA's and adjacent areas. Overall, infaunal communities could be split into those with and those without shell. The separation between under the mussel farm and away from the mussel farms was not as obvious.
22. Sulphide values from Admiralty sites (under and away from backbones) were all well below the lowest environmental rating class (Oxic A).
23. Apart from sample site 5 (non-farmed), all sample sites including site 6 collected under mussel droppers, had very low levels of sulphide. Site 5, although well below the Oxic A level, did show infaunal effects in terms of species abundance and composition suggesting some enrichment or change in the habitat. The effect was not, however, at a level that pollution indicating organisms became abundant and certainly well below the Anoxic level associated with severely polluted sites where species shifts occur.

24. Depth average water currents at the Admiralty Bay site predominantly flowed from south-west to northeast and reversed with the tide.

25. Surface currents were strong compared to most mussel farms sites in the Pelorus Sound, with the greatest current speed recorded in the northeast direction (peak = 51.6 cm s^{-1}). Mean surface current speeds for surface water over the entire sample was 13.5 cm s^{-1}. In contrast, near seabed currents were mild with a predominant flow to the northeast (peak = 11.1 cm s^{-1}, mean = 5.79 cm s^{-1}).

3.0 Conclusions

26. Overall, the two 15ha proposed AMA's are located over a deep mud and mud/shell substrata. The marine environment in the Hapuku Rock area is influenced by elevated wave energy and tidal currents compared to areas in sheltered Marlborough Sounds bays and inner Admiralty Bay. As such, the proposed sites will likely exhibit lower levels of farming impact compared to mussel farms in the more sheltered locations.

27. No surface-dwelling biological communities of particular interest, such as red algae or horse mussels, were recorded during the present investigation.

28. The infaunal communities recorded from the deep mud habitats in the proposed AMA's were uniform and supported a range of species considered typical of mud habitats (McKnight and Grange, 1991).

29. Hard substratum in the form of small cobbles were also recorded from within the northern inshore edge of the northern AMA. Rocky substrata are traditionally avoided for marine farming activities.

30. To avoid a marine farming impact on rocky and mud with a high cover of shell, it is suggested that no backbones be placed in the north-eastern inshore corner of the northern AMA (Figure 2).

31. If approved, it is expected impacts will be comparable to the existing marine farm. Mussel shell was common near droppers, but all other indicators of impacts were at the low end of the range.

32. Provided rocky and soft substrata with a high percentage cover of natural shell is avoided, no monitoring is suggested. Should monitoring be considered necessary, the quantitative data produced in the present report would be suitable to use as a baseline.



Figure 2. Existing consent (inshore rectangle) and two proposed consent options (A and B) relative to the recommended backbone exclusion zone (red hatched).

References

Davidson, R.J.; Richards, L.A.; Scott-Simmons, T. 2021. Ecological report for two proposed marine farm sites located near Hapuku Rock, Admiralty Bay, Marlborough Sounds. Prepared by Davidson Environmental Ltd. for Clearwater Mussels Limited. Survey and monitoring report no. 1105.

Davidson, R.J.; Richards L.A. 2014. Recovery of a mussel farm in Otanerau Bay, East Bay, Marlborough Sounds: 2002-2013. Prepared by Davidson Environmental Limited for Marlborough District Council. Survey and Monitoring Report No. 788.

Davidson R.J. and Richards L.A. 2007: Biological report on an off-site marine farm (Site 8057) located in Admiralty Bay. Prepared by Davidson Environmental Ltd for Pickering, Brownlee and Talley's. Survey and Monitoring Report No. 550.

Keeley, N.; Forrest, B.; Hopkins, G.; Gillespie, P.; Clement, D.; Webb, S.; Knight, B.; Gardner, J. 2009. Sustainable aquaculture in New Zealand: Review of the ecological effects of farming shellfish and other non-finfish species. Cawthron Report No. 1476.

McKnight, D.G.; Grange, K.R. 1991. Macrobenthos sediment-depth relationships in Marlborough Sounds. Report prepared for Department of Conservation by Oceanographic Institute, DSIR. No. P692.

Appendix 1 Representative benthic photos (Davidson et al., 2021).

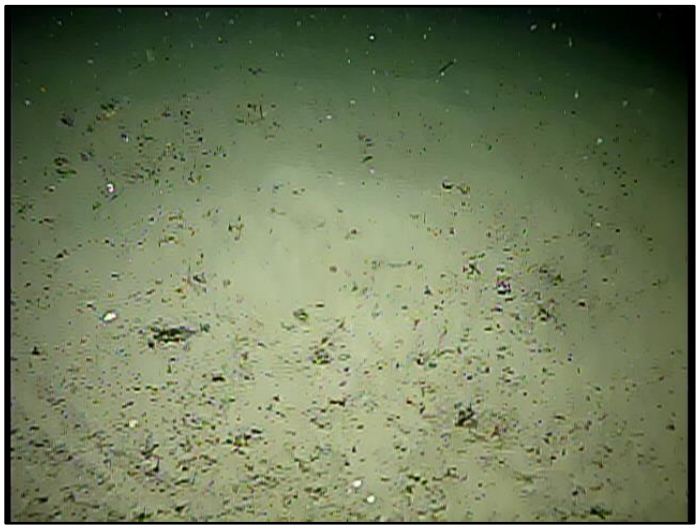


Plate 1. Silt and clay in the northern AMA (photo A1, 46.7m depth).



Plate 2. Silt and clay and a higher cover of natural shell inside the northern AMA (photo A5, 42.4 m depth). .



Plate 3. Silt and clay in southern AMA (photoA10, 40.9 m depth).

Appendix RJD1



Davidson Environmental Limited

Ecological report for two proposed marine farm AMA sites located near Hapuku Rock, Admiralty Bay, Marlborough Sounds

Research, survey and monitoring report number 1105

A report prepared for:
Clearwater Mussels Limited
C/o PALMS Ltd
P.O. Box 751
Blenheim

October 2021

Bibliographic reference:

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October 2021

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1.0 Introduction

Clearwater Mussels Limited operates an existing 4 hectare marine farm (8057) adjacent to the eastern shoreline of outer Admiralty Bay. Clearwater Mussels Limited proposes two AMA sites located north-east and south-west of existing marine farm 8057 (15ha each) (Figure 1, Plates 1 & 2). The present report presents a range of biological information for the new sites and relevant data for the existing farm site.

2.0 Studies and data

The wider area has been previously investigated in March 2014. Sites were sampled in and around a wide area including the presently proposed AMA's and the existing marine farm 8057. During that survey data collection was coordinated by Davidson Environmental. The 2014 survey included the following.

1. Water current data (ADCP).
2. Quantitative benthic infauna data.
3. Qualitative epifauna communities.
4. Depth and habitat from drop camera photographs.
5. Side imaging sonar.
6. Sediment sulphides.
7. Mussel shell debris observations.

In addition, a report investigating farm effects on the water column was produced by Berthelsen et al. (2015).

In September 2021, additional drop camera and sonar data were collected from the two 15ha proposed AMA's.

The following report presents and summarises information relevant to the two AMA areas.

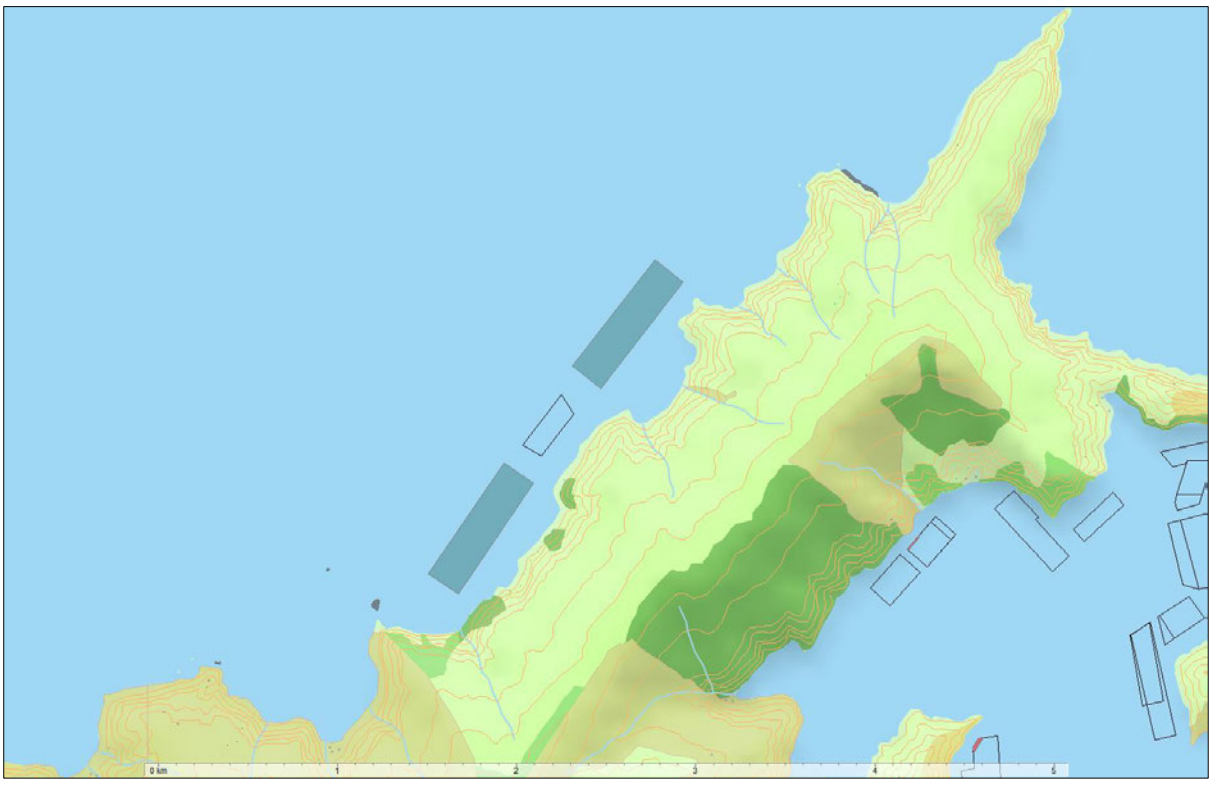


Figure 1. Location of the originally proposed AMAs (teal) and farm 8057 in outer Admiralty Bay.

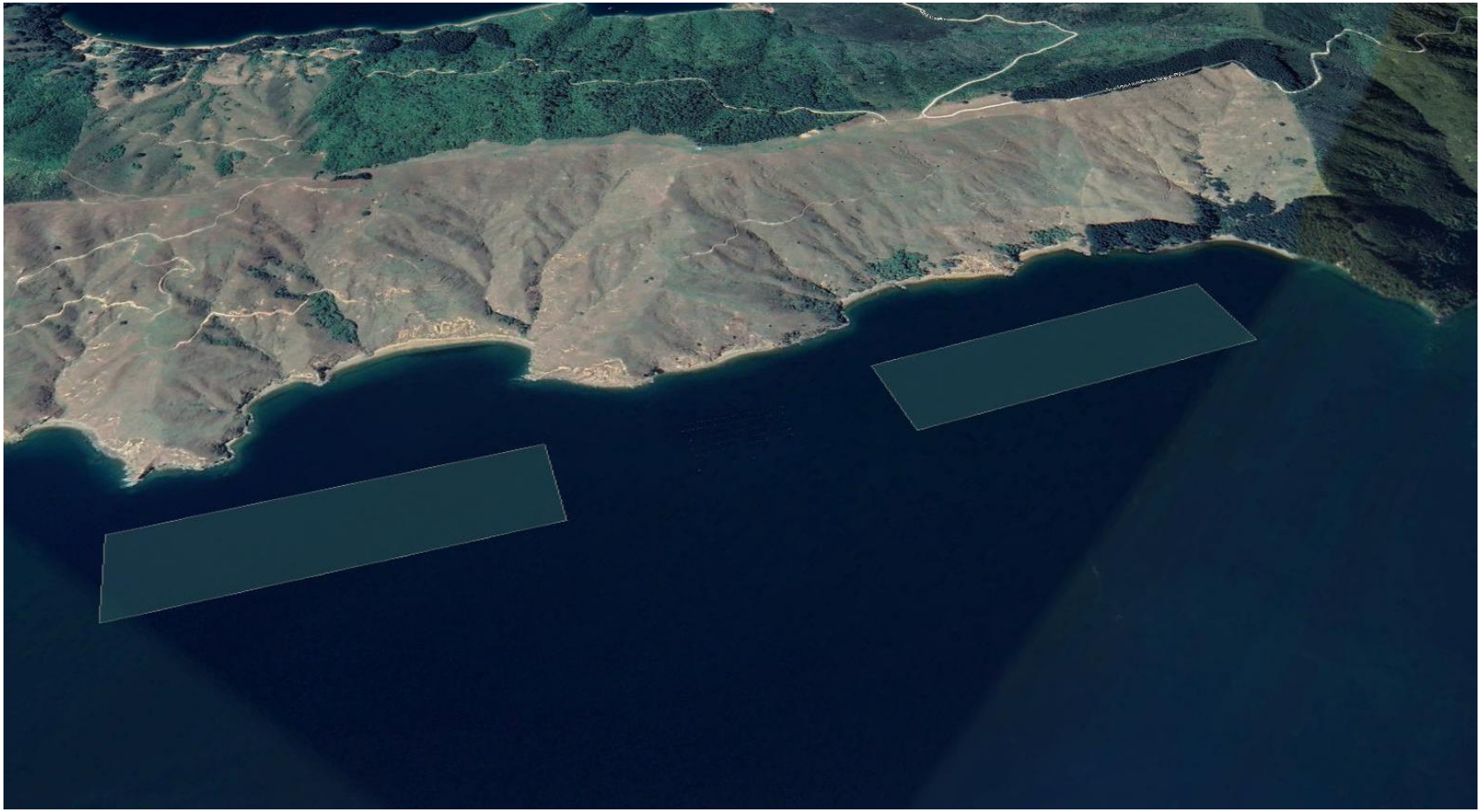


Plate 1. Proposal AMA areas in Admiralty Bay.



Plate 2. Admiralty Bay. Top = looking southwest-ward towards the proposal AMA areas; Bottom = Looking northeast-wards from south of the proposed AMA areas.

2.0 Background information

2.1 Study area

The greater Admiralty Bay area is large, extending approximately 15 km in length from the head at Hamilton Bay to a line joining Bonne Point (northwest headland) with Clay Point (northeast headland). Greater Admiralty Bay is partially bounded by D'Urville Island to the west, open to Cook Strait in the north, and is connected to Tasman Bay via French Pass.

2.2 Biology of greater Admiralty Bay

In the east, south and south-west the subtidal coast is steep comprised of mostly cobble, boulder and bedrock substrates. With increasing depth and distance from shore coarse soft substrates become dominant on the slope. These sloping shores usually end abruptly in relatively flat mud dominated habitats that cover the large offshore areas of the Bay (i.e. 40-45 m depth). Along the northwest coast adjacent to D'Urville Island, the rocky shore often terminates onto soft bottoms at shallower depths compared to the rest of Admiralty Bay. Along the northwest D'Urville coast, sandy, gravelly substrates are widespread.

Admiralty Bay is part of the largest biogeographic zone in the Marlborough Sounds (i.e. Two Bay point to Cape Jackson; In: Davidson *et al*. 2011). Based on biological communities known from the Bay it is representative of the western-most part of this biogeographic area and has components comparable to the western Tasman Bay biogeographic area. The Bay is sheltered from oceanic swells and supports an algal community characteristic of sheltered shores in the outer Sounds. Brown macroalgae are usually restricted to a narrow sublittoral fringe or zone. Deeper rocky shores are often characterised by "barrens" supporting a community often dominated by grazers such as kina and topshells.

Davidson and Brown (1994) surveyed the Hapuku Rock area (i.e. immediately north of the presently proposed marine farm) as part of an investigation looking at marine reserve options. The authors stated "Subtidally the area was characterised by bedrock substrata forming ridges and clefts. Surrounding and between the reef habitat was sand/shell soft bottoms colonised by beds of dog cockles (*Glycymeris* spp.). Relatively little foliose seaweed was observed from reef habitat with only a fringe of *C. maschalocarpum* at and immediately

below the low tide mark. Nine species of fish were recorded. Blue moki *(L. ciliaris*) and spotty (*N. celidotus*) were the most often fish seen."

2.3 Marine farming

Apart from marine farm 8057, no consented mussel farms are located near the present AMA proposals, however, a considerable number of farms exist south of the present site in southern Admiralty Bay (Figure 2).

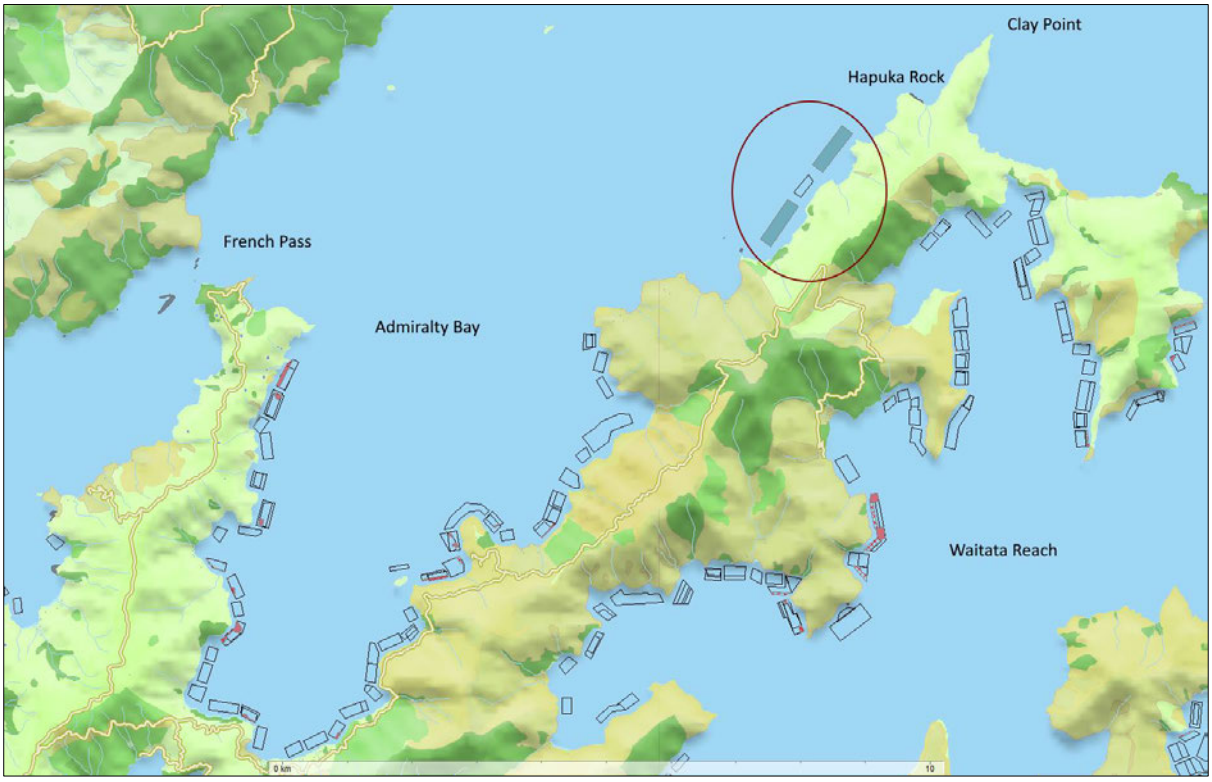


Figure 2. Location of the proposal AMA areas (teal) and consented marine farms in the vicinity (black shapes).

2.4 Historical reports for 8057

One biological report was found in relation to farm 8057. A benthic survey for off-site farm structures was reported by Davidson and Richards (2007). The authors of the report stated:

"Depths of the consent area were between 18 m to 42.4 m. Substratum type is based on drop camera images. Cobble substratum was recorded from the northern inshore area inside the consent. Other inshore areas of the consent were dominated by natural shell rubble and fine sand substratum. Offshore areas where existing farming structures are located outside the consent were very deep (> 38 m depths) and characterised by silt and clay with little or no natural shell. Mussel debris was recorded here on the benthos within surface structures and immediately adjacent to surface structures in photograph 10 (i.e. warp area).

An area inshore of the existing structures and within the consent showed cobbles present. The remainder of the inshore consent area supported natural shell rubble and fine sand substratum. No marine farm structures were positioned over this inshore consent area and no impact of marine farming activity was observed on this coarser inshore substratum. The area offshore of the existing consent with marine farm structures was dominated by silt and clay and showed moderate to high levels of mussel debris from marine farming activity.

From a biological perspective it is recommended that the inshore portion of the consent be removed and added to the offshore area of the consent where structures are presently located. This adjustment would avoid the inshore cobble habitat."

The MDC subsequently adjusted the original consent boundaries to fit the existing marine farm structures rather than moving the structures to fit the consent. It was argued by the authors that a better environmental outcome would be achieved if the consent was adjusted to fit the impact zone rather than shifting the lines into an area free of impact.

3.0 Methods for AMA sites

Davidson Environmental has investigated the area on two occasions (2014 and 2021).

In 2014 field work was conducted on 27-28th March 2014. Prior to all fieldwork, the proposed site boundaries, as well as the existing marine farm corners (8057), were plotted onto mapping software (TUMONZ Professional). The laptop running the mapping software was linked to a Lowrance GPS receiver allowing real-time plotting of the corners of marine farm surface structures and to pinpoint drop camera stations in the field. This GPS system

has a maximum error of +/- 5 m. All depths of the AMA corners and sample sites were adjusted to datum (Table 1, Figure 2).

Table 1. Coordinates and depths adjusted to datum for the proposed AMA's.

Depth (m)	Coordinates
1, 30.8m	1680338.2,5471652.9
2, 46m	1680181.0,5471774.6
3, 42.5m	1679720.2,5471183.6
4, 40.5m	1679877.8,5471061.0
5, 35.8m	1679504.3,5470531.8
6, 36.2m	1679081.1,5469913.3
7, 37.8m	1678916.7,5470025.8
8, 40.6m	1679339.6,5470644.6

3.1 Surface photographs

Surface photographs were collected from the research vessel looking into the proposed marine farm area from the southwestern and northeastern positions in 2014. Photographs were collected using the panoramic function on an iPhone4s to minimize distortion usually associated with 'stitching' separate photographs together. Some distortion associated with panoramic photos does however exist.

3.2 Sonar imaging

In 2014, sonar investigations of the area were conducted using a Lowrance HDS-10 Gen 1 and HDS-8 Gen2 linked with a Lowrance StructureScan™ Sonar Imaging LSS-1 Module. These units provide right and left side imaging as well as DownScan Imaging™. The unit also allows real time plotting of StructureMap ™ overlays onto the installed Platinum underwater chart.

In 2021, sonar was collected from the inshore edge of the northern AMA using a Humminbird Solix 15 SI+ mega imaging unit. This unit provides right and left side imaging as well as down imaging. A Lowrance HDS 12 Gen2 unit fitted with a high definition 1kw Airmar transducer was used to collect traditional sonar data from the site.

Prior to the collection of drop camera photographs, the inshore areas associated with the initial survey area were investigated using the sonar. Any bottom abnormalities such as reefs, hard substrata or abrupt changes in depth were noted for inspection using the drop camera (see section 3.3).

3.3 Drop camera stations, site depths

In 2014, a total of 70 drop camera photographs were collected during the survey. In 2021 a total of 17 photos were collected from parts of the adjusted AMA's where photos had not been previously collected (Figure 4). The 2021 photo stations were aimed to fill any gaps from the 2014 photos.

At each photo station, a Sea Viewer underwater splash camera fixed to an aluminium frame was lowered to the benthos and an oblique still photograph was collected where the frame landed. The location of photograph stations was selected to obtain good coverage of the proposal area. Additional photographs were taken when any features of particular interest (e.g. shell debris, reef structures, and cobbles) that were observed on the remote monitor on-board the survey vessel or from sonar and depth soundings. All photographs collected during the survey have been included in Appendix 1.

3.4 Surface dwelling species

All drop camera photos were viewed and notes taken on any conspicuous surface-dwelling species. Relative abundance based on observations were also included on a scale of occasional = seldom observed and when observed usually in small numbers, common = regularly observed or when observed often in number > 3 individuals, abundant = regularly observed and when observed often in numbers > 10.

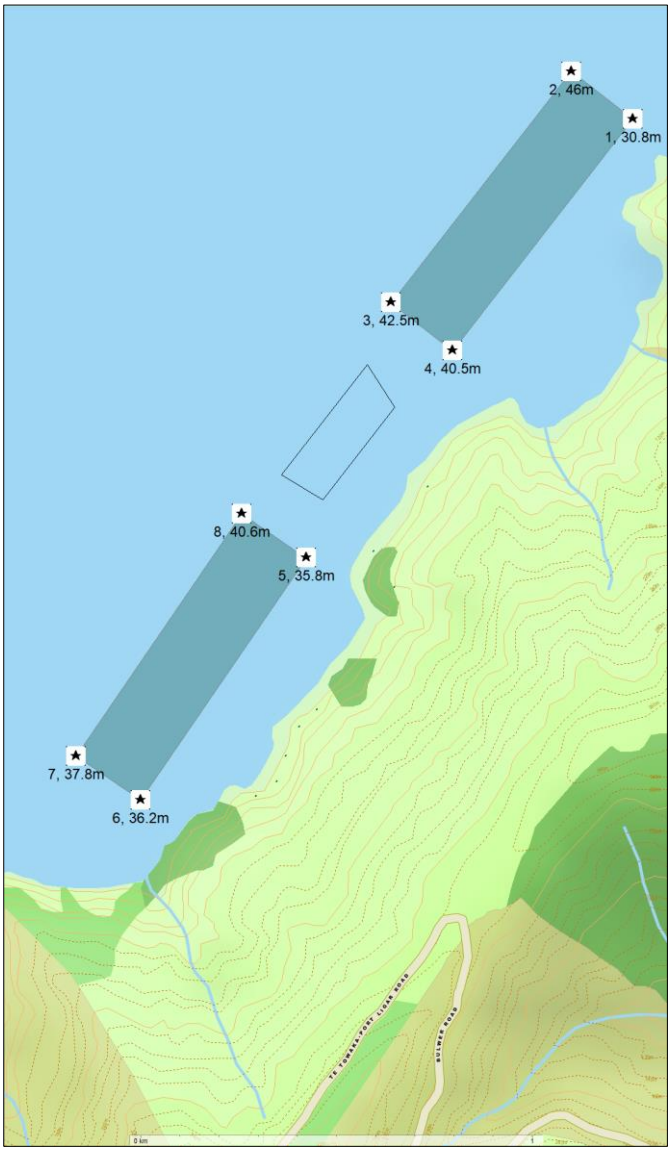


Figure 3. Corner depths of the two proposed AMA's in Admiralty Bay.

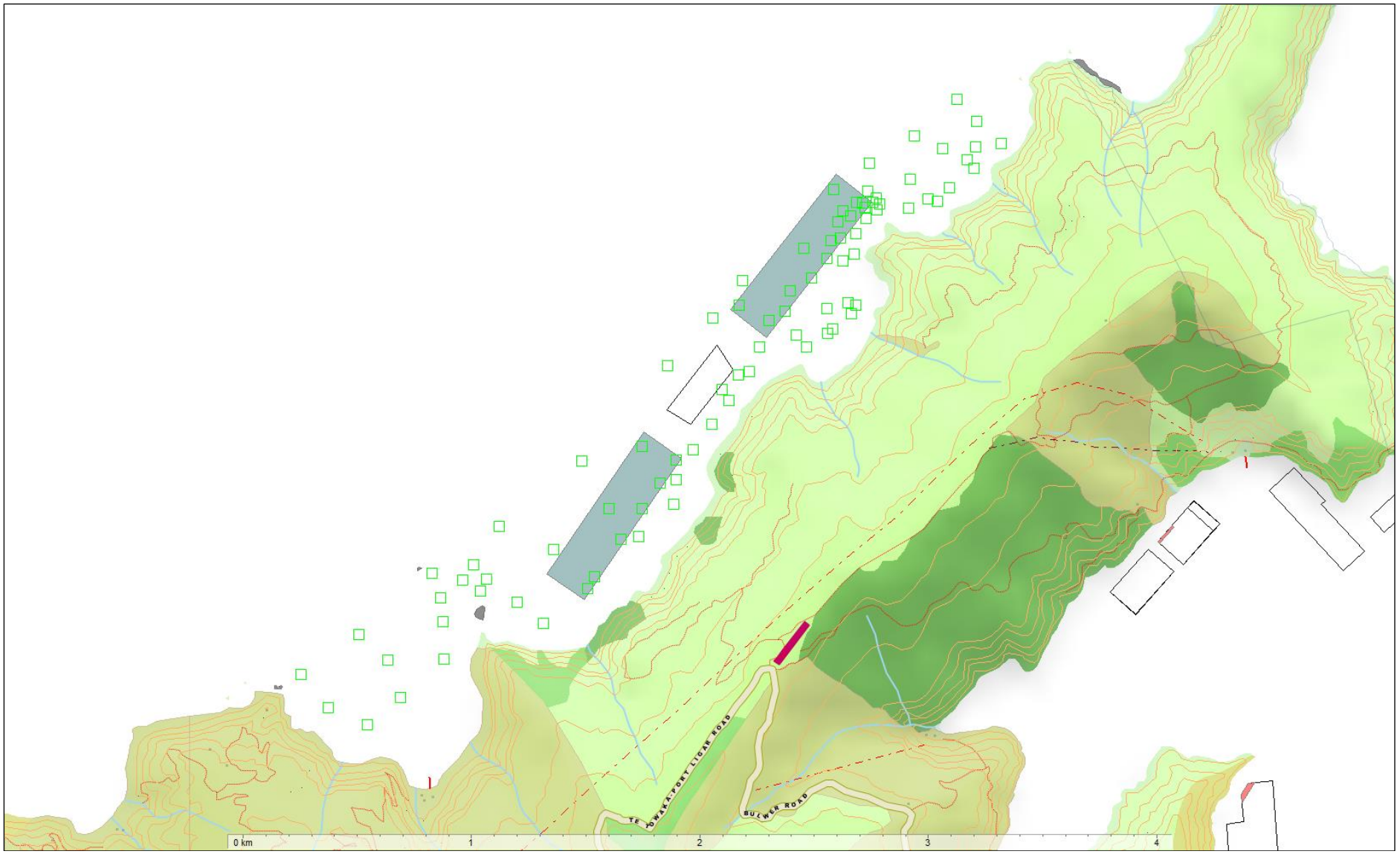


Figure 4. Location of all drop camera stations (green squares) sampled in 2014 and 2021.

3.5 Benthic grab samples

A total of nine benthic grab samples were collected using a 0.1 m^2 Van Veen grab sampler (Table 2a). Two grabs were collected under marine farm structures in farm 8057, while five were collected from with wider area. A further two samples were collected from the initial study area (i.e. outside the proposal). Subsamples were collected from each grab using a 63mm perspex corer. Samples were also assessed for apparent Redox Potential Discontinuity layers (aRPD layers) and to assess sediment color. Samples were passed through a 0.5 mm mesh and animals retained and preserved for later identification and enumeration in the Cawthron laboratory. From these data, animal abundance and species richness were determined.

The infaunal assemblages were contrasted using non-parametric multidimensional scaling (MDS: Kruskal and Wish 1978) and ordination and cluster diagrams based on Bray-Curtis similarities (Clarke and Warwick 1994). Abundance data were fourth-root transformed to de-emphasize the influence of the dominant species (by abundance). All multivariate analyses were performed by Cawthron staff using PRIMER v6 software.

3.6 Sulphide levels

Nine surface sediment samples were collected from grab samples and analyzed for sulphide (Table 2a). Samples were chilled and immediately frozen on the same day at the Cawthron laboratory.

3.7 Water current speed and direction (ADCP)

An Acoustic Doppler Current Profiler (ADCP) meter was deployed for approximately 20 hours at a site located 94 m distance offshore of marine farm 8057 (Table 2a, 2b), in 42.5 m water depth (corrected to chart datum). Water current speed and direction were assessed at 1 m depth bins throughout the water column.

Table 2a. Depths and positions of grab samples, sulphide samples and ADCP deployment. ***Coordinates = NZTM (Northing/Easting).***

Type	No. & Depth (m)	Coordinates
ADCP position	E, 42.5m	1679385.0,5470826.9
Grab sample	1, 38m	1678026.2,5469525.4
Grab sample	2, 40.4m	1678261.9,5469850.4
Grab sample	3, 40m	1678843.9,5470187.2
Grab sample	4, 40m	1679265.2,5470464.5
Grab sample	5, 31m	1679625.7,5470797.9
Grab sample	6, 27.1m	1679700.2,5470898.5
Grab sample	7, 31.6m	1680106.1,5471085.0
Grab sample	8, 42.9m	1679995.9,5471401.8
Grab sample	9, 40.8m	1680583.8,5471843.5

Table 2b. ADCP meter deployment details proposed marine farm site.

Particulars	Site
Device	RDI Sentinel Workhorse ADCP
Logging depth	Vertical profile @ 1.0 m intervals
Averaging interval	2 minutes
Sampling frequency	30 minutes
Deployment period	27/3/2014 to 28/3/2014
Mooring location	1679385.0 E, 5470826.9 N (NZTM)

4.0 Results

4.1 Proposal corner depths and low tide locations

The area surveyed included the proposed AMA's and the wider adjacent coast (Figure 4). Depths along the inshore edges of the AMA's ranged from 30.8m to 40 m, while offshore corner depths ranged from 37.8m to 46m (Table 3, Figure 3).

Most the proposal was in deep water >39 m depth. In these deep areas the benthos was gently sloping. An area in the northwest inshore corner of the northern block the AMA was located over the foot of the sloping shore.

4.2 Substratum and habitats

Substratum and habitat distribution relative to the proposed AMA's were based on drop camera images (Figures 5a & 5b) combined with depth soundings and sonar scans (Table 3, Appendix 1).

The proposed AMA's were dominated by a deep and relatively flat benthos comprised of silt and clay sized particles (Plate 3). The exception was the north-western inshore corner of the northern AMA. This area was characterised by silt, clay with a strong component of natural dead whole and broken shell (Plate 4). Cobbles were also observed along the inshore-most edge of the proposed northern AMA (Figure 4a).

Areas well inshore of the proposed AMA's were characterised by combinations of boulder, cobble, rock and reef substrata. With increasing depth and distance from shore soft sediments comprising sands, fine sand and shell were recorded. Apart from the northern inshore corner of the northern AMA, rocky and coarse soft substrata were not located within the proposal AMA areas.

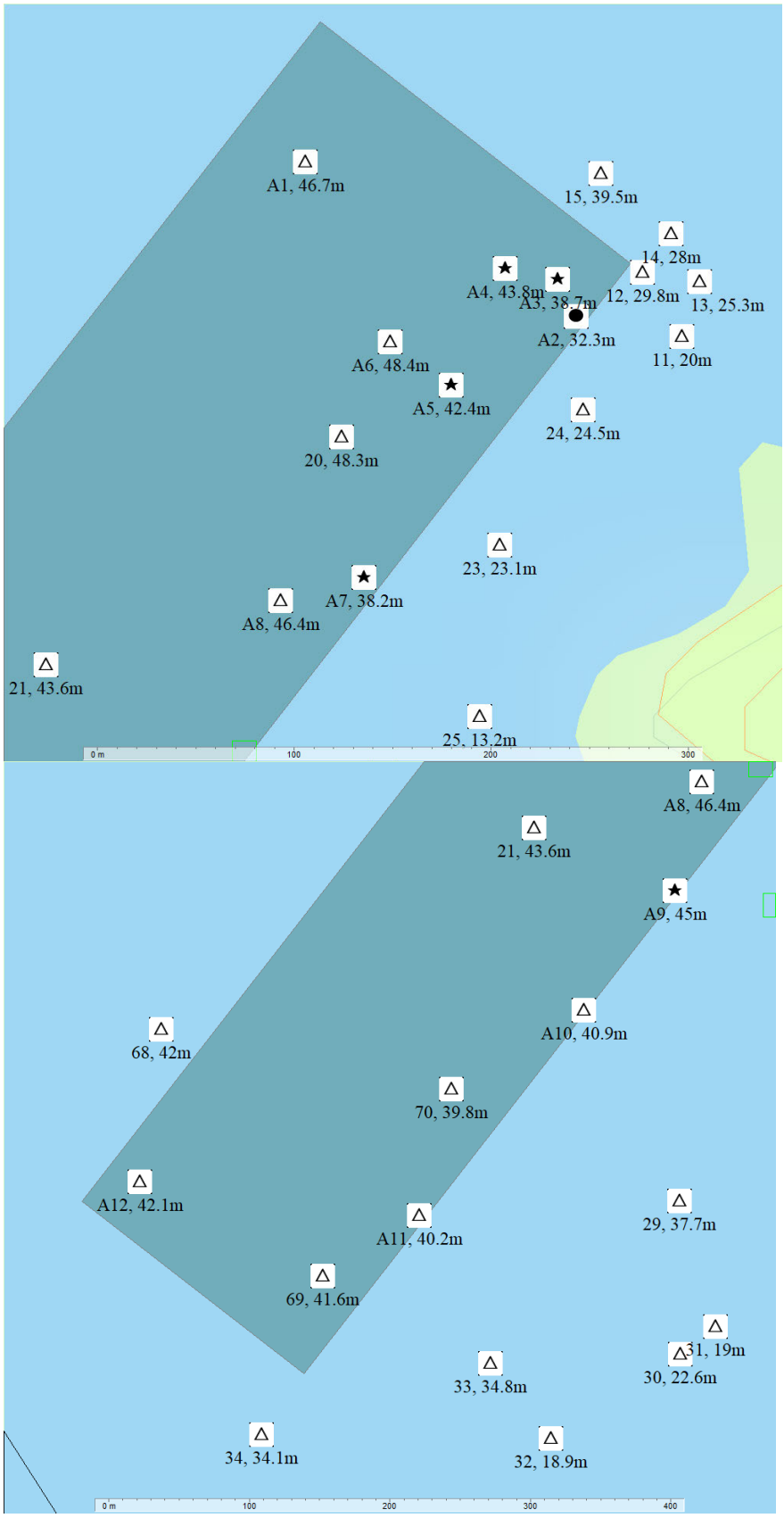


Figure 5a. Drop camera station numbers and depths from the proposed northern AMA (teal).

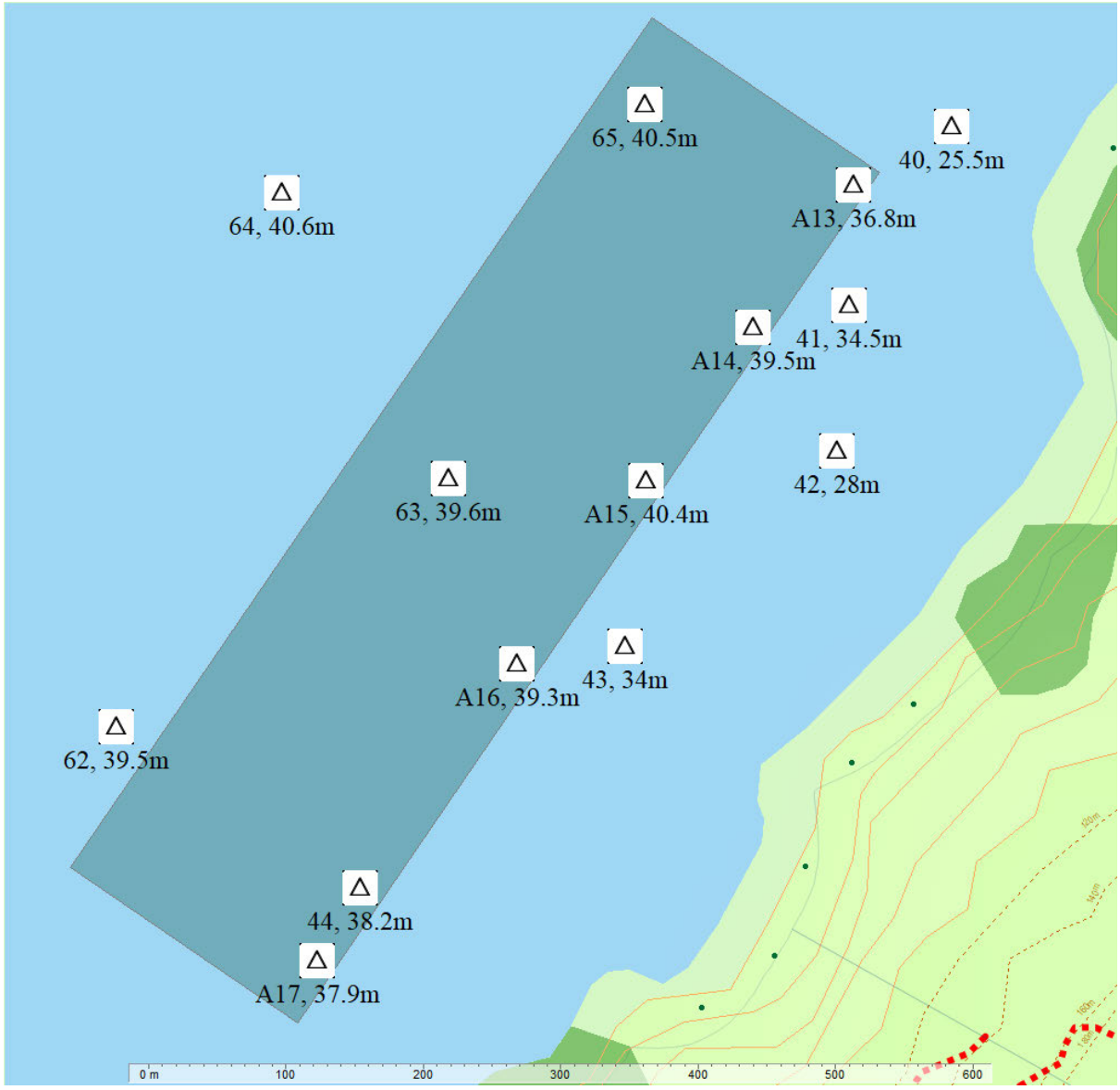


Figure 5b. Drop camera station numbers and depths from the proposed southern AMA (teal).



Plate 3. A representative example of silt and clay substratum recorded from the southern proposed AMA's (photo A15, 40.4m).

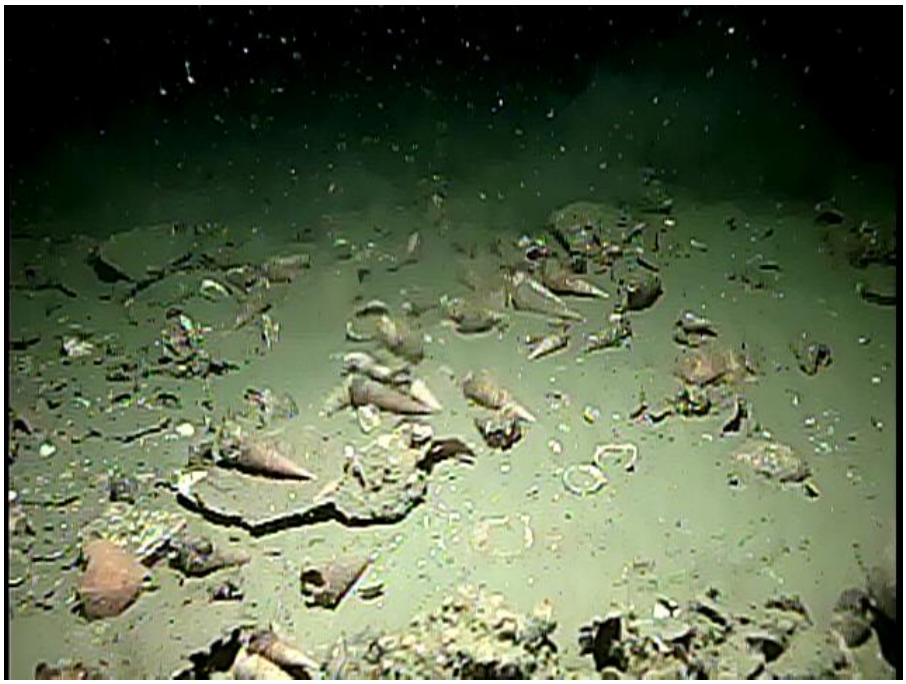


Plate 4. Silt, clay, natural shell from within the northern proposed AMA (photo A4, 43.8m).



Plate 5. Cobbles, silt and natural shell from the inshore edge of the northern AMA (photo A2, 32.3m).

Table 3. Coordinates of 2014 drop camera stations (NZTM). Colours are: blue = outside the initial proposal and no farm structures, inside the initial application option

No. & Depth (m)	Coordinates	Location	Substratum	Comment
1, 45.5m	1680712.8,5472099.7	In application	Silt & clay	
2, 41.8m	1680800.7,5472004.6	In application	Silt & clay	
3, 12.1m	1680907.7,5471907.8	Inshore of application	Outcropping rocks, fine sand, natural shell	Rocky
4, 8.6m	1680789.1,5471796.8	Inshore of application	Fine sand, silt, natural broken shell	Reef edge
5, 19.3m	1680759.1,5471835.0	Inshore of application	Fine sand, silt, natural broken shell, occ cobble	Occasional cobble
6, 27.5m	1680796.7,5471890.5	Inshore of application	Silt, natural shell	
7, 13.6m	1680681.7,5471710.8	Inshore of application	Fine sand, silt, natural broken shell, occ cobble	Reef
8, 11m	1680627.2,5471653.0	Inshore of application	Fine sand, silt, natural broken shell	
9, 21m	1680588.0,5471662.2	Inshore of application	Silt, fine sand	Shrimp holes
10, 19.4m	1680500.6,5471623.3	Inshore of application	Silt, fine sand	Reef present
11, 20m	1680364.3,5471615.4	Inshore of application	Rock, cobble, fine sand natural shell	Reef
12, 29.8m	1680344.3,5471648.0	Inshore of application	Shell hash, silt	
13, 25.3m	1680373.6,5471643.3	Inshore of application	Natural shell hash, silt. occ cobble	Occasional cobble
14, 28m	1680359.1,5471667.5	Inshore of application	Reef, natural shell	Reef
15, 39.5m	1680323.3,5471698.2	In application	Silt, natural shell hash	
16, 39.5m	1680508.0,5471751.3	In application	Silt & clay	
17, 41m	1680650.9,5471882.1	In application	Silt & clay	
18, 42.3m	1680526.7,5471941.2	In application	Silt & clay	
19, 43.3m	1680329.7,5471820.2	In application	Silt & clay	
20, 48.3m	1680191.5,5471564.6	In application	Silt & clay	
21, 43.6m	1680041.7,5471448.7	In application	Silt & clay	
22, 29.4m	1680213.4,5471393.4	Inshore of application	Silt, natural shell	
23, 23.1m	1680272.0,5471509.7	Inshore of application	Silt, fine sand, natural shell	
24, 24.5m	1680314.4,5471578.1	Inshore of application	Shell hash, silt, fine sand	
25, 13.2m	1680261.8,5471422.7	Inshore of application	Cobble, boulder, fine sand, natural shell	Cobbles, boulders
26, 14.5m	1680252.9,5471160.8	Inshore of application	Silt, fine sand	
27, 9.2m	1680269.2,5471197.8	Inshore of application	Bedrock reef	Reef
28, 24.5m	1680236.2,5471210.4	Inshore of application	Silt, fine sand	
29, 37.7m	1680144.9,5471183.5	In application	Silt & clay	
30, 22.6m	1680145.9,5471074.6	Inshore of application	Silt, fine sand, natural shell	
31, 19m	1680170.9,5471093.9	Inshore of application	Bedrock reef	Reef
32, 18.9m	1680053.7,5471014.4	Inshore of application	Silt, fine sand, natural shell	Rock to SE
33, 34.8m	1680010.6,5471067.7	In application	Shell hash, silt	
34, 34.1m	1679847.8,5471017.3	In application	Natural shell, silt	

Table 3 (continued). Coordinates of 2014 drop camera stations (NZTM). Colours are: blue = outside initial proposal and no farm structures, grey = inside the initial application option.

No. & Depth (m)	Coordinates	Location	Substratum	Comment
35, 17.6m	1679804.8,5470907.0	Inshore of application	Cobbles, fine sand, natural shell	Cobbles
36, 19.7m	1679754.9,5470894.6	Inshore of application	Fine sand, silt, natural shell, occ. cobble	Occasional cobble
37, 21.4m	1679687.5,5470828.3	In application	Fine sand, silt, natural and mussel shell	Mussel debris
38, 13.2m	1679713.7,5470781.7	Inshore of application	Fine sand, silt, natural shell	Doq cockle bed
39, 18m	1679639.8,5470678.2	Inshore of application	Silt, fine sand, natural shell	
40, 25.5m	1679558.2,5470564.3	Inshore of application	Natural shell, silt	
41, 34.5m	1679483.1,5470434.7	In application	Natural shell, silt	
42, 28m	1679474.4,5470328.4	In application	Silt, fine sand, natural shell	
43, 34m	1679320.1,5470186.2	In application	Natural shell, silt	
44, 38.2m	1679127.7,5470010.0	In application	Silt & clay	
45, 21.6m	1678903.3,5469803.7	In application	Silt, fine sand, natural shell	
46, 27m	1678789.1,5469898.4	In application	Silt, fine sand, natural shell	
47, 26.9m	1678652.4,5469997.3	Alongshore of application	Reef, silt, natural shell	Reef edge
48, 26m	1678550.1,5469994.9	Alongshore of application	Shell hash, silt, fine sand, Occ. cobbles	Occasional cobbles
49, 30m	1678598.4,5470063.8	Alongshore of application	Shell hash, silt	Rock nearby
50, 10.1m	1678627.5,5469947.1	Alongshore of application	Reef, fine sand, silt, natural shell	Reef
51, 36.5m	1678464.1,5469812.9	Alongshore of application	Silt & clay	
52, 32.2m	1678469.3,5469650.0	Alongshore of application	Shell hash, silt	
53, 37.7m	1678276.7,5469483.0	Alongshore of application	Silt & clay	
54, 36.2m	1678131.3,5469363.8	Alongshore of application	Silt & clay	
55, 37.5m	1677962.3,5469436.6	Alongshore of application	Silt & clay	
56, 31.4m	1677842.4,5469581.7	Alongshore of application	Shell hash, silt	
57, 39.5m	1678096.5,5469756.6	Alongshore of application	Silt & clay	
58, 39.2m	1678220.3,5469644.4	Alongshore of application	Silt & clay	
59, 42.7m	1678453.7,5469915.8	Alongshore of application	Silt & clay	
60, 44.2m	1678417.0,5470025.4	In application	Silt & clay	
61, 43.2m	1678711.7,5470231.1	In application	Silt & clay	
62, 39.5m	1678949.6,5470127.9	In application	Silt & clay	
63, 39.6m	1679191.4,5470308.5	In application	Silt & clay	
64, 40.6m	1679070.2,5470516.1	In application	Silt & clay	
65, 40.5m	1679334.6,5470580.6	In application	Silt & clay	
66, 42.8m	1679447.4,5470934.6	In application	Silt & clay	
67, 42.7m	1679643.1,5471142.3	In application	Silt & clay	
68, 42m	1679776.5,5471305.4	In application	Silt & clay	
69, 41.6m	1679891.5,5471129.9	In application	Silt & clay	
70, 39.8m	1679982.9,5471262.8	In application	Silt & clay	

Table 3 (continued). Coordinates of 2021 drop camera stations (NZTM). All 2021 drop camera stations are coded with the letter "A" in Figures 5a and 5b.

Depth (m)	Coordinates (NZTM)	Location	Substratum	Notable species	Shell debris	% mussel shell	% macrolalgae	% natural shell
A1, 46.7m	1680173.4,5471703.8	AMA, no structures	silt & clay,		0	0	0	0
A2, 32.3m	1680310.6,5471625.4	AMA, no structures	cobble,silt & clay,nat. shell,	blue cod,	0	0	0	15
A3, 38.7m	1680301.4,5471644.4	AMA, no structures	silt & clay,nat. shell,	-horse mussel,snake star,blue cod,cucumber,	0	0	0	40
A4, 43.8m	1680274.6,5471649.8	AMA, no structures	silt & clay,nat. shell,	sol. ascidian,blue cod,Terebratella,	0	0	0	40
A5, 42.4m	1680247.2,5471590.7	AMA, no structures	silt & clay,nat. shell,		0	0	0	40
A6, 48.4m	1680216.3,5471612.7	AMA, no structures	silt & clay,	Spiocheatopterus, hermits	0	0	0	25
A7, 38.2m	1680202.9,5471493.2	AMA, no structures	silt & clay,nat. shell,	sol. ascidian,	0	0	0	35
A8, 46.4m	1680160.8,5471481.3	AMA, no structures	silt & clay,nat. shell,	Spiocheatopterus, hermits	0	0	0	30
A9, 45m	1680142.1,5471404.0	AMA, no structures	silt & clay	opalfish,	0	0	0	1
A10, 40.9m	1680076.9,5471318.9	AMA, no structures	silt & clay,		0	0	0	0
A11, 40.2m	1679960.2,5471172.9	AMA, no structures	silt & clay,	opalfish,	0	0	0	0
A12, 42.1m	1679761.4,5471196.9	AMA, no structures	silt & clay,		0	0	0	1
A13, 36.8m	1679486.3,5470522.2	AMA, no structures	silt & clay,nat. shell,	opalfish,	0	0	0	10
A14, 39.5m	1679413.5,5470418.7	AMA, no structures	silt & clay,		0	0	0	1
A15, 40.4m	1679335.4,5470306.6	AMA, no structures	silt & clay,		0	0	0	1
A16, 39.3m	1679241.3,5470173.1	AMA, no structures	silt & clay,	opalfish,	0	0	0	0
A17, 37.9m	1679096.2,5469956.9	AMA, no structures	silt & clay,	opalfish,	0	0	0	1

4.3 Sonar

In 2014, side imaging sonar was collected from the wider area south-west of Hapuku Rock. Areas located close to shore supported a range of substrates including rocky features that often extended perpendicular to the coast (Figures 7a, 7b and 7c). Several small reefs and one substantial reef were located along this shoreline. All reef structures are well inshore of the presently proposed AMA's. Hapuku Rock itself is located well north of the presently proposed AMA areas.

In 2021, sonar was collected along the inshore edge of the northern proposed AMA. The aim was to investigate the extent of silt and shell and cobble substrata at its northern end. The foot of the shore slope was detected at the AMA's inshore northern end (Figures 6 & 7d). In this area, a stronger sonar return signal was recorded indicating the presence of hard material such as cobbles and shell. Based on sounder scans during the collection of drop camera images, no other rocky or coarse soft substrata were observed in the presently proposed AMA's

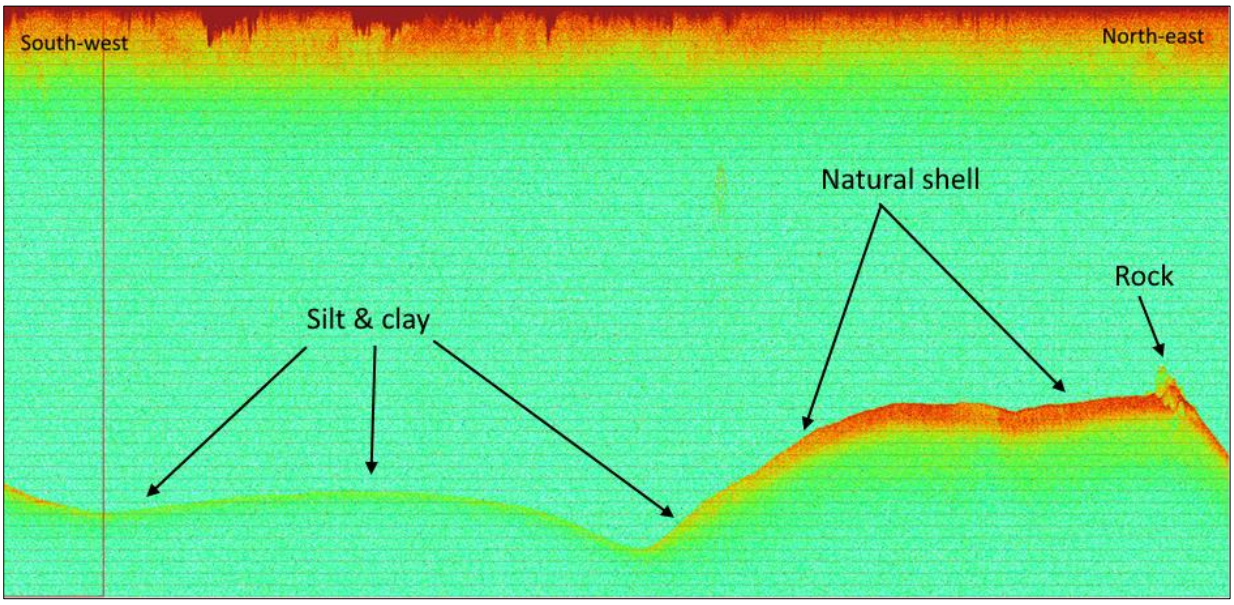


Figure 6. Down scan in 2021 of the inshore boundary of the northern AMA.

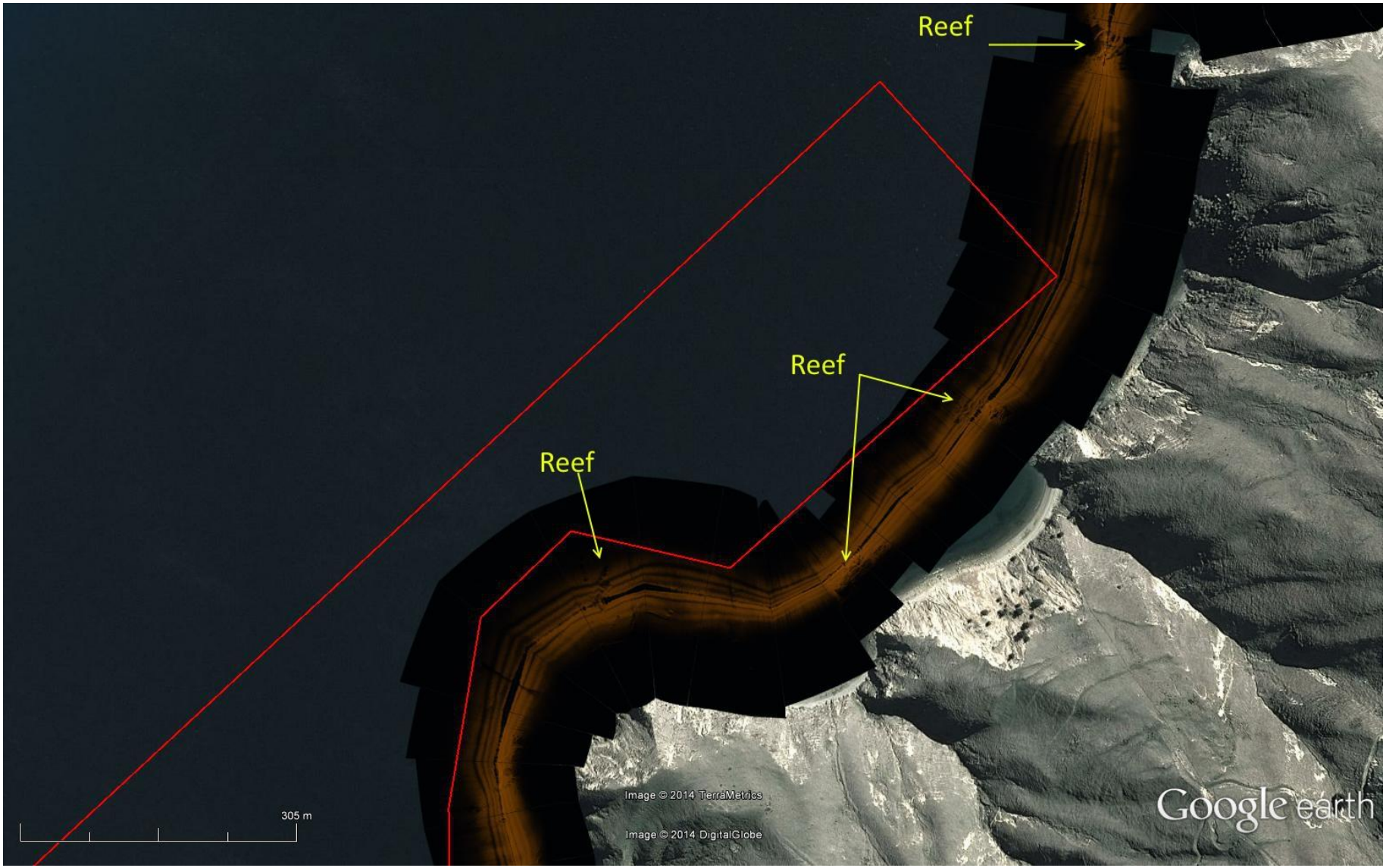


Figure 7a. Inshore sonar imaging in 2014 from the northern original proposal area. Red polygon = early application option.

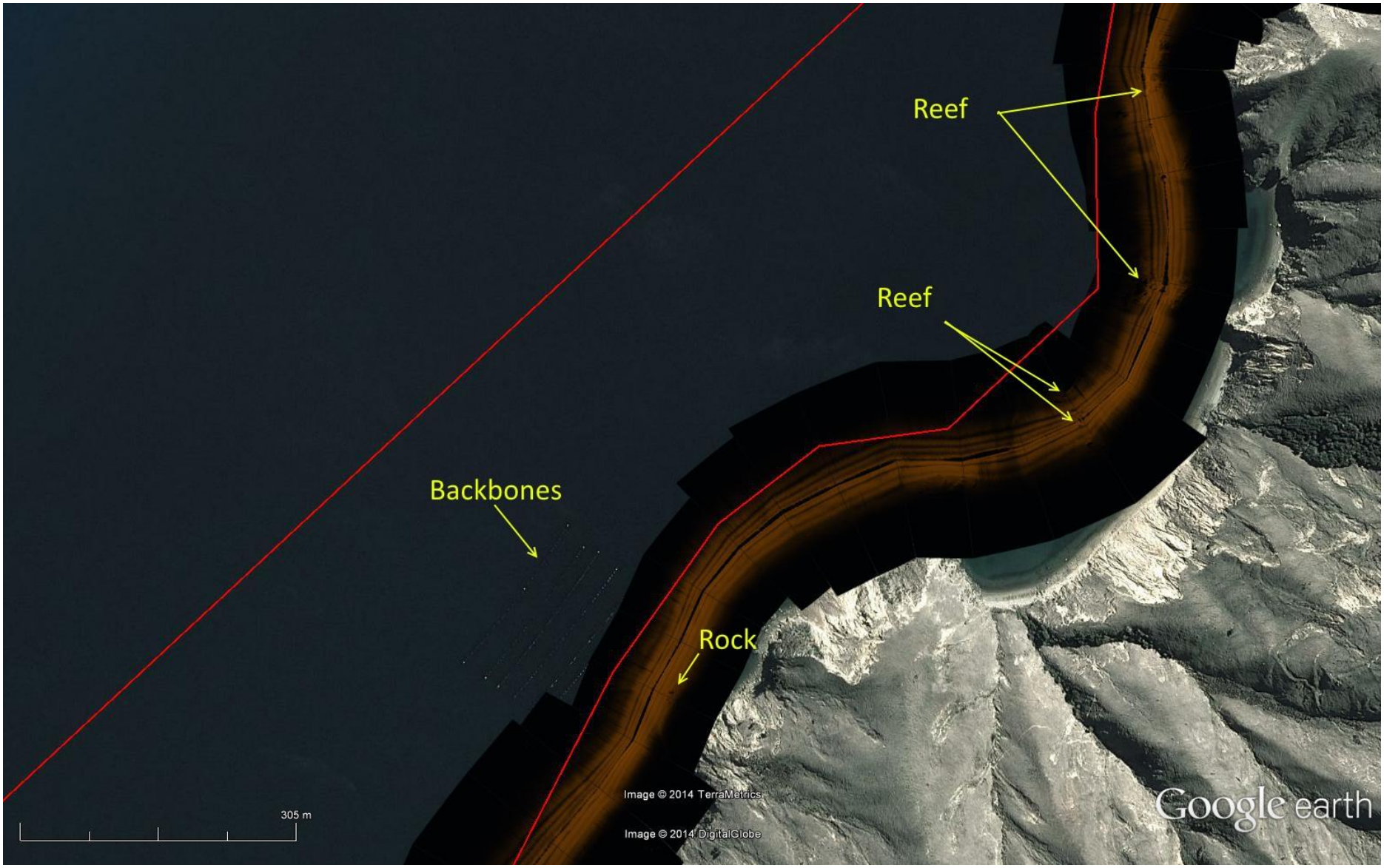


Figure 7b. Sonar imaging in 2014 from the central original proposal area. Red polygon = early application option.

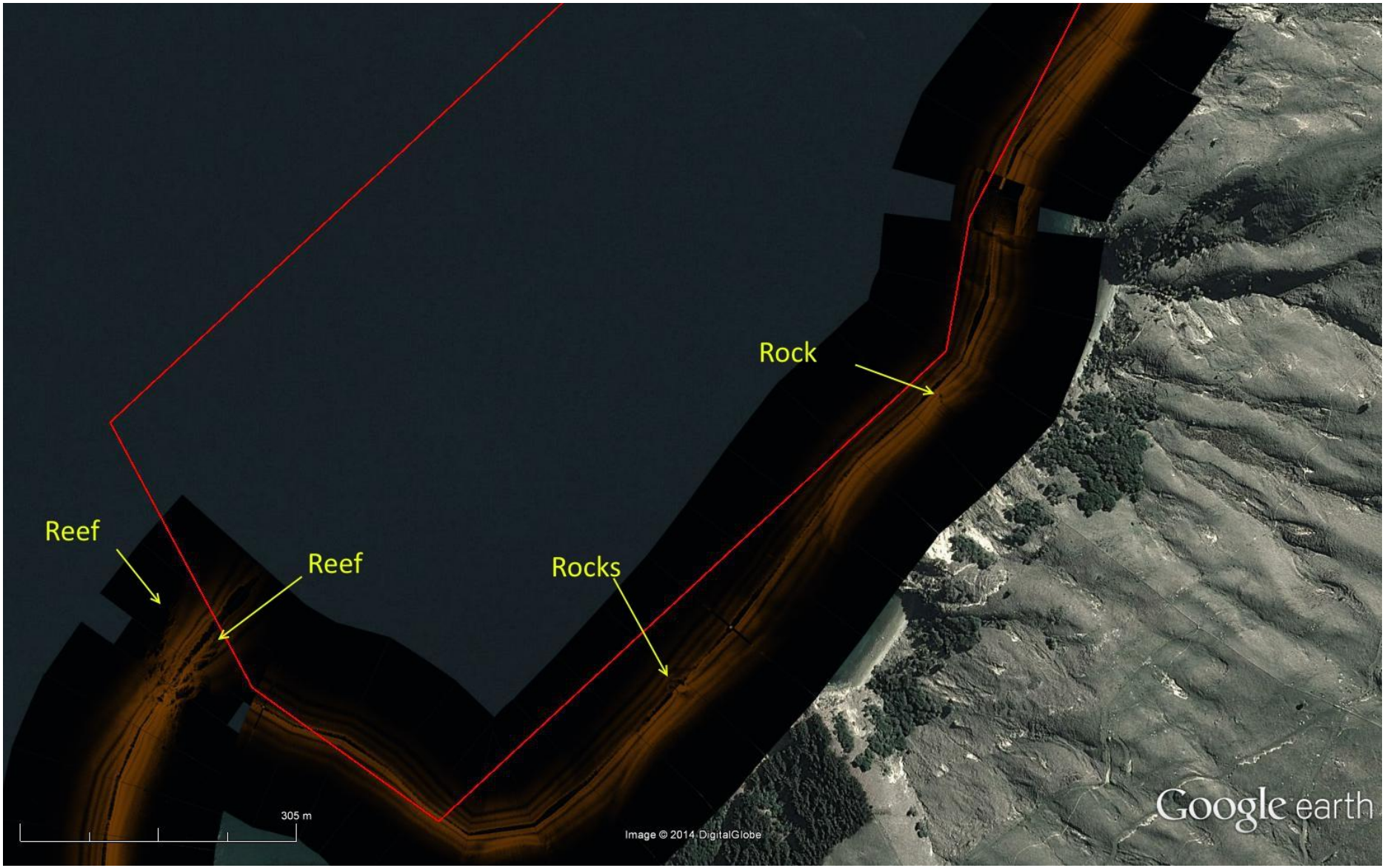


Figure 7c. Sonar imaging in 2014 from the southern original proposal are. Red polygon = early application option.

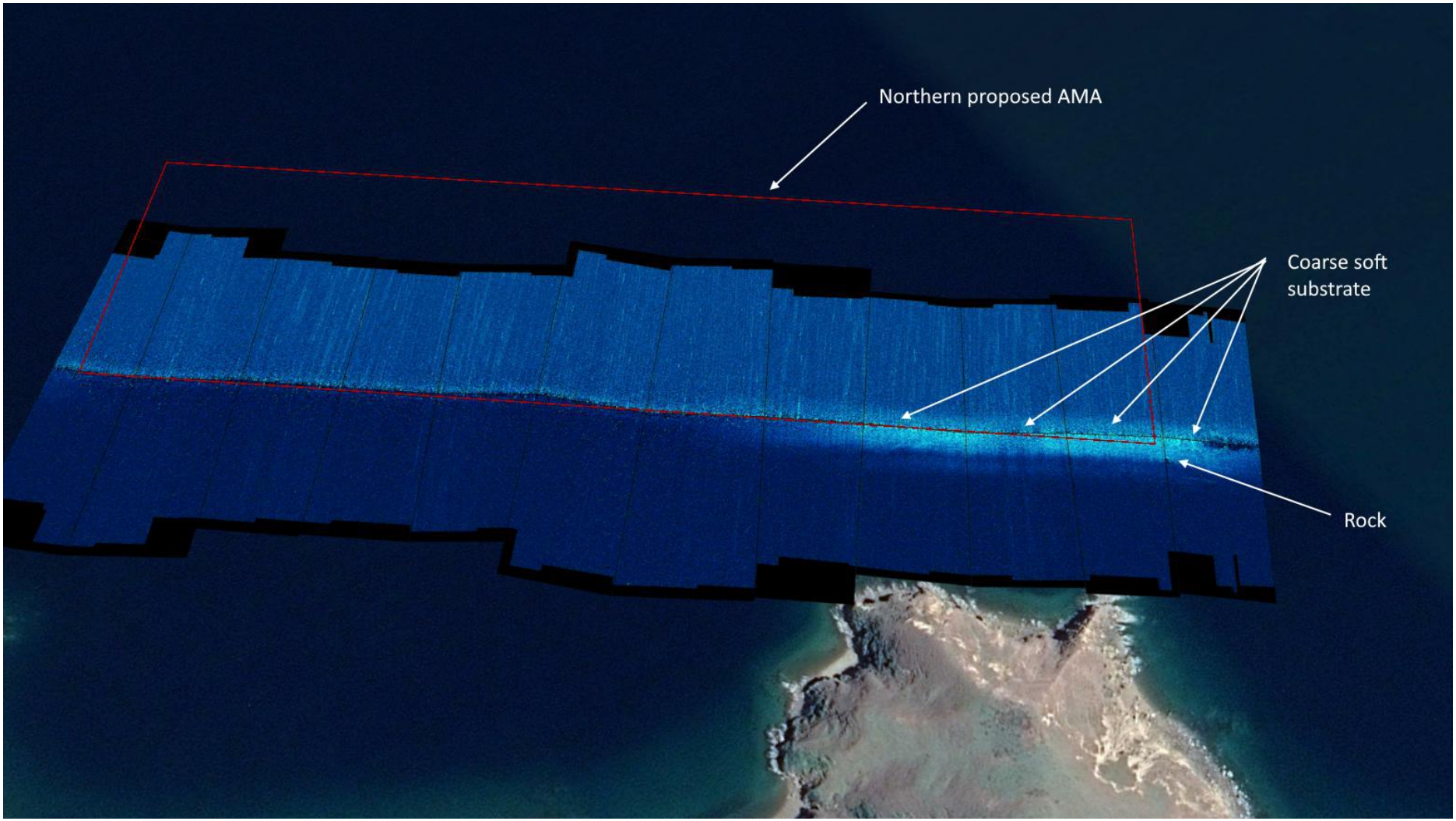


Figure 7d. Sonar collected in 2021 from along the inshore edge of the northern AMA area.

4.4 Surface dwelling species

A variety of surface-dwelling species (epibenthic) were recorded from the three major habitat types observed from the wider area south of Hapuku Rock (Table 4). Inshore areas comprising rocky and/or coarse soft substrata supported the most species in higher abundance compared to the offshore mud habitat. A variety of invertebrate species were observed from inshore habitats (e.g. snake stars, urchins, tubeworms and macroalgae). Fish species targeted by recreational fishers including scallop, blue cod, tarakihi and blue moki were most often observed from the inshore habitats, however, they were occasionally seen from offshore deep substrata. An occasional scallop was observed from the proposed AMA but they were not common.

Mud or mud/shell substrata found within the proposed AMA's supported a lower diversity of surface dwelling (epibenthic) species compared to inshore areas. Occasional lampshells (*T. sanguinea*) were observed from the northern AMA on the shore slope where natural shell was present.

4.5 Mussel shell debris

Photos from areas under and close to the existing mussel farm were collected in a revalidation report (Davidson and Richards, 2007). The authors reported high percentage cover of mussel shell under droppers and either no shell or lower levels of shell debris away from the growing structures. The authors recommended that the consent area be altered to encompass existing the existing farm structures.

Photos were not collected within 8057 in the present study, however, mussel debris was recorded from one site sampled in 2014 inshore of the farm droppers (Plate 6).

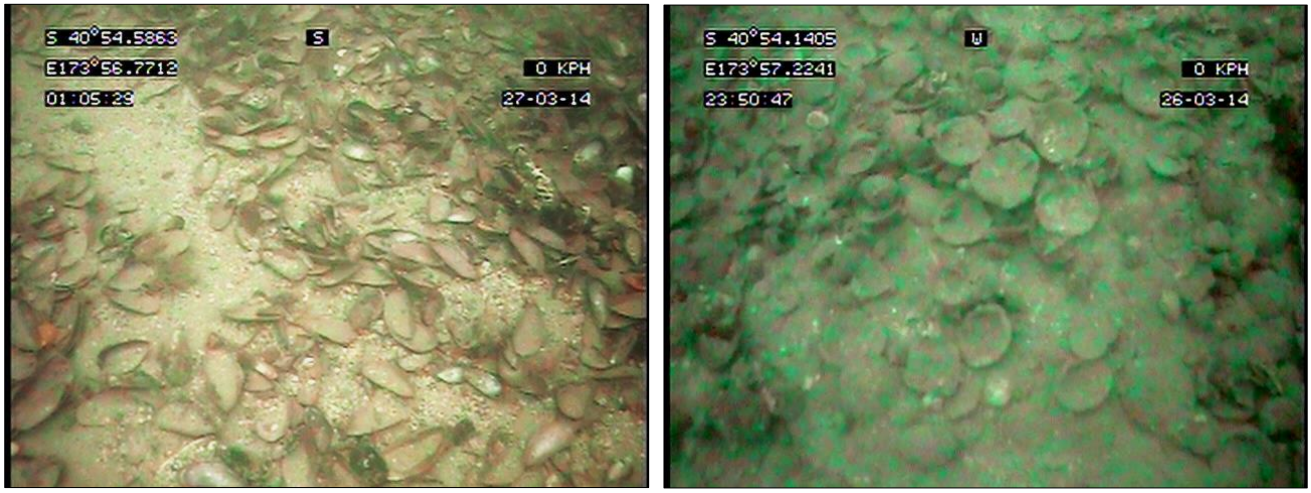


Plate 6. Left: Mussel debris recorded close to existing mussel farm 8057 (Photo 37, 21.4 m). Right: natural shell rubble inshore of the proposal (Photo 12, 29.8 m).

4.6 Infauna

A total of nine infaunal samples were collected in 2014, two from within the existing marine farm (samples 5 and 6), five from areas with no farm in the wider area (Table 5, Figure 8). Three of these sites were in or very close to the present AMA's. Raw data have been presented in Appendix 2.

Analyses of infauna samples showed a variable number of species and total number of individuals (Figure 9, Table 5). Sites located under farm droppers supported more species compared to deep mud in the proposed AMA's and adjacent deep areas. Site 7 supported the most species of all sites (n=49 species). Site 7 (n=1235 individuals) and one of the two farm sites (n=1071 individuals) supported the highest number of individuals organisms compared to the other mussel farm site and the remainder of proposal and control sites (Figure 9, Table 5). Species richness using Margalefs method was highest at site 7 followed by one of the marine farm sites. Overall site 1 (control) had lowest values and site 7 (proposal) exhibited highest values for number of species, number of individuals and Margalefs species richness (Table 5).

Species responsible for site 7 being the highest site were primarily amphipods and nematodes (Appendix 2). Of note was the low number or absence of pollution indicating polychaete worms (e.g. *Heteromastus filiformis, Capitella capitata, Polydora* sp., Lumbrineridae spp.) (Table 6). Dorvilleidae spp. was the only group of species indicative of

enrichment that were recorded under the farm and not recorded from other sites (Table 6). Infauna numbers were, however, relatively low and well below the numbers that would be expected from a polluted site (Pearson and Rosenberg, 1978).

The highest number of nematodes were recorded at site 6 located under the farm backbones, however, their numbers were second highest compared to site 7 located away from farm structures. Further, their abundance was relatively low at the second farm site located under droppers suggesting that enrichment was not a primary factor (site 5).

Two species were notable for their low numbers under farm droppers (Table 6). The polychaete worm family Paraonidae and the amphipod (*Phoxocephalidae* spp.) were recorded from the wider bay, but only in very low numbers from the marine farm. The reason for this phenomenon may be assigned to a marine farm effect.

Cluster diagram and the multidimensional scaling (MDS) diagrams showed that sites 5, 6 and 7 were different to all other sites. Site 5 and 6 were located in comparable depths to site 7 but they were under the existing backbones of mussel farm 8057. All other sites clustered closely and were characteristic of deep mud substrata. Sites 6 and 7 were closely related being representative of coarser soft sediments. Although site 5 supported a comparable number of species and had a comparable Magalefs score (Figure 9), site 5 supported a lower abundance of species compared to site 6 and 7 resulting in its separation in the MDS diagram (Figure 11). It is probable that fine sediment produced from mussels has altered the substratum and therefore the species and their abundance from this coarser substratum location, making it distinct between deep mud sites and shallower coarse substratum. This mix of traits is likely responsible for site 5 being separated in the MDS diagram.

Table 4. Relative abundance of surface-dwelling species observed from all drop camera photographs.

Habitats	Name	Species	Location	Relative abundance
Mud	Opalfish	*Hemerocoetes monopterygius*	Inside	Common
Coarse substrate & mud	Scallop	*P. novaezealandiae*	Inside & outside	Occasional
Coarse substrate & mud	Hermit crab	*Pagurus spp.*	Inside & outside	Occasional/common
Coarse substrate & mud	Sea cucumber	*S. mollis*	Inside & outside	Occasional
Rocky, coarse soft & mud	Spire shell	*M. roseus*	Inside & outside	Common
Rocky, coarse soft & mud	Spotty	*C. celidotus*	Inside & outside	Common
Coast soft	Lampshell	*Terebratella sanguinea*	Inside & outside	Occasional
Coarse soft	Nestling mussel	*A. maoriana*	Outside application	Common
Rocky	Green lip mussel	*P. canaliculus*	Outside application	Occasional
Rocky	Tubeworms	*G. hystrix*	Outside application	Occasional
Rocky	Ascidian	*Solitary* sp.	Outside application	Occasional
Rocky, coarse soft	Blue cod	*P. colias*	Outside application	Common
Rocky, coarse soft	Blue moki	*L. ciliaris*	Outside application	Occasional
Rocky, coarse soft	Tarakihi	*N. macropterus*	Outside application	Occasional
Coarse soft	Goatfish	*U. lineatus*	Outside application	Common
Rocky	Flap jack	*C. maschalocarpum*	Outside application	Common
Coarse soft	Red algae		Outside application	Occasional
Rocky	Grey sponge	*A. alata*	Outside application	Common
Rocky	Golf ball sponge	*A. aptos*	Outside application	Occasional
Coarse soft	Dog cockle	*G. modesta*	Outside application	Abundant
Rocky	Snake star	*O. maculata*	Outside application	Common
Rocky, coarse soft	Kina	*E. chloroticus*	Outside application	Common

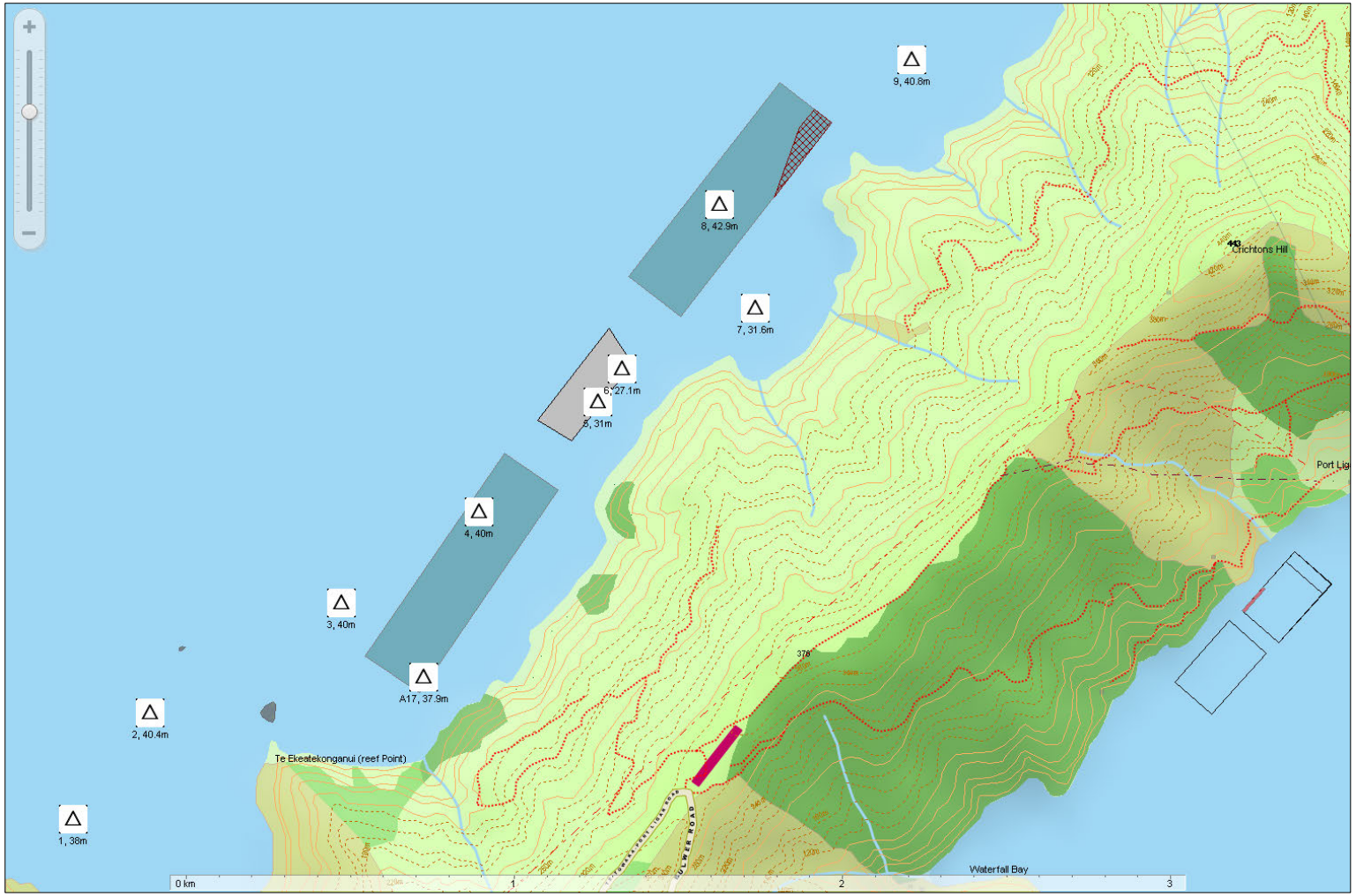


Figure 8. Location of grab samples relative to proposed AMA's (teal) and existing marine farm(grey).

Table 5. Summary of infaunal data collected from nine cores in Admiralty Bay.

Grab no.	Treatment	S	N	d	J'	H'(loge)
Grab01	No structures	16	74	3.485077404	0.7814565	2.16665748
Grab02	No structures	29	159	5.523876342	0.791564539	2.665431971
Grab03	No structures	26	101	5.416976633	0.780448899	2.542777856
Grab04	No structures	24	251	4.162554682	0.696229563	2.212655029
Grab05	Under backbones	32	173	6.015572655	0.780249994	2.704140418
Grab06	Under backbones	32	1071	4.443585625	0.396645828	1.374669688
Grab07	No structures	49	1235	6.742684583	0.560746815	2.182325837
Grab08	No structures	29	225	5.169771223	0.706033793	2.377424649
Grab09	No structures	21	97	4.371860888	0.689273385	2.098508288

S = Total number of taxa identified
N = Total number of individual organisms in sample
D = Margalefs species richness
J = Pielous Evenness score
H (loge) = Shannon-Wiener Diversity Index

Table 6. Dominant or pollution indicating species recorded from cores.

Species	Grab01	Grab02	Grab03	Grab04	Grab05	Grab06	Grab07	Grab08	Grab09
	No structures	No structures	No structures	No structures	Under droppers	Under droppers	No structures	No structures	No structures
Amphipoda	0	4	18	28	2	8	544	73	0
Cirratulidae	1	0	1	0	7	60	24	0	6
Dorvilleidae	0	0	0	0	42	13	0	0	1
Euchone pallida	0	0	0	0	0	27	74	1	0
Heteromastus filiformis	0	0	0	0	0	7	0	0	0
Lumbrineridae	5	13	4	5	6	11	1	10	3
Nematoda	0	0	0	55	21	768	213	0	1
Oligochaeta	0	1	0	0	0	27	22	0	0
Paraonidae	27	35	21	15	0	2	48	17	45
Phoxocephalidae	7	22	18	8	0	3	4	26	13
Prionospio multicristat	3	3	2	1	9	30	8	2	0
Prionospio sp.	0	1	0	0	7	13	40	1	3
Propontocypris sp.	0	6	1	73	0	0	0	14	2
Sphaerosyllis sp.	0	0	0	1	4	21	46	0	0

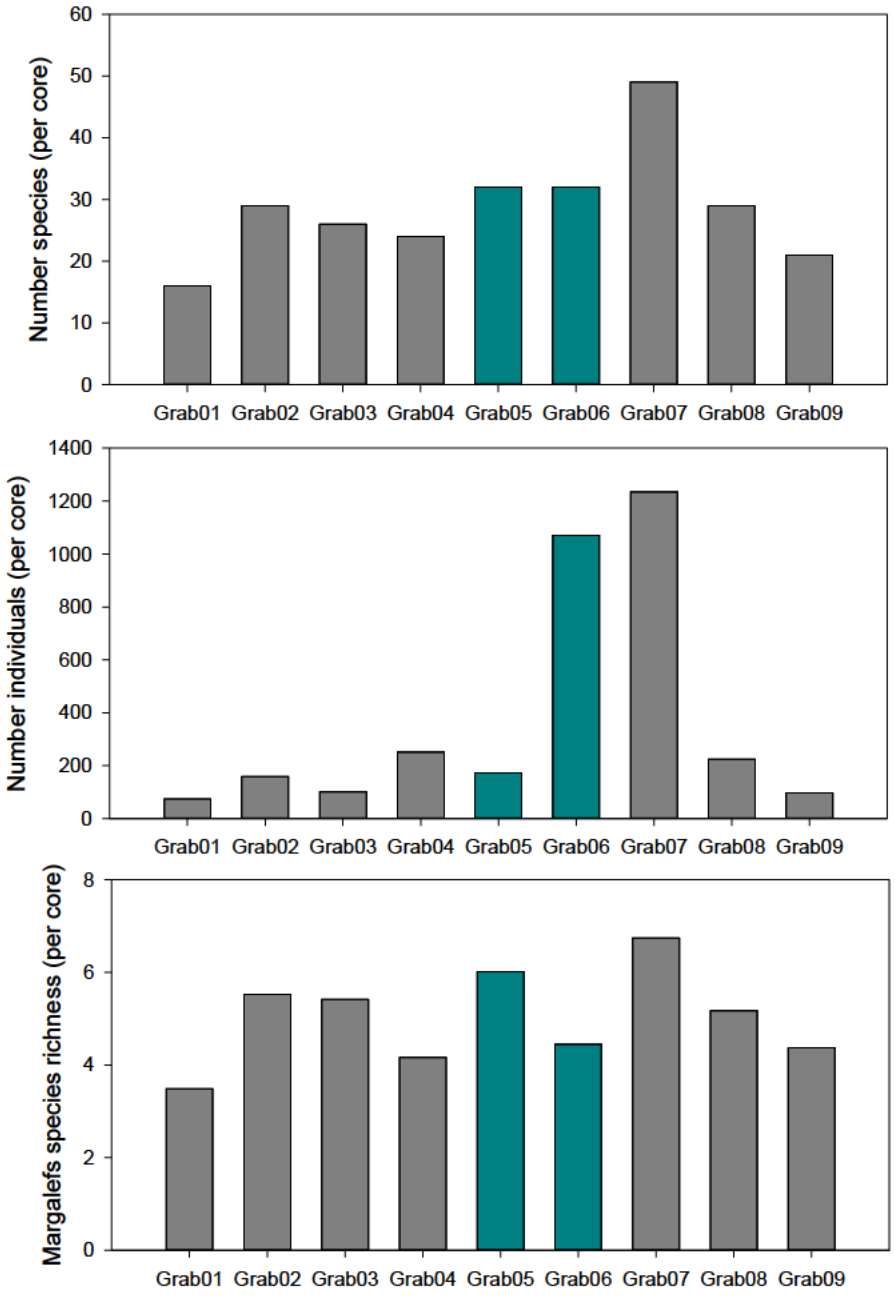


Figure 9. Number of infauna taxa, total number of individuals and Margalefs species richness score for animals retained from 0.5 mm mesh samples from sites under farm structures (teal), in the proposal or at controls in Admiralty Bay.

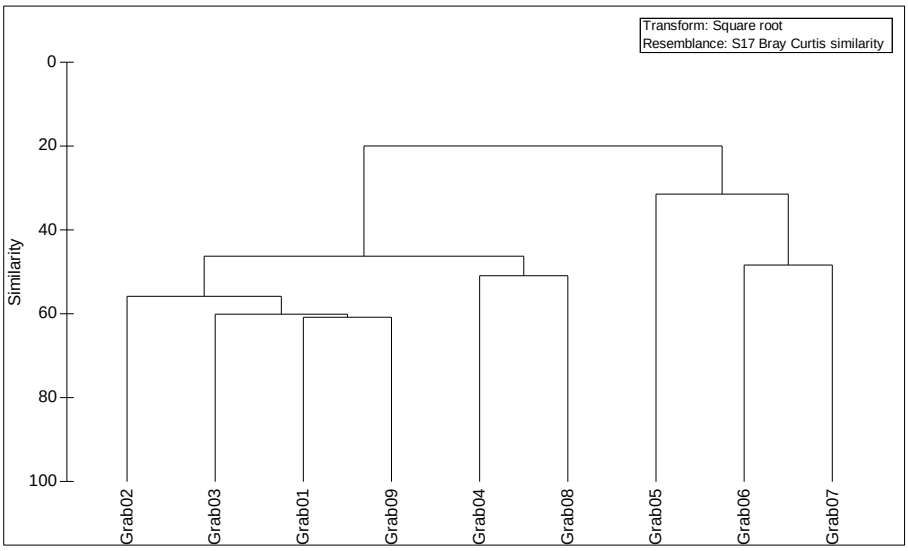


Figure 10. Cluster diagram showing similarity (using Bray-Curtis similarity indices) of square root transformed infaunal abundance from sites under farm structures (n=2), within the proposal (n=5) and alongshore of the proposal (n=2).

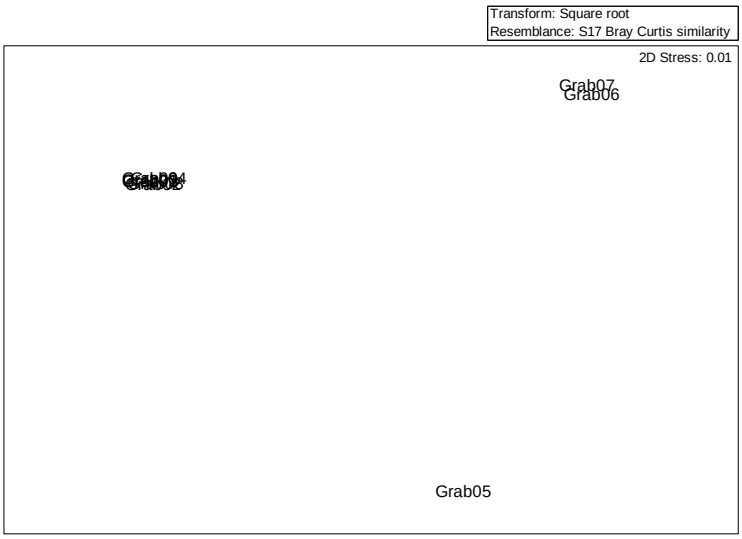


Figure 11. Multidimensional scaling (MDS) diagram of the similarities between infaunal communities from under structures (5 and 6) and around the proposal area. Infaunal abundance data were square-root transformed to down-weight the significance of particularly abundant taxa.

4.7 Sulphides in sediment

Enriched marine sediments can exhibit elevated sulphide and organic carbon levels. Since 2006 in Canada, sulphide has been used to assess organic enrichment in sediments associated with fish farms (Chang *et al*., 2013) (Table 7). Various studies have shown that the diversity of sediment macrofauna under salmon farms declines with increasing sediment-sulphide concentrations (Brooks & Mahnken 2003, Giles 2008, Hargrave et al. 2008, Hargrave 2010).

Sulphide values from Admiralty sites (under and away from backbones) were all well below the lowest environmental rating class (Oxic A) (Table 7, Figure 12). At the Oxic A level, effects on marine sediments and the animals living in sediments is at the low end of the range of effects.

Apart from site 5, all sites including site 6 collected under mussel droppers, had very low levels of sulphide. Site 5, although well below the Oxic A level, did show infaunal effects in term of species abundance and composition suggesting some enrichment or change in the habitat. The effect was not, however, at a level that pollution indicating organisms became abundant and certainly well below the Anoxic level associated with severely polluted sites where species shifts occur.

Table 7. Sulphide values recorded from Admiralty Bay and environmental ratings from Canada (NBDENV, 2006).

Sample ID	Sample Concentration in µM
Grab 1	55.19
Grab 2	83.16
Grab 3	70.58
Grab 4	28.64
Grab 5	262.12
Grab 6	14.86
Grab 7	5.12
Grab 8	19.01
Grab 9	65.03

Table 1. Environmental ratings based on average sediment sulfide concentration (total S^{2-}) in annual monitoring of finfish farms in southwestern New Brunswick. Based on NBDENV (2006)

Environmental rating class	Sediment sulfide (total S^{2-}) (µM)	Effects on marine sediments
Oxic A	<750	Low effects
Oxic B	750–1500	Low effects
Hypoxic A	1500–3000	May be causing adverse effects
Hypoxic B	3000–4500	Likely causing adverse effects
Hypoxic C	4500–6000	Causing adverse effects
Anoxic	>6000	Causing severe damage

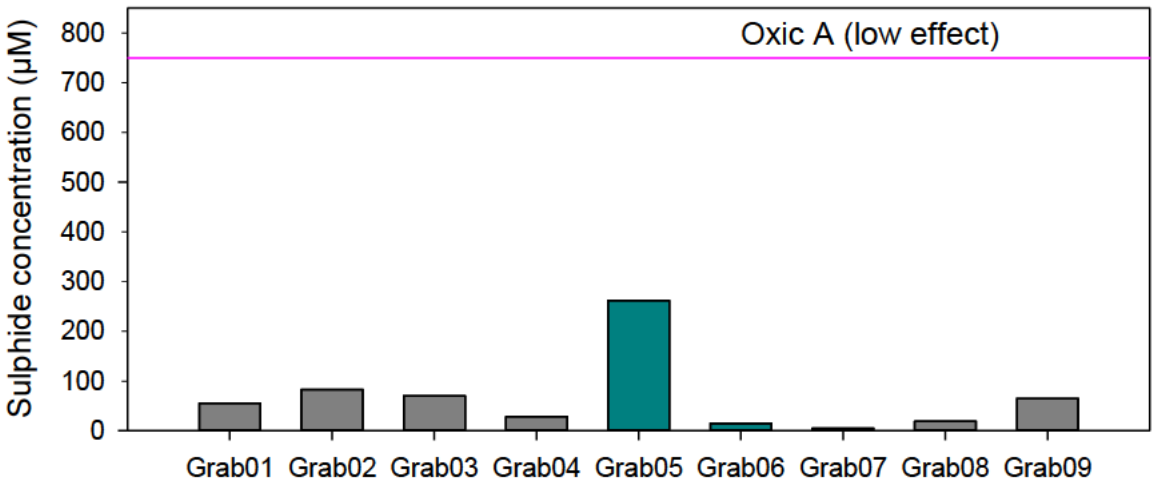


Figure 12. Sulphide values from the nine sites sampled in Admiralty Bay. Oxic A = pink line).

4.8 Water movement (ADCP data)

Depth average water currents at the Admiralty Bay site predominantly flowed from south-west to northeast and reversed with the tide (i.e. alongshore) (Figure 13). Surface water currents also followed this pattern with a reversal with the change of tide (Figure 13 middle). Southwest flowing water currents were much weaker than northeast flowing water. Surface currents were strong compared to most mussel farms sites in the Pelorus Sound, with the greatest current speed recorded in the northeast direction (peak = 51.6 cm s^{-1}). Mean surface current speeds for surface water over the entire sample was 13.5 cm s^{-1}.

In contrast, near seabed currents were mild with a predominant flow to the northeast (peak = 11.1 cm s^{-1}, mean = 5.79 cm s^{-1}). The reverse flow at depth was, however, very mild over a wider range of directions (Figure 13, right). The peak tide size during the deployment was at 7.46 am (2.28 m) and well below the largest tides of 2.59 m when stronger flows may be experienced.

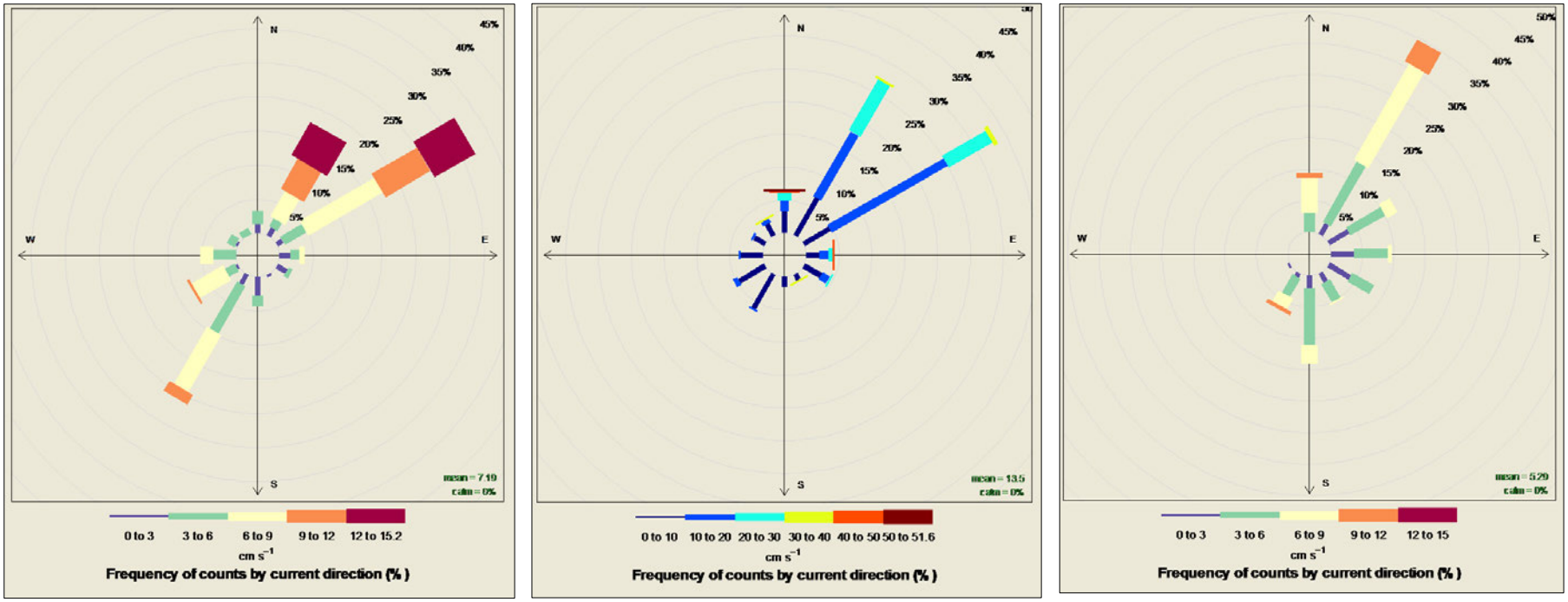


Figure 13. Current rose, left = depth averaged, middle = top currents, right = bottom currents. Colours on the graph show the current speed range cm s^{-1} with the length of the bars showing the proportion of time currents were in the given direction and speed range. Direction has been presented as the direction the current flow towards.

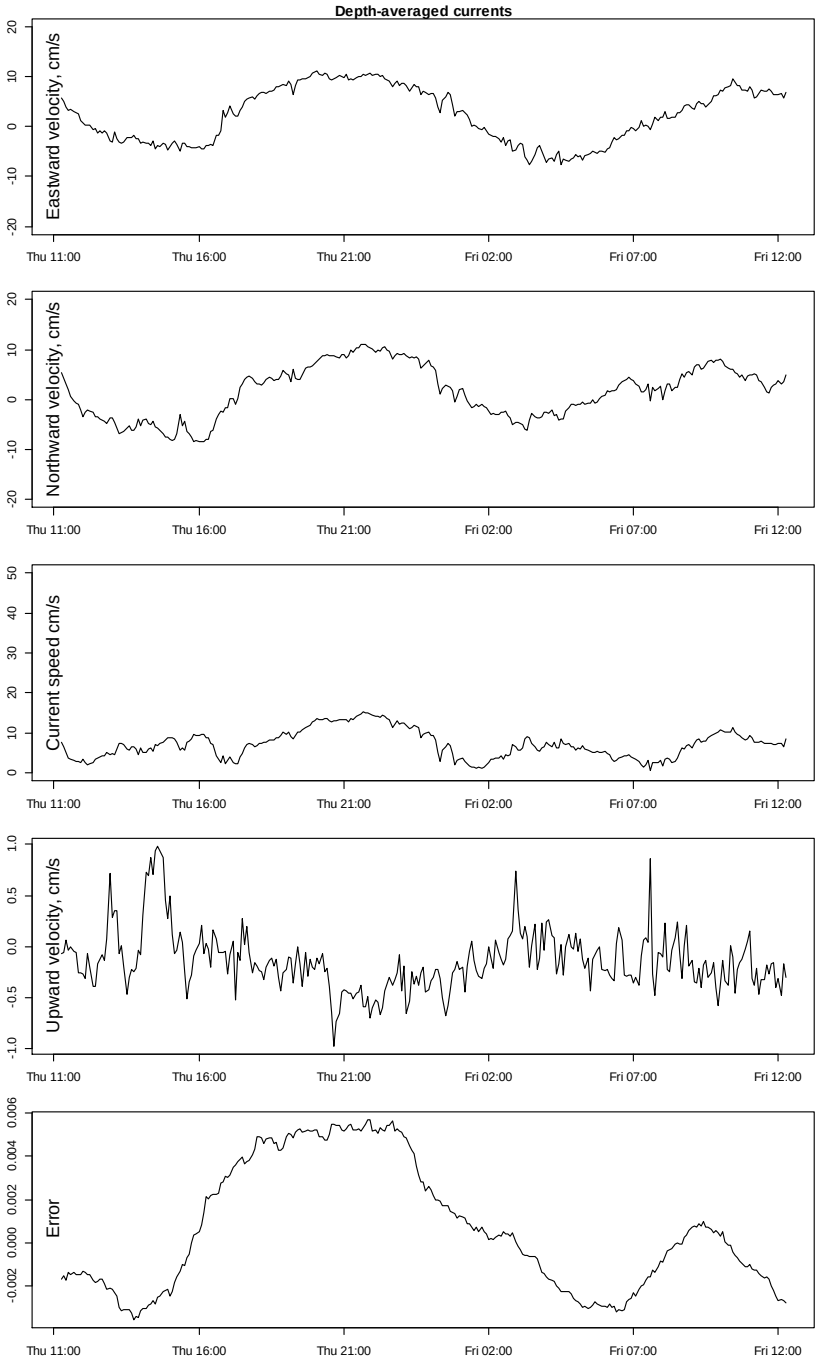


Figure 14 Depth averaged water current data recorded by acoustic Doppler current profiler (ADCP) instrument deployed in the proposed proposal in Admiralty Bay.

5.0 Summary and conclusions

Overall, the two 15ha proposed AMA's are located over a deep mud and mud/shell substrata. The marine environment in the Hapuku Rock area is influenced by elevated wave energy and tidal currents compared to areas in sheltered Marlborough Sounds bays and inner Admiralty Bay. As such, the proposed sites will likely exhibit lower levels of farming impact compared to mussel farms in the more sheltered locations.

5.1 Substratum and biological values

Most of the AMA's were located over a benthos characterised by deep gently sloping silt and clay (mud). An area close to the inshore north-eastern edge supported coarser material in the form of natural shell (broken and dead whole shell) and cobbles. Silt and clay and silt and clay with shell are widespread and common in the Marlborough Sounds. Mud (silt and clay) has been traditionally targeted by marine farming activities because this habitat is: (A) widespread in the Sounds, (B) the most common soft substrata sediment in the Sounds, and (C) the change that occurs when a mussel farm is placed over this substratum type represents a smaller community shift compared to the change that occurs when a farm is placed over coarse substratum or rocky habitats. Silt and clay with natural shell is functionally comparable to silt and clay with mussel shell as it allows colonisation of species that require hard surfaces provided by shell.

No surface-dwelling biological communities of particular interest such as red algae or horse mussels were recorded during the present investigation. No known species or habitats likely to be considered ecologically significant were observed from within the proposal area (see Davidson *et al*. 2011 for significant areas in Marlborough).

The infaunal communities recorded from the deep mud habitats in the proposed AMA's were uniform and supported a range of species considered typical of mud habitats (McKnight and Grange, 1991). Coarser soft substratum (i.e. mud, shell, cobbles) located near the inshore boundary of the northern AMA supported a greater range of species compared to deep mud. Communities associated with each substratum type were separated by the cluster analysis. Mud and shell substratum from deep sites in the Sounds is comparable to mud and shell found under mussel farms. The addition of a mussel farm over this type of habitat therefore represents a relatively small change.

Hard substratum in the form of small cobbles were also recorded from within the northern inshore edge of the northern AMA. Rocky substrata are traditionally avoided for marine farming activities.

To avoid a marine farming impact on rocky and mud with a high cover of shell, it is suggested that no backbones be placed in the north-eastern inshore corner of the northern AMA.

Davidson and Richards (2014) investigated the recovery of a mussel farm over a period of 12 years. The authors reported that highest impacts were located under backbones, with relatively little or no impacts recorded under the warp area. Placement of warps and anchors in the exclusion area is therefore considered acceptable.

Sulphide levels from the existing mussel farm, the proposal AMA's and the wider area were low and consistent with a low nutrient environment. It is likely the additional of new backbones in the AMA's would likely produce a comparable result (i.e. low levels of sulphide).

Water current measurements showed the site was swept by water currents at higher levels than most mussel farms located within Pelorus Sound. Strongest currents were recorded in surface waters in an alongshore direction. At sites with elevated wave energy and/or strong tidal flows Hartstein and Rowden (2004) reported lower levels of impact compared to mussel farms in sheltered locations. These authors were referring to a site located at Blow Hole Point in the entrance to Pelorus Sound only 5.7 km distant to the proposed AMA's.

5.2 Impact

A variety of data were collected from the existing marine farm located within the study area (8057). This enabled a description of the level of impact associated with a mussel farm in this area of Admiralty Bay. Photographs collected in 2014 and by Davidson and Richards (2007) that showed relatively high levels of shell under and close to mussel droppers. It is probable that the levels of shell recorded under the parent farm provides a good indication of the level of shell that will accumulate below the proposed AMA's should they be approved for farming. The level of mussel shell recorded was within the range known for mussel farms in the Marlborough Sounds. Provided farms are positioned over mud, the change and its associated impact will be at the lower end of the known range.

Sulphide levels were elevated at one farm site while the other farm site had relatively low levels. The elevated site was, however, well below the lowest enrichment rank (Oxic A). Even the highest value recorded for this study was well below the Oxic A level regarded as the entry level into a mildly enriched state.

The infaunal community under the mussel farm was comparable to an inshore site located away from the farm. This site had little in common with the deep mud sites. The similarities between farm sites and the inshore proposal sample site were likely due to depth, substratum and the presence of shell at all three sites (i.e. mussel or natural shell).

Of note was the absence or low numbers of pollution indicating organisms (see Pearson and Rosenberg, 1978) under the existing marine farm. This result aligns with the low sulphide levels that were representative of a mildly enriched site. This status is likely due to the good water flows that reduce the environmental effects of mussel farming (Harstein and Rowden, 2004; Keeley *et al*., 2009). This phenomenon suggests that any new lines installed in the AMA's may also have a low level of impact and be comparable to other farm sites located in areas with elevated wave energy and water movement.

Based on existing studies on the impact of mussel farms in the Marlborough Sounds and around New Zealand, it is unlikely that impacts would occur beyond 20-30 m from the droppers. The sediment footprint, however, will be considerably larger due to currents and wave action moving small particles, however, the impact of shell debris and fine sediment will be restricted to much closer (i.e. 20-30 m distance from droppers).

5.3 Boundary modifications and monitoring

Based on the presence of a small area of cobbles and a high percentage cover of natural shell located in the inshore corner of the northern site, it is suggested that a backbone exclusion zone be established (Figure 15). Alternatively, the site could be shifted further from shore to place it entirely over mud.

Provided rocky and soft substrata with a high percentage cover of natural shell is avoided, no monitoring is suggested. Should monitoring be considered necessary, the quantitative data produced in the present report would be suitable to use as a baseline.

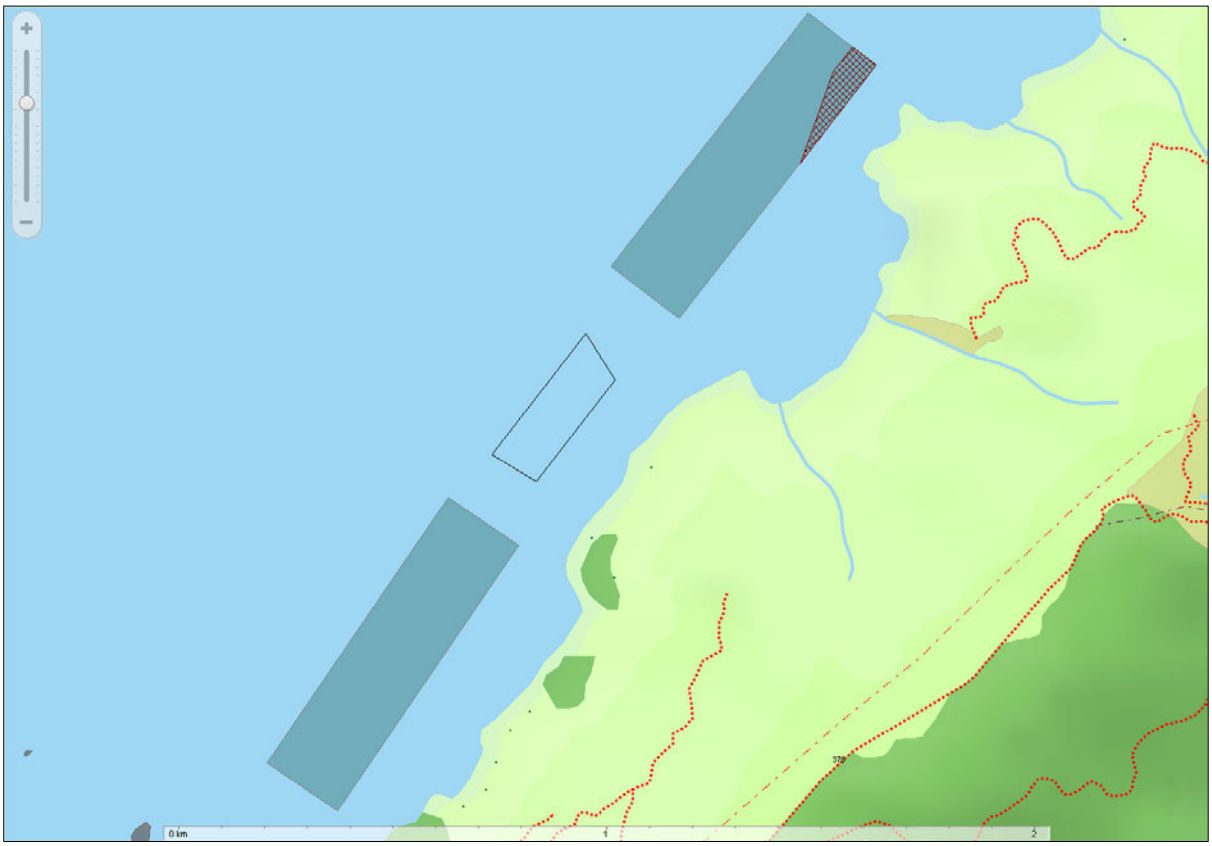


Figure 15. Location of suggested backbone exclusion (red hatched) in the northern AMA (teal).

5.4 National Environmental Standards – Marine Aquaculture (NES-MA)

According to Fisheries NZ (2021), the NES-MA provides a nationally consistent set of provisions to provide a more certain and efficient process for considering applications for the replacement coastal permits of existing marine farms and for realignment and change of species applications, while ensuring farms meet best environmental practice. The study area or "area of interest" for a subtidal marine farm with no feed is defined as the consent and an area of 20 m distance around the consent boundary. Within this area, an assessment of effects on reefs, biogenic habitat, and regionally significant benthic species is required. The assessment of biological effects is based on existing data and/or new site survey data.

MEP Policy 13.21.3 states – AMAs (other than ASA's) are established to provide for the area of existing marine farms within the Enclosed Water CMUs. AMAs within the Enclosed Waters CMUs are generally located, (b) Away from reefs and other areas of significant marine biodiversity value in order to protect the biodiversity values of those habitats.

"Reefs" are defined in V1 as per NES-MA. The s42A officer has accepted a submission that "Away from" should be 20m as per NES-MA.

5.4.1 NES-MA assessment of effects for 8550

"Reef", "biogenic habitat" and "regionally significant benthic species" are defined in NES-MA regulations 7 – 9, and criteria for applying the "biogenic habitat" and "'reef" definitions are contained in NES-MA Schedule 4. These same definitions are used in Variation 1 of the MEP.

Known reef, biogenic habitats and regionally significant species within the proposed AMA's and the area of interest are listed below and in Table 4.

1. >40% natural shell cover was recorded in the northern proposed AMA (now excluded).
2. Cobbles were recorded from the northern proposed AMA (now excluded).

No other NES-MA criteria were triggered by this present survey.

Table 4. Reef, biogenic habitats and regionally significant species summary for proposed AMA's.

NES	NES biotic and abiotic features	NES criteria or definition	Marine farm	Comments
7	Biogenic habitat	Section7	None seen or known	
8	Reef	Section 8	**Cobbles seen**	Small area near inshore edge of northern AMA (now excluded).
9 (a, b, c)	Status or significant species	Section 9	None seen or known	
9 (d)	Council significant site	Section 9	None near marine farm	
S4 1	Rhodolith	1 seen	None seen or known	
S4 2	Council recognised important dead shell	Present	Not seen or known	
S4 3 (a, b)	Biogenic prominent or raised (0.5m)	Present	None seen or known	
S4 4 (a) (i)	Biogenic (colony forming)	≥ 10%	None seen or known	
S4 4 (a) (ii)	Biogenic macroalgae or seagrass	≥ 10%	Not seen	
S4 4 (a) (iii)	Biogenic tubeworms, brachiopods, natural shellfish	≥ 10%	None seen or known	
S4 4 (b)	Natural shell	>40% cover	**>40% cover seen**	Natural shell cover was seen on the shore slope that extended into the inshore areas of the northern AMA (now excluded).
S4 4 (c)	Biogenic large habitat-forming species (e.g. horse mussel, hydroid tree)	Mean = ≥1 per m^2	None seen	

5.4 Biosecurity issues

Most major marine farm contactors, harvesters and major companies are members of the A+ programme (http://www.aplusaquaculture.nz/farmers-information). The A+ programme promotes good environmental practices. In particular, the A+ programme has a major objective that "farming activities do not cause an unacceptable biosecurity risk". All A+ members are also required to recognise the Biosecurity Act 1993, as well as the Hazardous Substances and New Organisms Act 1996.

5.5 King shags

A variety of authors have also outlined human activities that may impact king shags including aquaculture (Schuckard, 2006; Bell, 2019a; McClellan *et al*., 2020); commercial fishing (McClellan, 2017), colony disturbance (Butler, 2003; Davidson *et al*., 2018), and hunting (Nelson, 1971). Apart from aquaculture, little research has occurred on these topics despite their potential importance on a high-status species.

Butler (2003) undertook the first review of the possible effects of marine farms on king shag. He described the potential effects in three categories: physical effects (structures of farms, lights, debris from farms, and shell waste); effects of activities (disturbance, noise and water pollution); and effects on marine ecology (hydrography, sediment and water column changes, creation of new habitat, exclusion of trawlers, unwanted organisms). Butler (2003) considered that most king shag feeding occurred in deeper water and that potential impacts resulting from mussel farms excluding king shag foraging may become apparent if deeper-water mussel farms were developed. Lloyd (2003) reviewed the effects of aquaculture on seabirds and cetaceans. He also appeared to believe the existing pattern of inshore mussel farms was less likely to affect king shag foraging compared to proposals for extensive mid-bay mussel farms in Admiralty Bay. Fisher and Boren (2012) undertook a rigorous study of king shag foraging distribution in Admiralty Bay and concluded that deep water marine farms posed a greater threat compared to inshore sites.

Sagar (2013) conducted a general review of the ecological effects of aquaculture and only specifically mentioned king shag in relation to disturbance but discussed the main effects of 'filter feeder species' farms on seabirds in general, and their significance. The author stated the eight key effects were: entanglement with farm structures, habitat exclusion, smothering of benthos, changed abundance of prey, provision of roosts, disturbance by farm activities, ingestion and entanglement with farm debris, and attraction to lights. Sagar

(2013) considered that the potential effects of habitat exclusion and smothering of benthos were, in general, insignificant to seabirds given the small area occupied by filter feeder farms. However, he qualified this, noting that the significance of effects "will depend on the spatial scale of the aquaculture facility in relation to the distribution and abundance of prey species", and concluded that effective management could be achieved by avoiding locating farms in key foraging areas of species with restricted habitat requirements (see Sagar, 2013). The review listed "home ranges or location of important feeding and breeding habitats for most populations of seabird species" as being a key information gap for every one of the eight key potential effects.

Recent work on king shag has focused on a variety of aspects including foraging related behaviour (Bell 2019, 2019a; 2020; McClellan, et al., 2020). These studies have been funded by the MFA, Seafoods Innovations Limited and MPI. In the first year of a three-year study, Bell (2019a) attached GPS transmitters on birds from two Pelorus colonies located at Tawhitinui Bay and Duffers Reef. For the six tagged birds, between 7 and 13 days of data were recorded. Birds conducted between 7 and 20 foraging bouts over this period. Bell analysed the 42 complete foraging data sets to assess foraging behaviour and reported the average foraging trip duration was 4.5 hours (range: 23 minutes to 9 hours and 28 minutes). GPS data from the 42 complete datasets revealed birds spent on average 20 minutes flying to a foraging site. An average of 2 hours 59 minutes was spent foraging. Birds spent an average of 43 minutes resting or swimming on the water and 25 minutes roosting on mussel floats outside foraging bouts. Overall, birds spent 20% of each trip not foraging. Bell (2019a) reported that all six birds spent some time roosting on mussel floats including one bird that overnighted on a float. None of the birds visited land while away from the colony. The author also reported that the average foraging distance from the colony was 6.2 km (range: 0.4 km to 16.2 km).

Bell (2019a) reported that birds appear to have favoured foraging areas, with birds returning to broadly similar areas. Some birds foraged outside marine farms while some foraged within marine farms (Figures 16 and 17). Bell reported one bird foraged almost exclusively within mussel farms.

Bell (2019a) also reported birds had preferences for diving depth, with one bird having a mean maximum depth of 12.6 m (i.e. shallow preference), while one bird preferred deep diving with a mean maximum depth of 26.9 m.

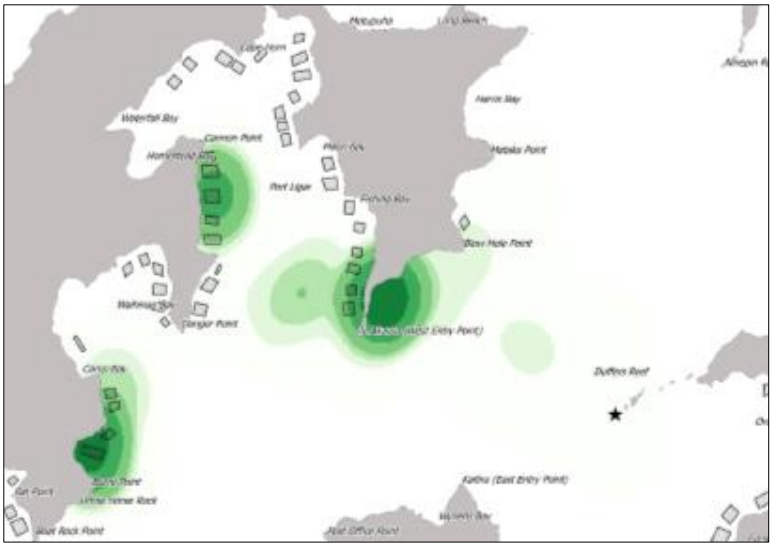


Figure 16. Heat map of foraging location of king shags from Duffers Reef colony (from Bell, 2019). Note marine farms are depicted as grey shapes and the king shag colony as a star.



Figure 17. Duffers Reef king shag individual who preferred to forage in marine farms.

McClellan *et al.* (2020) conducted a pilot study comparing king shag use at paired sites with and without mussel farms. Each of eight paired sites in Pelorus Sound were observed for two days (approximately 14 hours), except for one paired site, which was only observed for one day, as a harvesting vessel arrived on the morning of the second day. Counts were made at the farm and control sites at 15-minute intervals throughout each two-day period. General notes were made on the behaviours at the sites, for example, foraging between backbone ropes, feeding on algae and other biota associated with backbone ropes, roosting on buoys, resting on the sea surface, etc. McClellan *et al*. (2020) reported that king shags

were present at five of the eight study farms and four of the control sites. Birds were not observed at two of the eight paired sites. King shag roosted (no foraging) at two farms and roosted and foraged at three farms. In evidence before the Waikato Regional Council, McClellan (2019) stated "it has long been thought that mussel farms may exclude king shag from feeding in and around the structures of mussel farms due to benthic habitat changes under the farms and/or the structures themselves. The results from both this pilot study and from Bell (2019a) which involved attaching GPS loggers to six breeding adult king shags for 6-12 days, indicate that king shags do forage in mussel farms, sometimes for long periods of time and sometimes exclusively over that period."

In the second year of the three year programme, Bell (2020) reported on the results of tagging studies. The author tagged seven birds with results showing birds regularly returned to the same foraging sites on repeat foraging trips. The authors stated there appeared differences in male and female foraging behaviour with m foraging for longer, further from the colony, diving deeper and forage later in the day compared to females. Pooling data from both years, 4 of 11 King Shag tracked that foraged in areas with mussel farms, foraged within mussel farms. All 11 birds roosted on farms and all foraged immediately adjacent or close to mussel farms.

Fisher and Boren (2012) conducted boat line transects for king shags three times a month from February 2006 to March 2007 (Figure 18). In total, 38 surveys were undertaken with 131 sightings of birds foraging at sea, 65 in flight, 63 roosting in colonies, six resting on mussel floats, and two were foraging at sea within 200 m of a farm boundary. The authors reported that most sightings of king shags occurred in outer areas of Admiralty Bay (Figure 18).

Proposed AMA's

The two proposed AMA's are located in an area used by foraging king shags. The AMA areas total 30ha and represent a small proportion of the adjacent Admiralty Bay utilized by these birds.

Based on recent king shag research, it is likely king shags would utilize farm structures for roosting. It is also possible they would continue to forage under the farm.

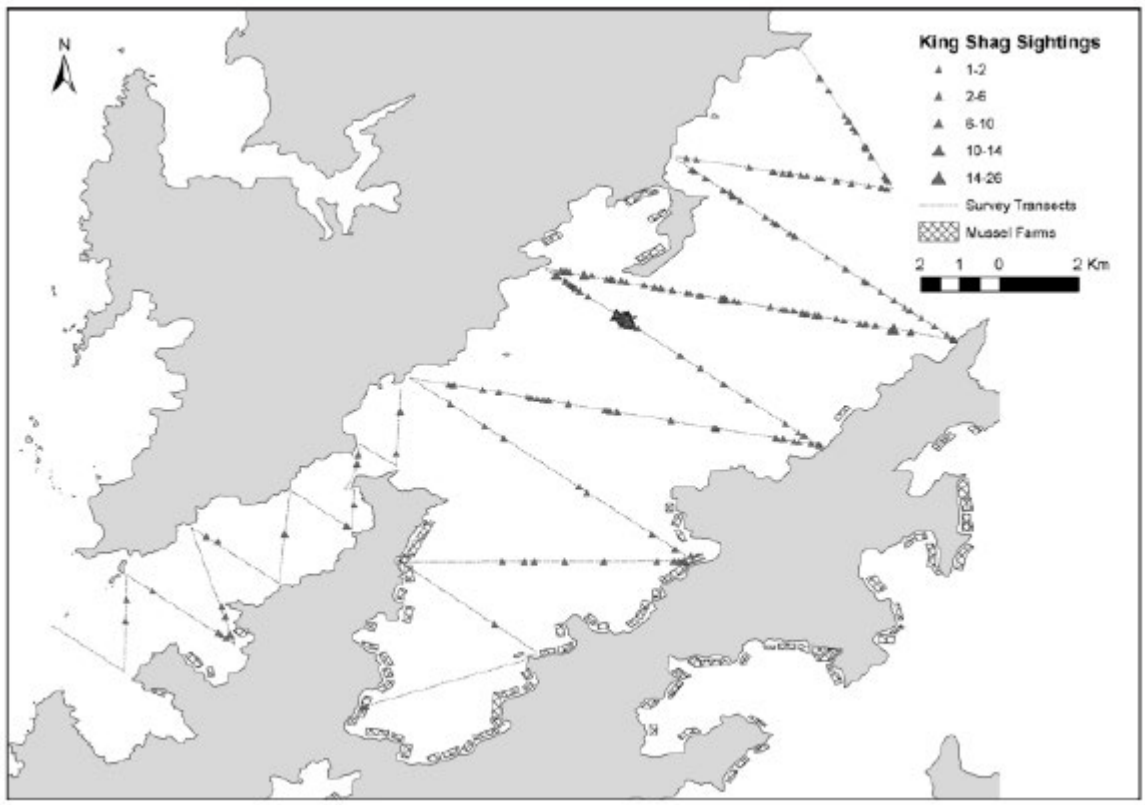


Figure 18. Distribution of king shag sightings in Admiralty Bay during boat transects.

5.5 Marine mammals

International research demonstrates that the nature and scale of any direct displacement or avoidance vary greatly between culture methods and marine mammal species (MPI, 2013). While particular species of whales or dolphins will be highly sensitive to disturbance, other species (such as bottlenose dolphins) and pinnipeds may be attracted to the structures (Lopez, 2012; Clement and Halliday, 2014; Davidson and Richards, 2017; Methion and Lopez, 2019).

For mussel farming, occupied farm areas may be perceived by some marine mammals (particularly those that echolocate) as a physical, visual or acoustic obstruction within their habitat. Based on research to date in Admiralty Bay, dusky dolphins appear unable to cooperatively herd schooling fish when adjacent to or within mussel farm structures (see Pearson *et al*., 2012). Clement and Halliday (2014) also noted the reluctance of common dolphins to enter or feed near farm structures within the Admiralty Bay region. Over the

course of five consecutive winters between 1998 and 2002, Markowitz *et al.* (2004) found that dolphins spent significantly less time in areas occupied by mussel farms than other parts of the inner bay. Pearson *et al*. (2012) also reported similar findings from tracking dolphin groups both inside and outside of mussel farms across all of Admiralty Bay during the winters and springs of 2005-2006. To test specifically whether these results were due to the fact that dusky dolphins might not use habitats closer to shore in general, rather than avoiding the farm areas themselves, Markowitz's study looked at the amount of time groups spent near farms (<200 m) and Pearson's study looked at time spent within the nearshore zone (<400 m of the shoreline) around inner and all of Admiralty Bay, respectively. Both studies found dolphins frequented areas occupied by mussel farms significantly less often than similar areas near farms or within the general nearshore zone.

The significance of such 'disruptions' to their foraging and feeding success over time may range from minor, (i.e. they simply employ other foraging strategies or move to other sources) to major implications (i.e. the loss of a primary food source begins to have population-level effects, such as reduced reproduction rates). It is difficult to assess whether these foraging limitations are impacting on the survival and reproduction of these dolphins at the population level and research can take several decades to determine and population dynamics (e.g. closed versus open structure) can affect the efficiency with which data can be collected (D. Clement, pers. comm.).

Displacement

Some species such as NZ fur seals may be attracted to mussel farms as hauling outs (Clement and Halliday, 2014; Davidson and Richards, 2017). Farm structures may also attract bottlenose dolphin and possibly killer whales, due to these species' curious natures and the associated aggregations of possible prey species under and near farms. Bottlenose dolphins have been frequently recorded 'sweeping' through mussel farms in the Sounds (D. Clement, pers. comm; Authors, pers. obs.).

Entanglement

Globally, 15 whales have been recorded as being entangled and/or damaging in marine farms with 10 of those being associated with salmon farms (Clement & Elvines, 2019). Ten dolphin entanglements have been reported in New Zealand salmon farms between 1987 and 2018 (A. Baxter pers. comm.). Entangled species include dusky dolphin (n= 7), Hector's

dolphin (n = 2), and bottlenose dolphin (n = 1). Almost all animals were found or believed drowned in predator nets or during operational changes when nets were no longer under tension.

Internationally, fatal entanglements of dolphins in predator nets on finfish farms have been reported from Australia (Kemper and Gibbs, 2001; Kemper *et al*., 2003) and Italy (Díaz López and Bernal Shirai, 2007). This may reflect the attraction of dolphins to a food source (Kemper and Gibbs, 2001) although such interactions between finfish farms and cetaceans have not been proven (Kemper *et al*., 2003).

There is also one record of a marine mammal becoming trapped or tangled in a mussel farm (a Bryde's whale; Wursig and Gailey, 2002). The low incidence of mussel farm entanglements is probably related to warps and backbones being under tension thereby reducing the chance of entanglement. This is in stark contrast to lobster pots that have a single line to the surface. This line is usually under little or no tension. Whales migrating up the east coast of the South Island pass hundreds of lobster lines that present a serious entanglement threat. A humpback first spotted by DOC staff near Banks Peninsula with a cray pot buoy line tangled around its tailstock and flukes then became entangled in mussel floats when it swam alongside a farm in Tory Channel several days later. This animal was cut free from the cray pot lines by a mussel farmer (Scott Madsen) and was released alive.

Wursig and Gailey (2002) stated that entanglements by larger whales in aquaculture facilities are relatively rare events.

The AMA's

For dusky and common dolphins, the AMA's could represent an area lost as foraging habitat. Dusky dolphin are regularly seen in Admiralty, especially in the winter months. The AMA areas total 30ha and represent a small proportion of the adjacent Admiralty Bay utilized by these species.

Based on the location of this farm and known whale migratory patterns and behaviour, it is unlikely this farm represents a threat for migrating whales. The present marine farm utilises standard mussel farming structures that are under tension and therefore present a low risk of entanglement to marine mammals.

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Appendix 1. Drop camera photographs (2014)

Photo site 1



Photo 2



Photo site 3

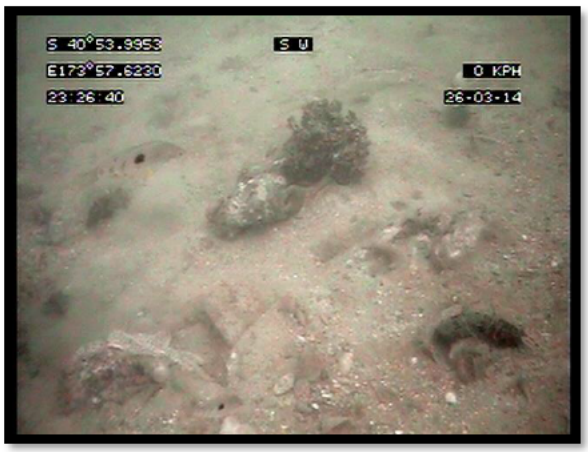


Photo 4



Photo site 5



Photo 6



Photo site 7



Photo 8



Photo 9



Photo 10

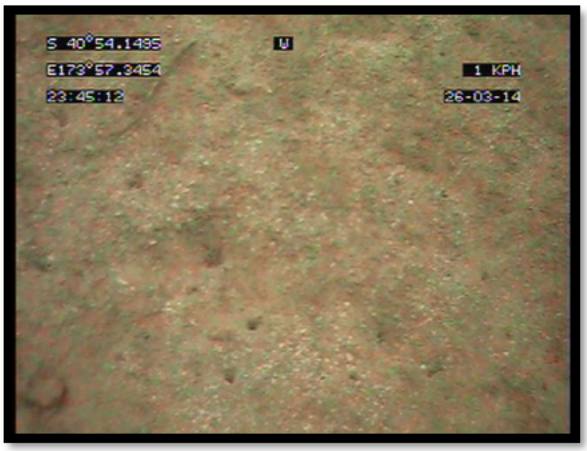


Photo site 11



Photo 12

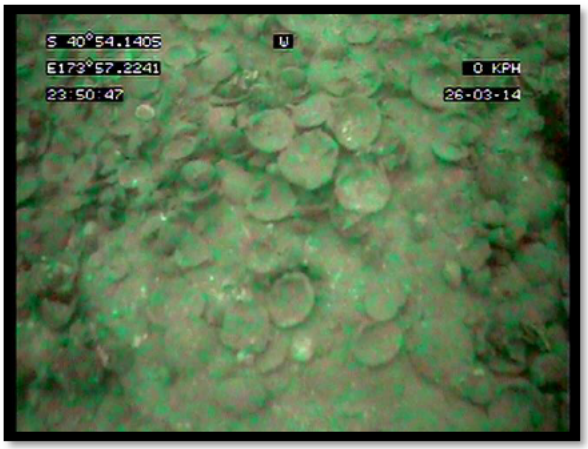


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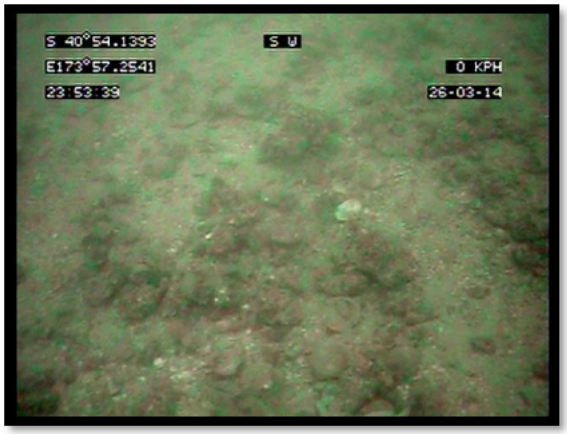


Photo 14



Photo 15



Photo 16

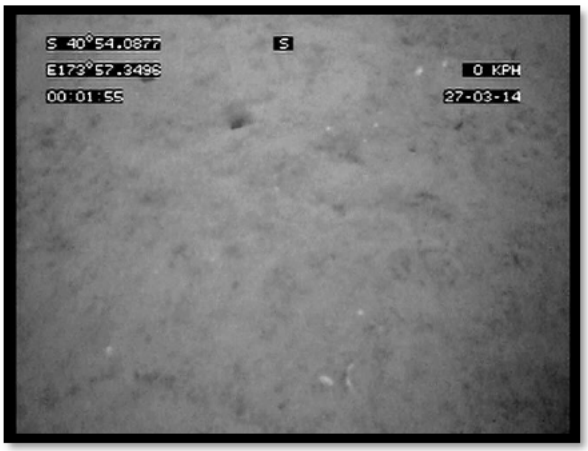


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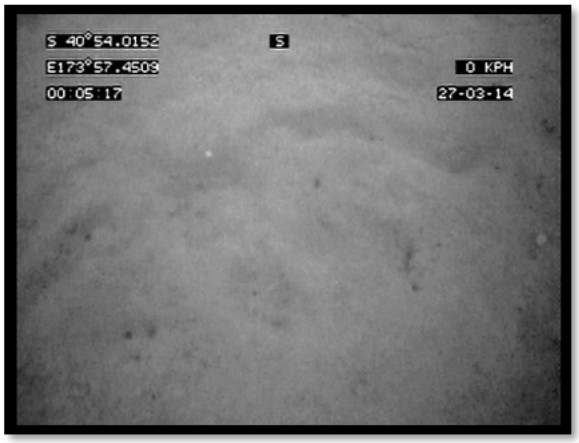


Photo 18



Photo 19

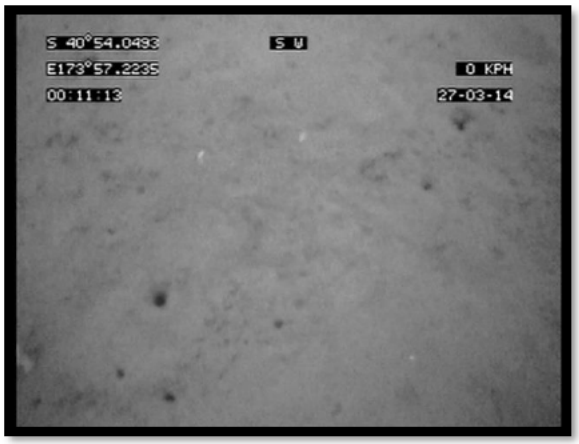


Photo 20



Photo 21

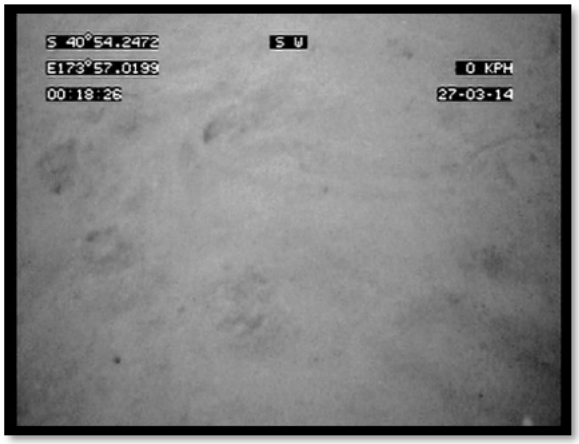


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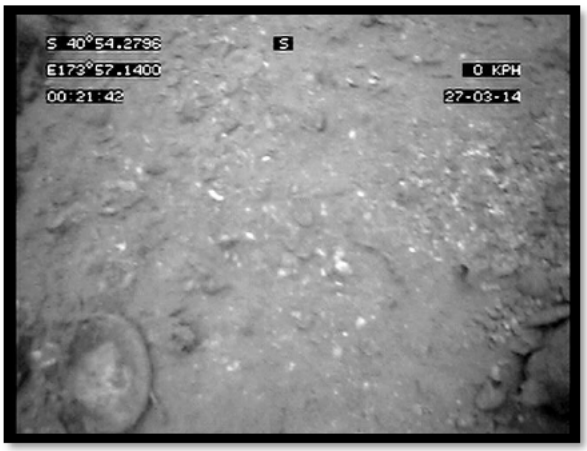


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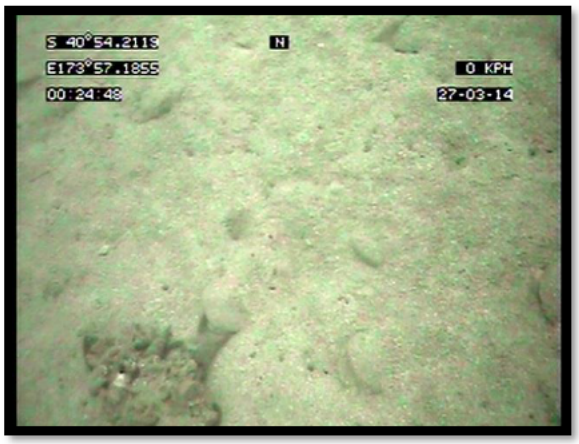


Photo 24



Photo 25

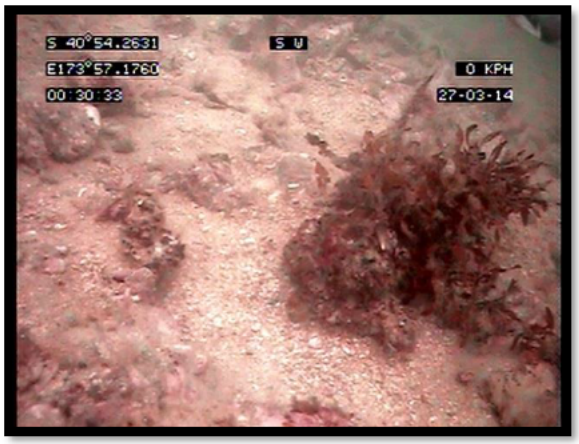


Photo 26



Photo 27

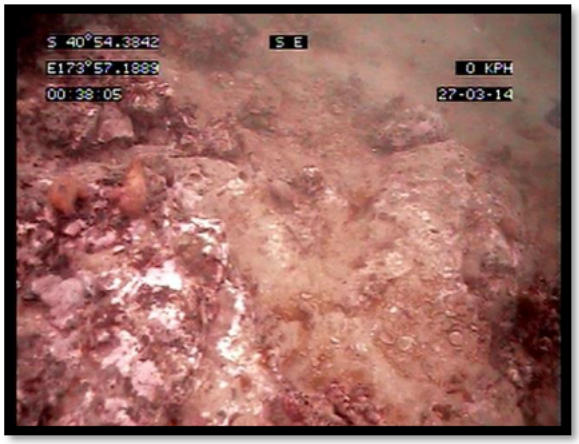


Photo 28



Photo 29

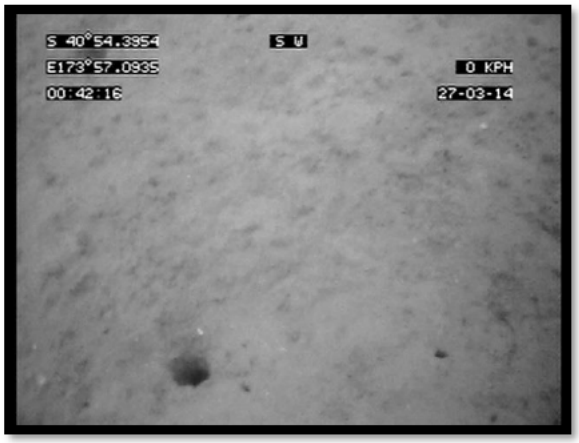


Photo 30



Photo 31

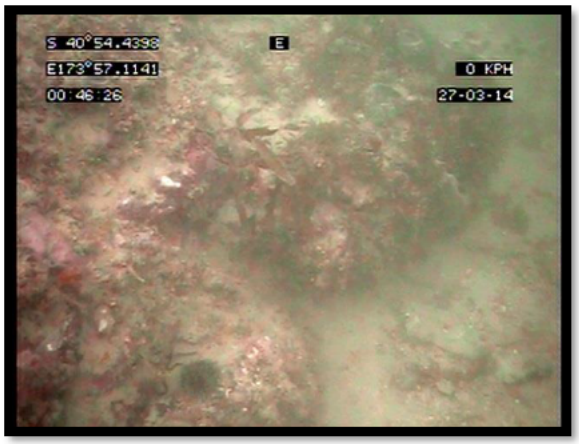


Photo 32



Photo 33



Photo 34



Photo 35



Photo 36



Photo 37

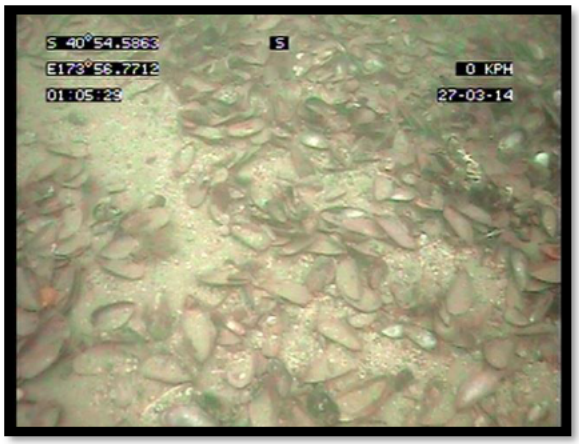


Photo 38



Photo 39



Photo 40

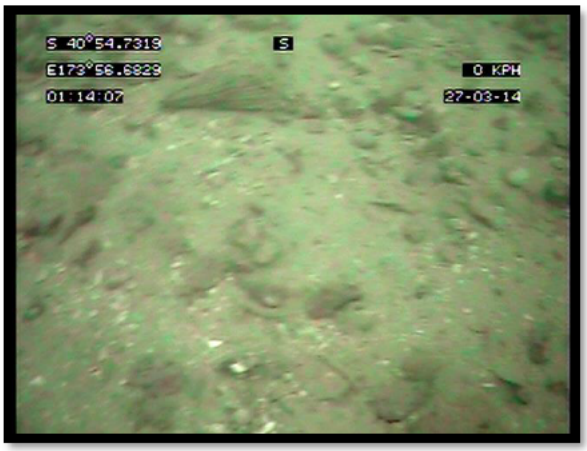


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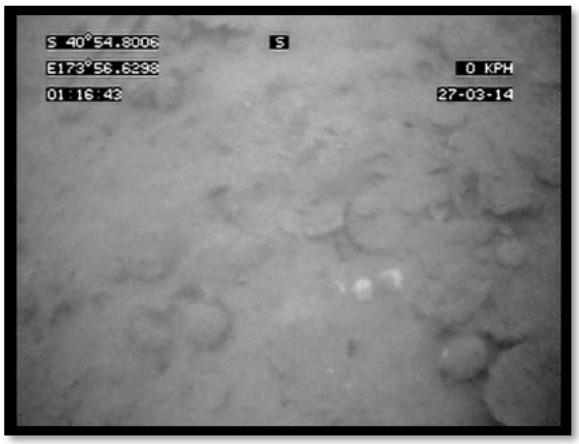


Photo 42



Photo 43



Photo 44



Photo 45



Photo 46



Photo 47

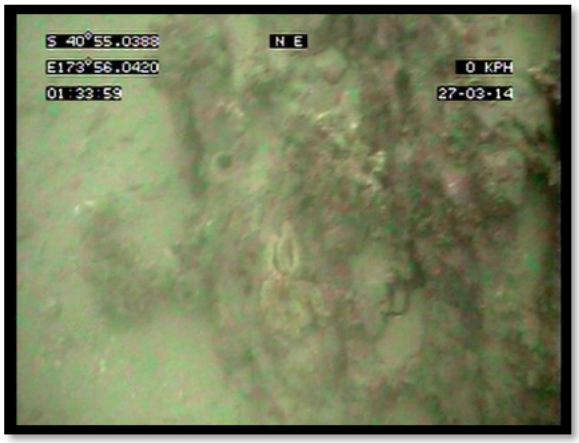


Photo 48



Photo 49



Photo 50



Photo 51

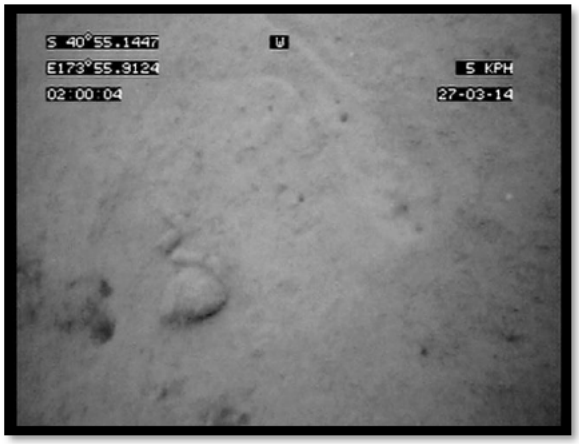


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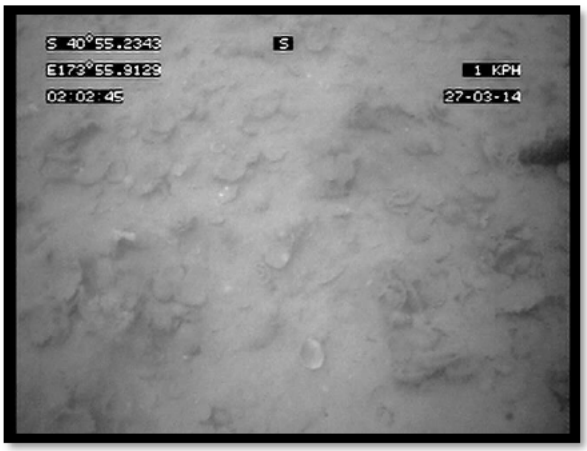


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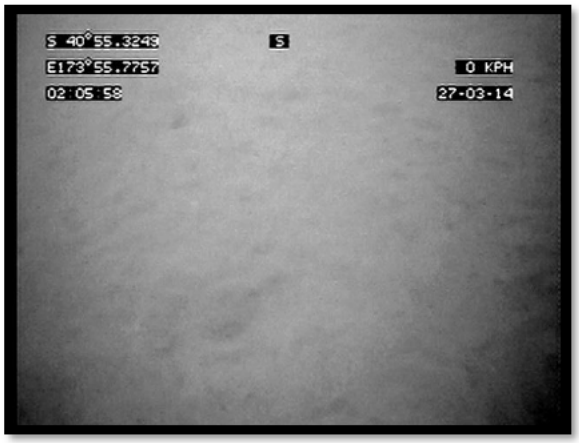


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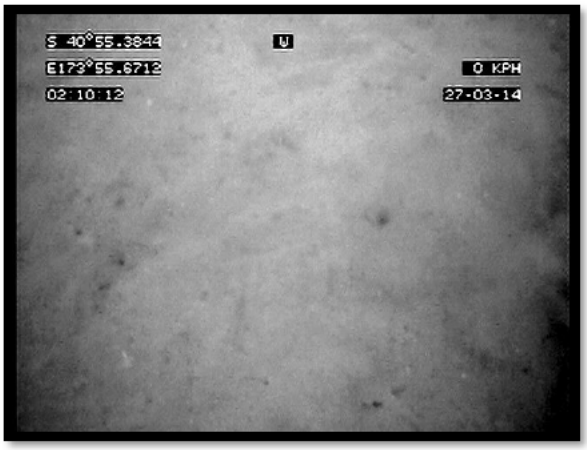


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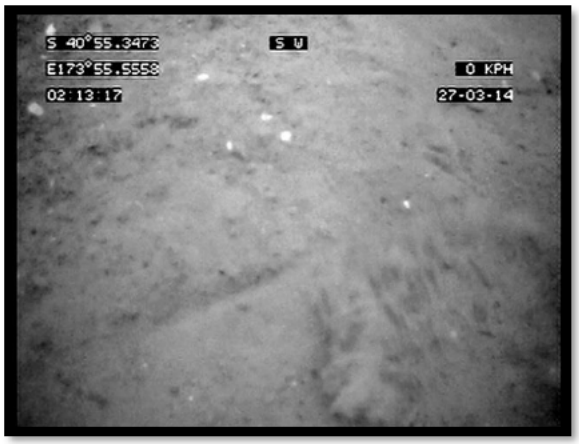


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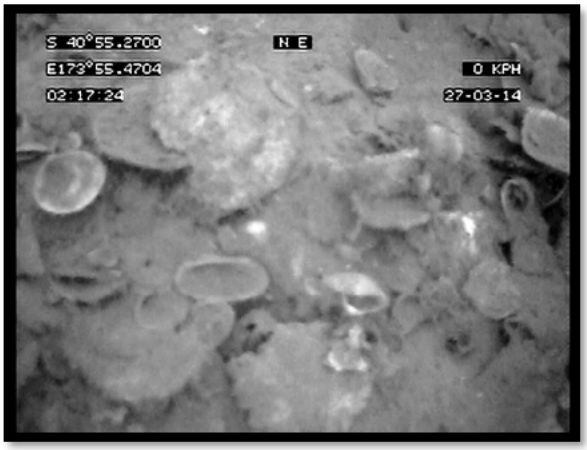


Photo 57



Photo 58



Photo 59



Photo 60



Photo 61

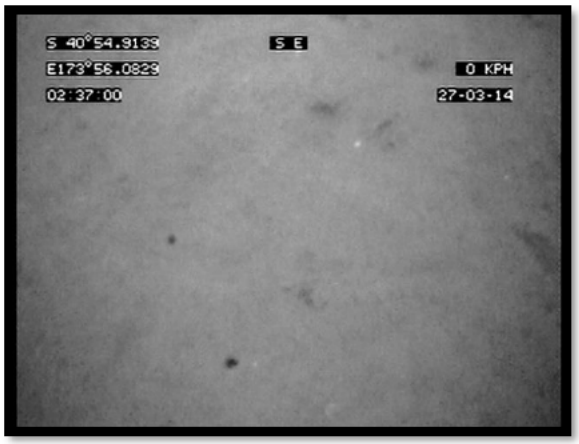


Photo 62



Photo 63

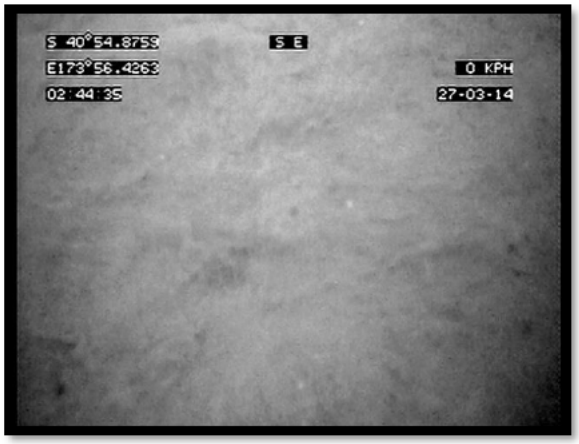


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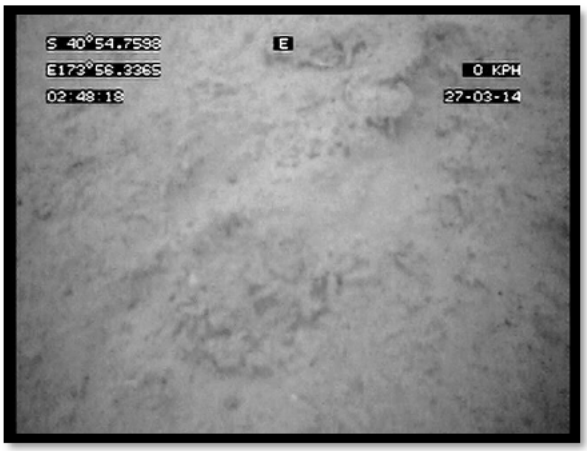


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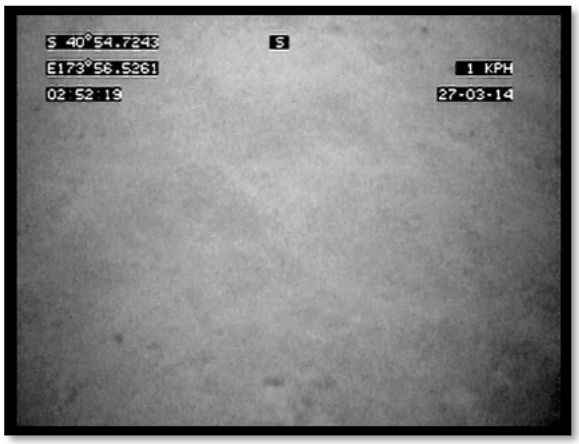


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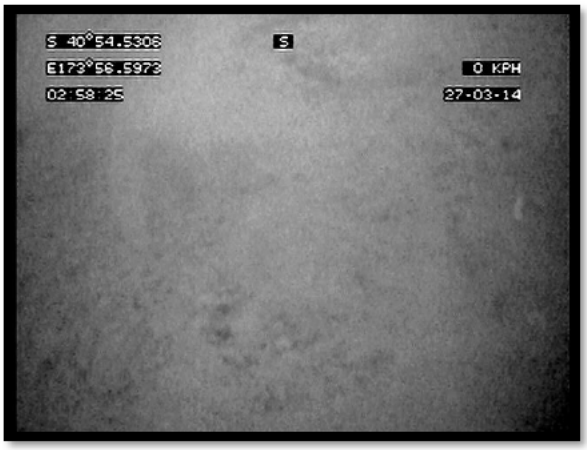


Photo 67



Photo 68



Photo 69



Photo 70



Appendix 1 (cont.) 2021 drop camera photos.

Photo A1

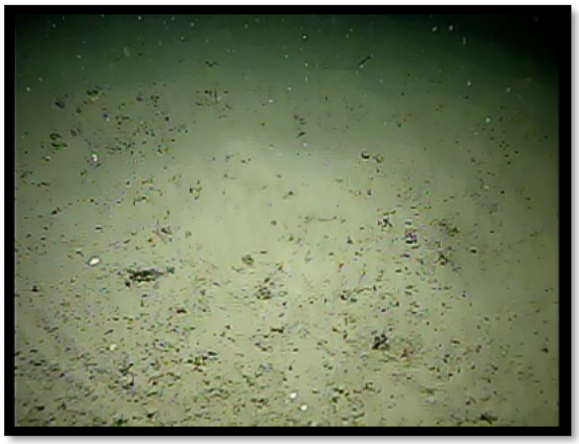


Photo A2



Photo A3



Photo A4



Photo A5



Photo A6



Photo A7



Photo A8

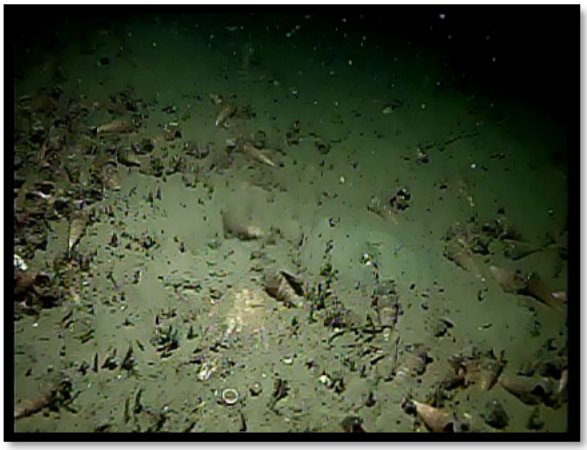


Photo A9



Photo A10

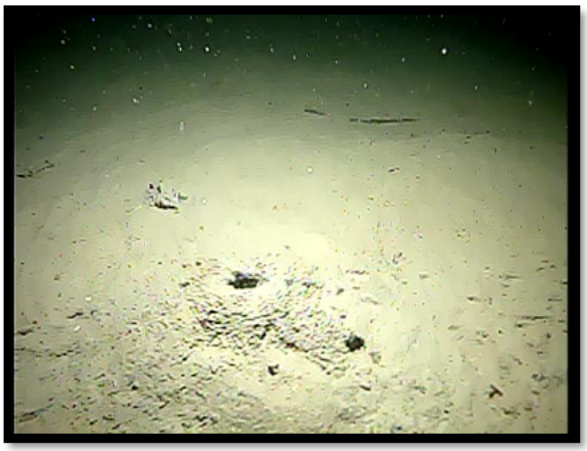


Photo A11

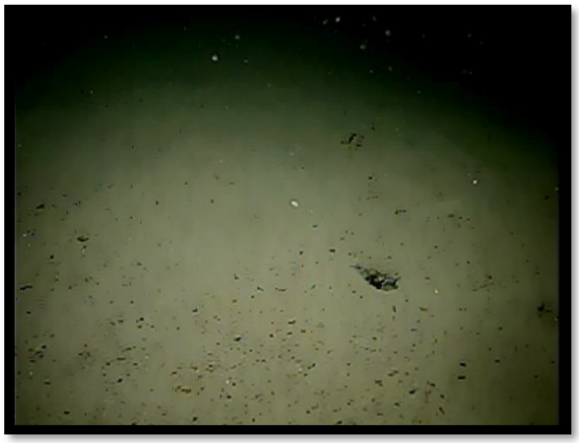


Photo A12

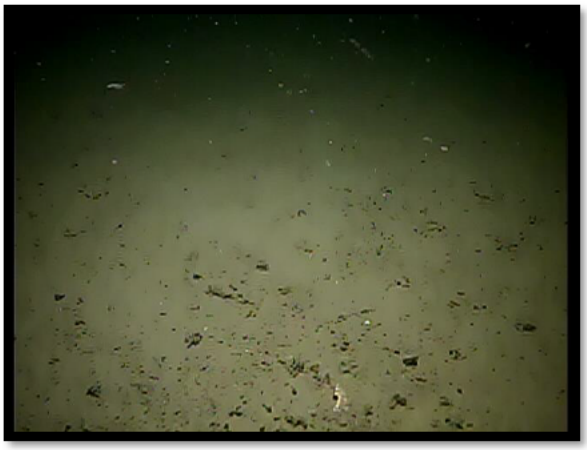


Photo A13



Photo A14

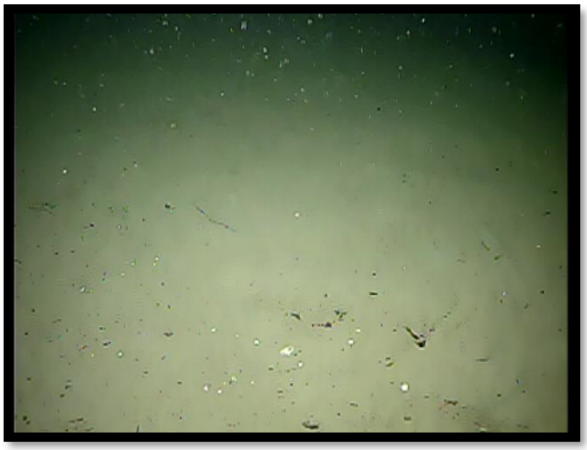


Photo A15

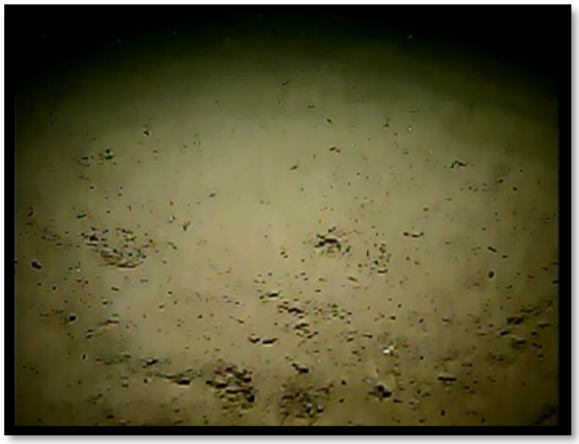
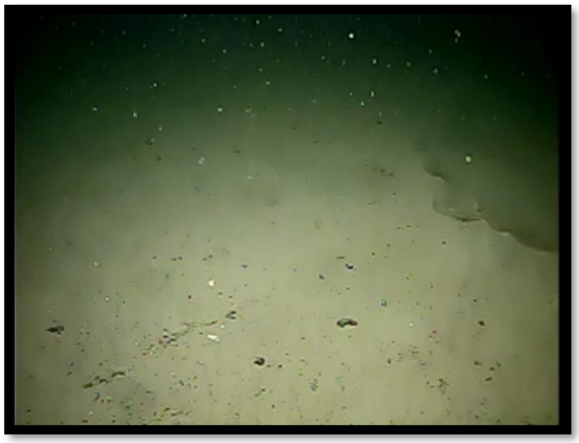


Photo A16



Photo A17



Appendix 2. Infauna.

From 0.1 m^2 Van Veen grab sampler benthic grabs.

Species	Grab01	Grab02	Grab03	Grab04	Grab05	Grab06	Grab07	Grab08	Grab09
	No structures	No structures	No structures	No structures	Under droppers	Under droppers	No structures	No structures	No structures
Aglaophamus sp.	0	0	0	0	0	0	1	0	0
Ampelisca sp.	0	0	0	0	0	0	1	0	0
Ampharetidae	0	0	0	0	2	0	2	0	0
Amphipoda	0	4	18	28	2	8	544	73	0
Anthuridea	0	0	0	0	0	0	6	0	0
Aonides trifida	0	0	0	0	0	0	0	1	0
Aricidea sp.	0	2	0	0	0	0	17	0	0
Armandia maculata	0	0	0	0	1	9	17	0	0
Arthritica bifurca	0	0	0	0	1	0	0	0	0
Asellota	0	0	0	0	0	0	0	0	1
Barantolla lepte	0	0	0	0	1	1	1	0	0
Bivalvia	0	2	0	0	0	0	0	0	0
Bivalvia Unid. (juv)	0	0	0	0	0	0	1	1	0
Brachiopoda	0	0	0	0	0	1	0	0	0
Brachyura indet.	0	0	0	0	0	0	1	0	0
Cadulus teliger	0	4	1	1	0	0	1	6	0
Cirratulidae	1	0	1	0	7	60	24	0	6
Copepoda	0	0	0	1	2	0	0	0	0
Corbula zelandica	0	0	0	0	0	1	2	0	0
Cossura consimilis	0	2	4	0	0	0	2	0	3
Cumacea	5	23	8	10	0	0	8	35	2
Cymbicopia hispida	2	2	2	3	0	1	0	1	1
Cypridinodes reticulata	0	0	1	0	0	0	0	0	0
Cytherella sp.	0	0	0	16	0	0	0	0	0
Decapoda (Juvenile)	0	0	0	0	1	0	0	0	0
Diasterope grisea	0	0	1	0	0	0	0	1	0
Dorvilleidae	0	0	0	0	42	13	0	0	1
Dosinia lambata	0	0	0	0	0	0	0	1	0
Echinocardium cordatum	0	1	1	1	0	0	0	2	0
Echinoidea	0	0	0	0	1	0	0	0	0
Ennucula strangei	2	2	1	1	0	0	0	0	1
Euchone pallida	0	0	0	0	0	27	74	1	0
Euphilomedes agilis	1	6	1	0	0	0	0	0	1
Flabelligeridae	1	1	0	1	0	0	0	1	1
Gastropoda Unid. Juv.	0	0	0	1	0	0	2	0	0
Glyceridae	0	0	0	0	3	1	2	0	0
Goniadidae	0	0	0	0	0	1	0	0	0
Halicarcinus cookii	0	0	0	0	1	0	0	0	0
Hesionidae	0	1	1	0	0	2	0	0	0
Heteromastus filiformis	0	0	0	0	0	7	0	0	0
Heterothyone alba	0	1	0	0	0	0	0	0	0
Hiatella arctica	0	0	0	0	0	1	0	0	0
Ischnochiton maorianus	0	0	0	0	1	0	0	0	0
Leitoscoloplos kerguelensis	0	0	0	0	1	12	0	0	0
Leptochiton inquinatus	0	0	0	0	14	2	0	0	0
Leuroleberis zealandica	0	0	0	0	0	0	0	5	0
Limatula maoria	0	0	1	0	0	0	0	0	0
Lumbrineridae	5	13	4	5	6	11	1	10	3
Lysianassidae	0	1	0	0	0	0	0	0	0
Maldanidae	1	2	0	0	0	0	3	0	0
Melliteryx parva	0	0	0	0	0	0	1	0	0
Munna schauinslandi	0	2	0	0	0	0	0	0	0

Species	Grab01	Grab02	Grab03	Grab04	Grab05	Grab06	Grab07	Grab08	Grab09
	No structures	No structures	No structures	No structures	Under droppers	Under droppers	No structures	No structures	No structures
Mussel Spat	0	0	1	0	0	0	0	0	0
Natatolana pellucida	0	0	0	0	0	8	1	0	0
Neilo australis	0	0	0	1	0	0	0	1	0
Nematoda	0	0	0	55	21	768	213	0	1
Nemertea	0	1	0	0	0	2	3	0	0
Notomastus sp.	0	0	0	0	3	0	1	0	0
Oligochaeta	0	1	0	0	0	27	22	0	0
Onuphis aucklandensis	1	0	0	0	0	0	0	0	0
Ophiuroidea	1	1	0	0	24	0	0	0	0
Osteichthyes	0	0	0	0	2	0	0	0	0
Paguridae	0	0	0	0	0	2	0	0	0
Palaemon sp.	0	0	0	0	1	0	0	0	0
Paramunna serrata	0	0	0	0	0	0	1	0	0
Paraonidae	27	35	21	15	0	2	48	17	45
Paraprionospio coora	0	3	0	1	1	0	3	2	0
Parasterope quadrata	0	0	1	1	0	0	0	0	0
Phoxocephalidae	7	22	18	8	0	3	4	26	13
Phyllodocidae	0	0	0	0	0	0	1	1	0
Pilargidae	0	0	0	0	0	0	1	0	0
Polynoidae	0	0	0	0	1	0	1	0	0
Poroleda lanceolata	0	0	0	0	0	0	0	4	0
Pratulum pulchellum	0	0	0	0	0	0	0	4	0
Prionospio multicristata	3	3	2	1	9	30	8	2	0
Prionospio sp.	0	1	0	0	7	13	40	1	3
Prionospio yuriel	0	0	0	1	0	0	0	0	3
Propontocypris sp.	0	6	1	73	0	0	0	14	2
Pyura sp.	0	0	0	0	0	0	0	1	0
Ruditapes largillierti	0	0	0	0	0	1	0	0	0
Sabellidae	0	0	0	0	0	4	19	0	0
Scalibregma inflatum	0	0	0	0	0	0	1	0	0
Serpulidae	0	0	0	0	0	1	0	0	0
Sigalionidae	0	0	1	0	0	0	0	1	1
Sigapatella sp.	0	1	1	0	2	1	0	1	0
Sigapatella spp.	0	0	0	0	0	0	4	0	0
Sphaerosyllis sp.	0	0	0	1	4	21	46	0	0
Spionidae	0	0	0	0	0	0	1	0	0
Spiophanes sp	0	0	0	0	0	0	1	0	0
Syllidae	0	0	0	0	5	30	32	0	0
Tanaid sp.	0	0	0	0	0	0	0	4	0
Tanaidacea	0	0	0	3	0	0	40	0	0
Tawera spissa	0	0	0	0	0	0	2	0	0
Terebellidae	0	0	0	0	1	0	14	0	1
Terebellides stroemi	0	0	0	0	0	0	13	0	0
Theora lubrica	9	12	2	2	2	0	0	0	1
Thracia sp.	0	0	0	0	0	0	1	0	0
Thyasiridae	0	0	0	0	0	0	2	0	0
Trachyleberis lytteltonensis	7	0	5	21	0	0	0	7	4
Trochodota dendyi	0	0	0	0	1	0	0	0	0
Uromunna schauinslandi	0	0	1	0	0	0	1	0	0
Varinucula gallinacea	1	4	2	0	3	0	0	1	3