Davidson Environmental Limited

Significant marine site survey and monitoring programme (survey 3): Summary report 2016-2017

Research, survey and monitoring report number 859

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Summary

Davidson and Richards (2015) conducted the first survey and monitoring programme of Marlborough's significant marine sites in the summer of 2014 - 2015. Their study focused on sites initially described in Davidson *et al*. (2011). Davidson and Richards (2015) investigated sites located in Queen Charlotte Sound, Tory Channel and Port Gore using protocols detailed in Davidson *et al.* (2013). The second survey was conducted in the outer north-western Sounds and Croisilles Harbour (Davidson and Richards, 2016).

Sites investigated in the present study were in three biogeographic regions: (1) Croisilles Harbour (Tasman Bay biogeographic area); (2) eastern D'Urville Island to Port Gore (Two Bay Point to Cape Jackson biogeographic area); and (3) outer and central Pelorus Sound (Pelorus Sound biogeographic area).

A variety of qualitative and quantitative methods were adopted (Davidson *et al.,* 2013). Methods varied between sites and sub-sites depending on site specific environmental factors and information needs outlined in Davidson *et al.* (2014). As part of the present survey programme, a remote HD video and still photograph GoPro Hero 4 (black) fitted with a filter and macro lens was also used to collect HD media at selected sites.

A total of 10 sites were described during the present study. One site (Titi Island) was split into 3 sub-sites while one site (Rangitoto Islands) was split into four sub-sites. Sub-sites were defined as having comparable habitats and communities, but each sub-site was physically separate. One new sub-site was added to an existing set of three sub-sites at Hunia (Port Gore). In total, 15 sites and sub-sites were investigated in the present study.

Three new sites were investigated and described (6.04 ha). Three sites increased in size by a total of 583.3 ha (Sites 1.2, 2.10 and 2.33). These increases were due to an improvement in the level of detail. Four sites declined in size by a total of 458.9 ha (Sites 2.6, 2.27, 2.30 3.1). Declines were due to a combination of improved information and, in two cases (Sites 2.30 and 2.27), a loss of habitat likely due to physical damage. No existing significant sites were recommended for removal.

Note: Raw data collected during the 2016-2017 season were collated into excel spreadsheets and supplied to MDC for storage (e.g. HD video, photographs). The present report is a therefore a summary and does not include all data collected from sites and sub-sites.

Overall, the area occupied by significant sites investigated in the present study increased by 130.4 hectares between previous studies (Davidson *et al.,* 2011; Davidson and Richards, 2016) and the present survey (Table 1).

This report makes recommendations to the MDC expert review panel in relation to each of the surveyed significant sites. These recommendations may not be adopted by the expert panel; therefore, the status of each site remains pending until they are assessed by the panel (see Davidson *et al.* 2013 for the process).

Marlborough's significant marine sites are likely remnants of larger areas reduced or lost due to historic anthropogenic activities. Davidson and Richards (2015) stated that, based on their 2015 survey, it was clear that some of the remaining significant sites were being degraded or lost. The present study suggests that some significant sites are naturally protected from physical disturbance by natural structures such as rock and reef systems, however, some sites are still vulnerable to damage and loss. Protection of significant sites should therefore be prioritised.

Adult blue cod on biogenic habitat at Titi Island (2017).

Table 1. Summary of sites and sub-sites investigated during the present study and main recommendations.

Attribute	Values
Area based on 2011 and 2015 (ha)	1742.2
Area in 2017 (ha) *	1872.64
Potential new sites*	3
Potential site removed*	0
Increase in area (ha) *	589.34
Decrease in area (ha) *	-458.9
Overall change (ha) *	130.44
Sites	Work conducted/recommendations
Site 1.2 Croisilles Harbour Entrance	Quantitative survey of lancelet abundance to investigate impacts of recreational dredging
Site 2.6 Rangitoto Passage	Adjust boundaries, protect significant sites from all forms of physical disturbance
Site 2.10 Trio Islands (west) (biogenic community)	Adjust boundaries, protect significant sites from all forms of physical disturbance
Site 2.27 Titi Island (biogenic community)	Adjust boundaries, protect significant sites from all forms of physical disturbance
Site 2.30 Waitui Bay (biogenic community)	Adjust boundaries, protect significant sites from all forms of physical disturbance
Site 2.33 Hunia Coast (tubeworms)	Adjust boundaries, protect significant sites from all forms of physical disturbance
Site 3.1 Harris Bay (algae)	Adjust boundaries, protect significant sites from all forms of physical disturbance
Titi Island Rock (biogenic community)	Establish significant site and protect from all forms of disturbance
Bonne Point (rhodolith bed)	Establish significant site and protect from all forms of disturbance
Tawhitinui Bay (king shag)	Establish a new site and establish an approach distance guideline for colony

*Recommended but subject to expert peer review

1.0 Background

The Resource Management Act requires local authorities to monitor the state of the whole or any part of the environment (s35 2(a)). Additional obligations also exist, such as maintaining indigenous biodiversity (s30 1(g)(a)). The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna is a matter of national importance (Section 6(c)).

Since 2010, the Marlborough District Council (MDC) has supported a programme for surveying and assessing marine sites within its region. A key milestone in this programme was the publication of a report identifying and ranking known ecologically significant marine sites in Marlborough (Davidson *et al.* 2011). The assembled group of expert authors developed a set of criteria to assess the relative biological importance of a range of candidate sites. Sites that received a medium or high score were ranked "significant". A total of 129 significant sites were recognised and described during that process.

The authors stated their assessment of significance was based on existing data or information, but was not complete. Many marine areas had not been surveyed or the information available was incomplete or limited. The authors stated that ecologically significant marine sites would exist, but remain unknown until discovered. In addition, some significant sites were assessed on limited information. Further, some existing sites required more investigation to confirm their status. The authors also stated that many sites not assessed as being significant had the potential to be ranked at a higher level in the future as more information became available. They also recognised the quality of some existing significant sites may decline over time due to natural or human related events or activities. The authors therefore acknowledged that their report had limitations and would require updating on a regular basis.

Two subsequent reports were produced. Davidson *et al.* (2013) produced a protocol for receiving information for new candidate sites and for reassessing existing ecologically significant marine sites. The aims of that report were to ensure a rigorous and consistent process that establishes:

(1) The level of information required for new candidate sites.
(2) The process for assessment of new sites and reassessment of existing sites.

(3) A protocol for record keeping, selection of experts and publication of an updated ecologically significant marine sites report.

Davidson *et al*. (2014) provided a report outlining "guidance on how to continue a survey and monitoring programme for ecologically significant marine areas in Marlborough and to assist with the management and overarching design of such work to optimise the collection of biological information within resource limitations".

The Davidson *et al.* (2014) report had the following objectives:

(1) Provide survey and monitoring options for MDC to consider based on different levels and types of investigation (e.g. health checks, regular monitoring, surveys of new sites, and surveys to fill information gaps at existing sites).
(2) Prioritisation of survey and monitoring based on factors such as ecological distinctiveness, rarity and representativeness, as well as vulnerability, issues and threats to marine values.
(3) Recommend a simple, robust, and repeatable methodology that enables site health to be monitored and assessed.
(4) Provide guidance on the assessment of a site's health that can be conveyed to Council and the community in a simple but effective way that will aid tracking of changes in site condition.

In particular, Davidson *et al.* (2014) aimed to add to the ecologically significant marine sites programme by providing guidance for the collection, storage and publication of biophysical data from potential new significant sites as well as existing sites. The biological investigation process was separated into three main elements:

(1) Survey of new sites;
(2) Collection of additional information from existing significant sites or sites that previously were not ranked as being ecologically significant; and
(3) Status monitoring of existing significant sites (i.e. site health checks).

1.1 Field survey 1 and expert peer review

Davidson and Richards (2015) undertook the first survey following the protocols outlined in Davidson *et al.* (2013, 2014). The authors focused on selected sites detailed in Davidson *et al.* (2014) in Queen Charlotte Sound, Tory Channel and Port Gore. These areas were selected by a joint MDC/DOC monitoring steering group that also considered advice from Davidson

Environmental Ltd. At the time, it was agreed that the work should focus on biogenic habitats because of their biological importance (e.g. substratum stabilisation, increase biodiversity, juvenile fish habitats, food sources). Biogenic habitats were also prioritised as they have a history of being adversely affected by a variety of anthropogenic activities (Bradstock & Gordon 1983, Morrison 2014).

The work presented by Davidson and Richards (2015) was then reviewed by the experts review panel and their findings produced in Davidson *et al*. (2016). Davidson *et al.* (2016) stated: "The expert panel was reconvened to reassess the new information for the 21 sites and sub-sites outlined in Davidson and Richards (2015). The review report presents the findings of that reassessment. It also comments on issues associated with physical disturbance of significant sites supporting benthic biological values and appropriate management categories for the protection of those values."

The expert panel also made alterations to some of the seven criteria originally used to assess significant sites as developed by Davidson *et al*. (2011).

The Panel's overall findings recommended that:

(1) three sites be removed from the list of significant sites due to the loss or significant degradation of biological values (Hitaua Bay Estuary, Port Gore (central) horse mussel bed and Ship Cove).

(2) the offshore site located north of Motuara Island be removed and replaced with a small area located around a rocky reef structure.

(3) adjustment to the boundaries of most of the remaining significant sites in accordance with the recommendations of Davidson and Richards (2015).

Based on the removal of the three sites and several boundary adjustments, a total of 1544 ha was removed and 113.8 ha added at the significant site level. The overall change between that recorded in 2011 and 2015 was a loss of 1430.8 ha of significant sites.

1.2 Field survey 2 and expert peer review

Prior to the 2015-2016 field work season, a report outlining potential or candidate sites for survey and/or monitoring was produced (Davidson, 2016). That report was used to guide the selection of sites surveyed and described in the second field survey report by Davidson and Richards (2016).

Davidson and Richards (2016) reported on a total 15 sites and sub-sites. The authors suggested that five sites and sub-sites be increased in size (178.4 ha total), while eight sites and sub-sites be reduced (-214.6 ha). One site remained unchanged between surveys (Hunia king shag colony). A new site was also described at Lone Rock, Croisilles Harbour (rhodoliths bed = 4.68 ha). Penguin Island (suggested Site 2.37) was initially described by Davidson *et al*. (2011) as part of a larger site (Site 2.12) and was not therefore recorded as an increase. This site was resurveyed as it supported a different range of habitats and communities compared to the original larger site (2.12). The remaining sites and sub-sites increased or declined in size due to an improved level of survey detail. No sites were identified as no longer supporting significant values.

The Davidson and Richards (2016) report was reviewed by the MDC expert peer review panel (Davidson *et al*., 2016). The expert peer review panel accepted all but one boundary modification proposed by Davidson and Richards (2016). The panel recommended that the Chetwode significant site (2.20) remain unchanged and only be enlarged when further data were collected to support an increase in size.

The review panel also suggest one change to the Davidson *et al*. (2011) criteria. Criteria 7 (adjacent catchment modification) was amended to include a “not applicable” option in recognition of sites located in areas little influenced by catchment effects.

The new rank is: **NA = The site is little influenced or is not influenced by catchment effects.**

The reviewed boundary refinements suggested by Davidson and Richards (2016) lead to both increases and decreases to the size of individual significant sites and an overall decline of 262.6 ha between 2011 and 2016.

For each significant site, the expert peer review panel assessed anthropogenic threats based on (1) the level of anthropogenic disturbance and (2) the site’s vulnerability (Table 2). This assessment was based on the review panel’s knowledge of the biophysical characteristics of each significant site (e.g. personal knowledge and/or from the literature).

Similar approaches have been adopted by Halpern *et al.* (2007) and further adapted for the assessment of New Zealand’s marine environment by MacDiarmid *et al.* (2012). Robertson and Stevens (2012) described an ecological vulnerability assessment (originally developed by UNESCO (2000)) for use at estuarine sites in Tasman and Golden Bays. The UNESCO methodology was designed to be used by experts to represent how coastline ecosystems were likely to react to the effects of potential "stressors".

Anthropogenic disturbance is the known or expected (based on experts' experience) level of impact associated with human-related activities. Disturbance levels range from little or no disturbance (low score) to sites regularly subjected to disturbance (high score). Impacts range from direct physical disturbance to indirect effects, including from the adjacent catchments.

Vulnerability is the sensitivity of habitats, species and communities to disturbance and damage. Scores ranged from relatively robust species or habitats such as coarse substrate/mobile shores and high energy kelp forests (low vulnerability score) to extremely sensitive biological features such as lace corals and brittle tubeworm mounds (high vulnerability score).

Table 2. Selected environmental variables used to assess the vulnerability of significant sites to benthic damage from physical disturbance.

Variables	Descriptions, definitions and examples
Anthropogenic disturbance level	
Low	Little or no known human associated impacts. Catchement effects low (i.e. vegetated, stable catchments)
Moderate	Light equipment and/or anchoring disturbance. Well managed catchment.
High	Subjected to regular and heavy equipment seabed disturbance, and/or catchments effects high due to modification or poor management.
Vulnerability	
Resilient (low or unlikely)	Algae forest, coarse substrata, moderate or high energy reefs, high energy shore, short-lived species.
Sensitive (moderate)	Horse mussels, soft tubeworms, shellfish beds, red algae bed, low current (sheltered reefs).
Very sensitive (high)	Massive bryozoans, sponges, hydroids, burrowing anemone.
Extremely sensitive (very high)	Lace or fragile bryozoans, tubeworm mounds, rhodoliths.

2.0 Study sites (present study)

All sites and sub-sites investigated during the present study were in three recognised biogeographic regions: (1) Croisilles Harbour and southern D'Urville Island (Tasman Bay biogeographic area), (2) eastern D'Urville Island to Chetwode Islands (Two Bay Point to Cape Jackson biogeographic area), and (3) Pelorus Sound (Pelorus Sound biogeographic area) (Figure 1, Table 3).

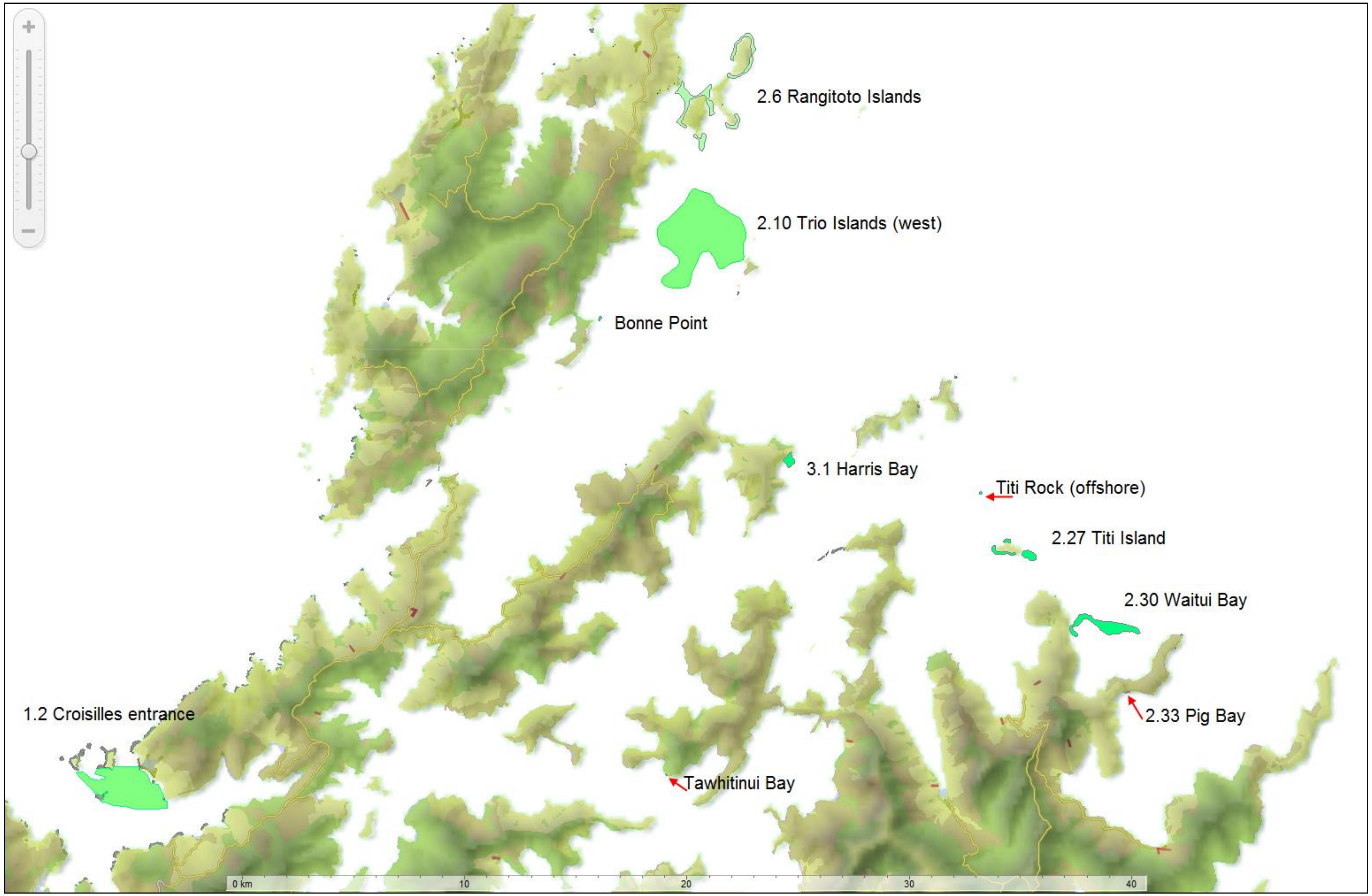

Figure 1. Location of sites and sub-sites investigated in the present study.

3.0 Methods

A variety of standard survey methods were adopted to investigate sites. Different survey methods were used at each site depending on the level of survey required (i.e. survey or monitoring) and the environmental variables at each site (e.g. depth, currents, water clarity).

3.1 Sonar imaging

Sonar investigations were conducted using a Lowrance HDS-12 Gen 2 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™, and were linked to a Point 1 Lowrance GPS Receiver. The unit also allows real time plotting of StructureMap™ overlays onto the installed Platinum NZ underwater chart. A Lowrance HDS 10 Gen 1 unit fitted with a high definition Airmar 1KW transducer was used to collect traditional sonar data from the site. Sonar data were converted into a Google Earth file to overlay onto Google Earth imagery.

3.2 Drop camera stations and site depths

At each drop camera station, a low-resolution Sea Viewer underwater splash camera fixed to an aluminium frame was lowered to the benthos and an oblique still photograph was taken where the frame landed. The locations of photograph stations were selected to obtain a representative range of habitats and targeted any features of interest observed from sonar (e.g. reef structures, cobbles). On many occasions, the survey vessel was allowed to drift for short periods while the benthos was observed on the remote monitor. Field notes were collected and appended to the relevant data spreadsheet.

3.3 Percentage cover estimation

The percentage cover of biological features (e.g. rhodoliths, macroalgae, biogenic clumps) from GPS-positioned drop camera images were estimated both in the field by the boat observer and in the laboratory on the computer screen. Percentage cover was estimated into 5% class intervals by the same trained recorder at all sites and for all images to ensure consistency. All photo images were numbered and coded to a GPS position, depth and a percentage cover score.

3.4 Underwater HD video and still photographs

HD underwater video was collected using a remote GoPro Hero 4 (black) mounted on a purpose-built frame and tripod. The camera also collected HD still photographs at 5 second intervals. The GoPro was fitted with a magenta filter and a macro-lens that were intermittently used to improve video resolution and improved colour representation in certain light and water conditions.

When the GoPro was lowered to the benthos, the survey vessel was allowed to move in a controlled fashion across a selected area. Video footage and photos were collected by allowing the camera to settle on the benthos and then intermittently moved across the benthos. The area selected for investigation was based on findings from the low-resolution camera and sonar data. The start and end GPS positions for video footage were recorded.

3.5 Surface photos

A representative surface photo was collected from most sites using a Samsung S6 in panoramic mode. Selected surface photos have been included in the Excel spreadsheets, while all photos collected are held on the MDC database.

3.6 Core sampling

Core samples were haphazardly collected from Croisilles Harbour Entrance (Site 1.2) by divers using a 13 cm diameter by 15 cm deep corer. Cores were sorted on board the survey vessel and lancelets within each core were counted.

3.7 Excel site sheets and data

Data collected from each site during the present study were entered into a predesigned Excel template. Data sheets include a summary page and several other pages comprising data, maps, photos, sonar images and sample coordinates. A complete set of data for each site is stored on the MDC database. The spreadsheets also outline other data types that have been stored at MDC for each site (e.g. video clips).

3.8 Ranking

No assessment or ranking of sites was carried out during the present investigation. Recommendations for each site are, however, included in page 1 of the Excel site sheets. It is expected that the expert review panel will conduct a ranking exercise based on the findings and recommendations of the present report.

4.0 Results and recommended changes

Survey data from the 2016-2017 survey are summarised in the present report. Detailed data (maps, photos, video, sonar) are either produced or listed in separate Excel spreadsheets. All media, raw data and spreadsheets have been supplied to MDC to be stored in an MDC database. The present report should therefore be regarded as a summary or front end to all the raw data and the summary spreadsheets.

4.1 Site and sub-site changes

Ten sites were investigated (Table 3). All sites are discussed in full in section 4.5. One site (Titi Island) was split into 3 sub-sites while one site (Rangitoto Islands) was split into four sub-sites. Sub-sites were defined as having comparable habitats and communities, but each sub-site was physically separate. One new sub-site was added to an existing set of three sub-sites at Hunia (Port Gore). In total, 15 sites and sub-sites were investigated and described in the present study. Of the 15 sites and sub-sites, approximately half were based on existing significant sites/sub-sites first identified in Davidson *et al.* (2011) or Davidson and Richards (2015).

Based on data collected during the present study, it is recommended that:

(A) Site 1.2 Croisilles Entrance: update excel spreadsheet with lancelet quantitative data.

(B) Site 2.6 Rangitoto Islands: adjust site boundaries and establish four sub-sites around biogenic communities.

(C) Site 2.10 Trio Islands west: update boundary to encompass biogenic communities.

(D) Site 2.27 Titi Islands: update boundaries and establish three sub-sites around biogenic commuities.

(E) Site 2.30 Waitui Bay: update boundary to encompass biogenic community.

(F) Site 2.33 Hunia coast, Pig Bay: add new sub-site around tubeworm bed.

(G) Site 3.1 Harris Bay: update red algae boundary.

(H) New site Titi Island offshore rock: establish a new site around deep rock.

(I) New site Bonne Point: establish new site to encompass rhodolith bed.

(J) New site Tawhitinui Bay: establish new site around a king shag breeding colony.

4.2 Size change since 2011 report

Three new candidate sites were described totalling 6.04 ha. Three existing significant sites increased in size by a total of 583.3 ha (Sites 1.2, 2.10 and 2.33); these increases were due to an improvement in the level of detail. Four sites declined in size by a total of 458.9 ha (Sites 2.6, 2.27, 2.30 3.1). Declines were due to a combination of improved information and, in two cases (Site 2.30 Waitui Bay, Site 2.27 Titi Island), loss of habitat likely due to physical damage (Table 3).

4.3 Substratum

Most sites and sub-sites were located on soft substratum, while three were combinations of soft and rocky substratum (Table 3). Significant sites located on soft substratum are considered the most threatened biogenic habitat type as they are vulnerable to anthropogenic physical damage and are also vulnerable to sediment smothering. Based on this knowledge, the present survey prioritised soft sediment significant sites.

4.4 Habitats and their biological importance

The present survey focussed on soft sediment communities. In addition, one site supported an uncommon benthos type with a species of scientific interest (i.e. Site 1.2 Croisilles Harbour entrance) and one site was dominated by a current-swept rock.

Most sites investigated supported biogenic community types (e.g. bryozoans, sponges, ascidians, hydroids). This community type is often fragile, slow growing and has been reduced in extent and quality world-wide (Airoldi and Beck, 2007).

Biogenic mounds

Numerous studies have highlighted the importance of biogenic structure. Kuti *et al*. (2014) reported that complex habitats such as coral reefs attracted many times the abundance of reef fish compared to simpler habitat types. DeSmet *et al*. (2015) reported that biogenic reefs composed of the tube-building polychaete *Lanice conchilega* noticeably increased the biodiversity in otherwise species poor environments. Rabaut *et al.* (2010) reported that biogenic tubeworm structures were important to juvenile flatfish.

The ecological functions provided by biogenic habitats are diverse and can include the elevation of biodiversity, bentho-pelagic coupling, sediment baffling, protection from erosion, nutrient recycling, the provision of shelter and food for a wide range of other organisms, and even the creation of geological features over longer time scales (Bradstock and Gordon 1983; Turner *et al*., 1999; Carbines and Cole, 2009; Wood *et al*., 2012; Morrison *et al*., 2014). Morrison *et al*. (2014) stated a range of biogenic habitats also directly underpin fisheries production for a range of species through: 1) the provision of shelter from predation; 2) the provision of associated prey species; and, in some cases, 3) the provision of surfaces for reproductive purposes e.g. the laying of elasmobranch egg cases; as well as, 4) indirectly in the case of primary producers through trophic pathways.

Red algae

Red algae beds can be productive. For example, Everett (1994) reported that the increased abundance of small deposit-feeding fauna was likely a result of an increase in food resources due to *in situ* burial and decomposition of macroalgae. The author also stated macroalgae can play an important functional role in structuring benthic faunal assemblages.

Table 3. Summary of sites and sub-sites surveyed in 2017 including recommended changes and the suggested reason for site changes.

Site	Sites/subsites 2011	Sites/subsites 2015	Candidate sites/subsites 2017	Original (ha)	Recommended (ha)	Change (ha)
Site 1.2 Croisilles Harbour Entrance (habitat & lancelet)	1		1	368.5	492	123.5
Site 2.6 Rangitoto Islands (biogenic community)	1		4	429.8	168.5	261.3
Site 2.10 Trio Islands (west) (biogenic community)	1		1	558.5	1017.3	458.8
Site 2.27 Titi Island (biogenic community)	1		3	52.5	38.1	14.4
Site 2.30 Waitui Bay (biogenic community)	1		1	294.9	112.8	182.1
Site 2.33 Hunia Coast (tubeworms)		3	1	17.5	18.5	1
Site 3.1 Harris Bay (algae)	1		1	20.5	19.4	1.1
Titi Island Rock (biogenic community)			1	0	1.2	1.2
Bonne Point (rhodolith bed)			1	0	4.68	4.68
Tawhitinui Bay (king shag)			1	0	0.16	0.16
Totals	**6**	**3**	**15**	**1742.2**	**1872.64**	**130.44**
Increase to significant sites						589.34
Decrease to significant sites						-458.9

4.5 Significant sites

4.5.1 Site 1.2 Croisilles Harbour Entrance (habitat and lancelet)

New information on the lancelet density was collected over a wide area of the significant site. No change to the size or boundaries of this site are suggested, however, new data supports the significant site.

The shallow Croisilles Harbour entrance supports three main soft substratum habitat types: (1) rippled mobile sand and shell, (2) medium sand, fine sand and shell, and (3) silt (Davidson and Richards, 2016). The authors recorded one patch of sparse cobbles at a central location during their survey, suggesting this shallow habitat area may have an underlying base of cobble material.

The site is notable as a distinct shallow substrata habitat as well as supporting lancelet (Davidson and Richards, 2016) (Plate 1). Davidson and Duffy (1992) sampled one site and recorded a mean of 450 individual lancelets per m^2. Davidson and Richards (2016) resampled that site with four replicate cores (mobile rippled sand and shell substratum). The mean density was 1315 individuals per m^2 (SE = 422.4) (Table 4). The authors stated this substratum type (Plate 1) covers at least 250 ha of the Harbour. Further, they noted no other lancelet density measurements exist at this significant site and it remained unknown if recreational dredging has impacted on this species.

During the scallop season, dredging by recreational fishers is regularly observed in this area. The authors and the expert peer review panel recommended a widespread quantitative survey of lancelet abundance and distribution be conducted at this significant site with the aim of documenting its distribution and abundance and to investigate if recreational dredging of the site is impacting this species.

Table 4. Density of lancelet from four repliocate cores collected by Davidson and Richards (2016) from mobile rippled sand and shell substratum in Croisilles Harbour Entance (24/2/2016).

Core number	Depth (m)	Number of lancelet per core	Density m^2
1	5.5	10	565.9
2	6	39	2206.9
3	6.5	11	622.5
4	5.5	33	1867.4
Mean	5.9	23.25	1315.7
SD	0.48	14.93	844.9
Number cores	4	4	4
SE	0.24	7.47	422.4

During the present survey, seven new sites were core sampled (Figure 2). At each site, one core sample was collected from a haphazard location on the benthos. The benthic core contents were sieved through a 2 mm mesh sieve and the number of lancelets counted.

Densities ranged from 0 to 1132 individuals per m^2 in February 2017 (Table 5). In February 2016, densities at ranged from 565 to 1867 individuals per m^2 at replicate samples collected from one site (Table 4). In 2017, lancelet densities varied from site to site. Sites closest to the entrance supported the lowest numbers of individuals. At these sites, the substratum was influenced by components of cobbles and sorted sands. It is probable that tidal flows associated with the entrance alter the substratum making the habitat less suitable for lancelets.

Records of lancelet exist from a small number of other sites in the Croisilles Harbour, Tasman and Golden Bays, as well as some sites elsewhere in the Sounds (n=9 sites in total) (Table 5a). With time, it is probable they will be discovered in new locations; however, the present site is by far the largest known.

Anthropogenic activities are a regular occurrence in the area and are mostly related to recreational scallop dredging during the scallop season (Table 6). Recreational dredges are light and generally travel over the surface of the substratum and likely have a minimal impact on species like lancelets living below the surface as evidenced by a wide distribution of this species at this location.

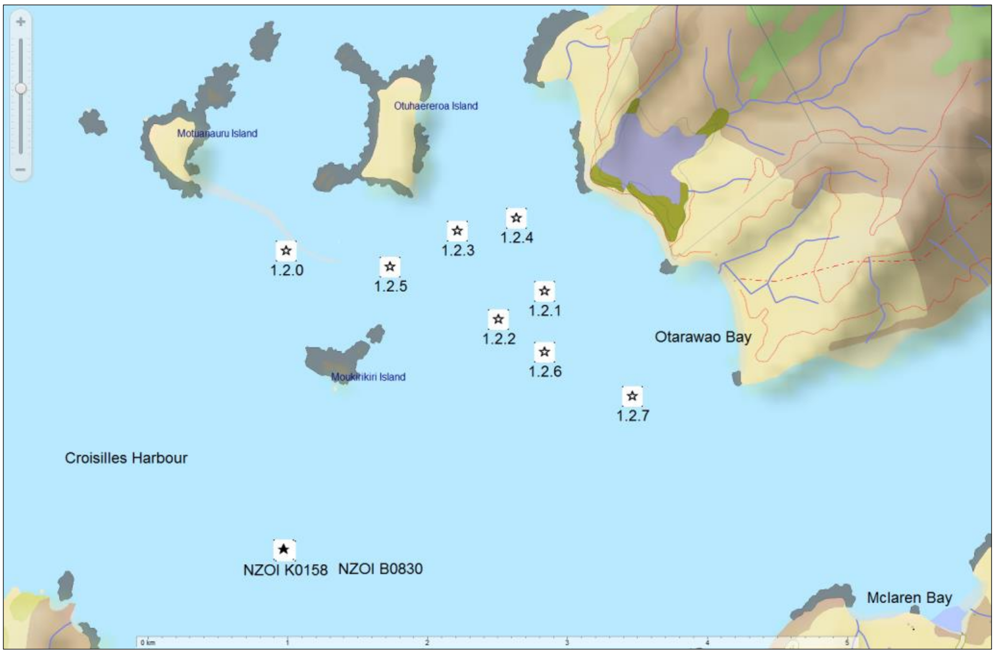

Figure 2. Location of lancelet cores collected in 2016 (Station 1.2.0) and 2017 (Station 1.2.1 to 1.2.7).

Table 5. Lancelet sample site data (top = present study), (bottom = historic records).

Coordinates	Depth (m)	Density per m^2	Site no.	Company	Sample date	Area	Substratum
41 03.035,173 40.322	4.3	283	1.2.1	Davidson Environmental	25 February 2017	Croisilles Harbour	Sandy dead whole and broken shell
41 03.143,173 40.089	5.9	226	1.2.2	Davidson Environmental	25 February 2017	Croisilles Harbour	Sandy dead whole and broken shell
41 02.804,173 39.874	3.6	57	1.2.3	Davidson Environmental	25 February 2017	Croisilles Harbour	Cobbles, sandy dead whole and broken shell
41 02.751,173 40.174	2.5	0	1.2.4	Davidson Environmental	25 February 2017	Croisilles Harbour	Sandy (very little shell)
41 02.945,173 39.533	5.8	57	1.2.5	Davidson Environmental	25 February 2017	Croisilles Harbour	Sandy dead whole and broken shell
41 03.269,173 40.326	7	736	1.2.6	Davidson Environmental	25 February 2017	Croisilles Harbour	Sandy dead whole and broken shell
41 03.437,173 40.773	6.1	1132	1.2.7	Davidson Environmental	25 February 2017	Croisilles Harbour	Sandy dead whole and broken shell
41 02.88624,173 39.00250	6	1315	1.2.0	Davidson Environmental	24 February 2016	Croisilles Harbour	Sandy dead whole and broken shell

Table 5a. Records of lancelets from northern South Island (from Te Papa).

Coordinates	No Specimens	Depth	Station	Collected By	Col. Date	Location	Locality
40 49.500, 173 00.500	15	6	BS 522	RV Acheron	8-Mar-76	Totaranui Bay, Golden Bay	Totaranui Bay, Golden Bay
40 53.000, 173 03.500	1	4	BS 538	RV Acheron	11-Mar-76	Tasman Bay	Tasman Bay
40 53.000, 173 54.000	1	40	BS 540	RV Acheron	11-Mar-76	Catherine Cove, Admiralty Bay, Pelorus Sound	Catherine Cove, Admiralty Bay, Pelorus Sound
41 13.700, 173 17.400	12	14	NZOI K0109	New Zealand Oceanographic Institute	2-Mar-71	Tasman Bay; off Nelson Haven/Boulder Bank	Tasman Bay; off Nelson Haven/Boulder Bank
41 08.900, 173 13.050	1	55	VUZ A32	Victoria University of Wellington	13-Dec-66	Queen Charlotte Sound, Marlborough Sounds	Queen Charlotte Sound, Marlborough Sounds
41 13.700, 173 17.400	1	14	NZOI K0109	New Zealand Oceanographic Institute	2-Mar-71	Tasman Bay; off Nelson Haven/Boulder Bank	Tasman Bay; off Nelson Haven/Boulder Bank
41 04.045, 173 39.010	43	17	NZOI K0158	New Zealand Oceanographic Institute	6-Apr-71	Croisilles Harbour; outer NW Marlbourough Sounds	Croisilles Harbour; outer NW Marlbourough Sounds
41 04.040, 173 39.000	27		NZOI B0830	New Zealand Oceanographic Institute	10-Mar-63	Crosilles Harbour; Nth of Okiwi Bay	Crosilles Harbour; Nth of Okiwi Bay
40 51.000, 173 02.000	3	13	NZOI B0825	New Zealand Oceanographic Institute	10-Mar-63	Awaroa Bay, Abel Tasman National Park	Awaroa Bay, Abel Tasman National Park

Plate 1. Substratum typical of sites where lancelets were collected in Croisilles Harbour Entrance (Site 1.2). Red arrow = lancelet individual.

Table 6. Assessment of anthropogenic impacts for Site 1.2 (Croisilles Harbour Entrance).

Original area of significant site (ha)	492
Recommended area of site (ha)	492
Change to original site	No change
Change (ha)	0
Percentage change from original (%)	0
Human Use	High (recreational dredging frequent event during scallop season).
Vulnerability	Low (dredging has occurred historically, it is probable the benthos has been modified). Recreational dredging does not appear to impact lancelets.
Impact observed	No dredge tracks noted during survey. Area was closed for 2017 season.

4.5.2 Site 2.6 Rangitoto Islands (biogenic communities)

This current-swept group of four sub-sites is located around the Rangitoto Islands and includes a submerged ridge extending from Tinui Island (southern-most Rangitoto Island) across to D'Urville Island (Figure 3). The current-swept submerged ridge sub-site was dominated by low-lying sponge, anemone, ascidian and bryozoan colonies (Davidson and Richards, 2016) (Plate 2). Davidson and Richards (2016) also reported bryozoan-dominated biogenic structures at the north-western end of Wakaterepapanui Island (site 2.6) (Plate 3). The present survey is a continuation of the initial survey by Davidson and Richards (2016) around the edges of the Rangitoto Islands (Figure 2).

The present study discovered biogenic structures of variable percentage covers and composition from new areas around the Rangitoto Islands (Figure 2). For sites that supported biogenic habitats, the estimated mean percentage cover was 25.6 % ($^{+}$/- 2.7 s.e.). These new sites were mapped and described. The new sites are located along the eastern shore of Wakaterepapanui Island and the south-eastern tips of Puangiangi and Tinui Islands. Sites supported benthic communities dominated by variable densities of upright biogenic clumps composed of bryozoans, sponges, ascidians and hydroids (Plates 3 and 4). In particular, the north-western biogenic habitat is considered the best of its kind in the Marlborough Sounds (Plate 3).

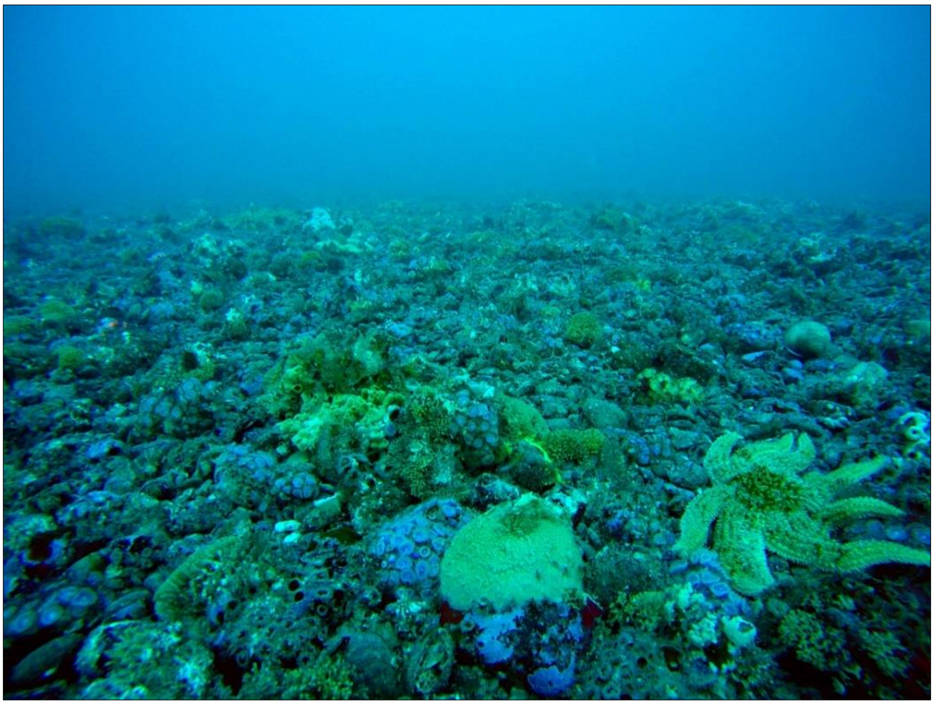

Plate 2. Biogenic community located on cobble substratum on a submerged ridge between Tinui and D'Urville Islands.

Plate 3. Biogenic community located on soft substratum at the north-western end of Wakaterepapanui Island.

Plate 4. Biogenic benthic community and blue cod located on rocky substratum at the north-eastern end of Wakaterepapanui Island.

Based on data collected in the present study, it is recommended the original Rangitoto site outlined in Davidson *et al.* (2011) and Davidson and Richards (2016) be amended and renamed as sub-sites 2.6a (83.4 ha), 2.6b (50.1 ha), 4.6c (15.1 ha) and 4.6d (19.9 ha) (Figure 3). If these sites are approved, the total area around the Rangitoto Islands would be 168.5 ha. Overall, the area has declined in size from that originally described in Davidson *et al*. (2011), due to improved data and accuracy rather than a documented decline in habitat quality or extent.

Anthropogenic issues

Commercial trawlers periodically trawl the Rangitoto Passage. The frequency and detailed location where this activity occurs is not publicly available. Biogenic communities located along the north-western side of Wakaterepapanui Island are extremely vulnerable to physical disturbance because they are located on a base of soft substratum. Biogenic habitats around the edges of the Islands and on the subtidal ridge located between Tinui and D'Urville Island are also dominated by fragile communities, vulnerable to physical disturbance, but their recovery rates would likely be shorter compared to the north-western area (Table 7). It is recommended that all suggested sub-sites be protected from all physical disturbance.

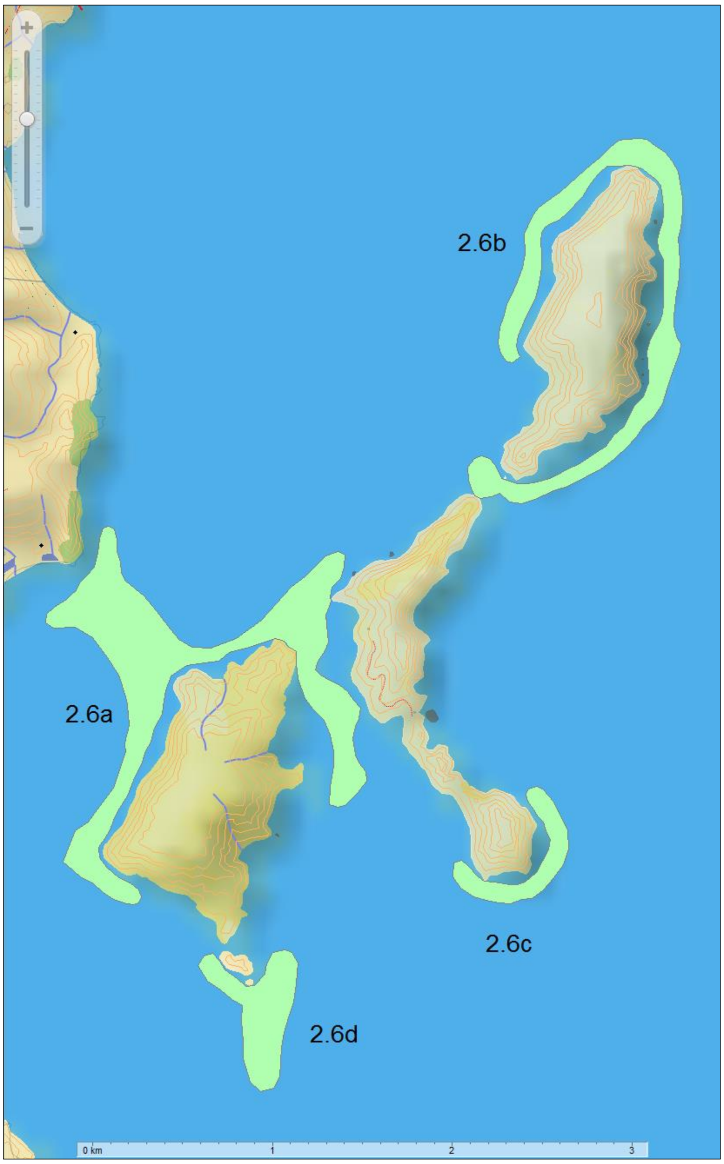

Figure 3. Suggested significant sub-sites 2.6 a-d (green) around the Rangitoto Islands (green).

Table 7. Assessment of anthropogenic impacts for Site 2.6 a-d (Rangitoto Islands).

Original area of significant site (ha)	429.8
Recommended area of site (ha)	158.6
Change to original site	Decrease
Change (ha)	271.2
Percentage change from original (%)	-63.1
Human Use	Moderate (commercial trawling periodically occurs).
Vulnerability	High (biogenic communities are fragile and slow to recover from physical disturbance)
Impact observed	Commercial trawling is known to periodically occur in the area.

4.5.3 Site 2.10 Trio Islands (west) (biogenic communities)

The Trio Islands are located offshore of the eastern coast of D'Urville Island (Figure 4). The survey area is located to the west of the Trio Islands in an area dominated by soft substrata ranging from approximately 24 to 32 m depth. The area appears to be swept by light to moderate tidal currents, however, no flow data currently exists.

This site was originally one part of a two-part site located in offshore areas east and west of the Trio Islands (Davidson *et al.,* 2011). The present survey provided a better resolution of the location of biogenic habitats for the western site and resulted in redefined boundaries and an increase in size compared to that reported in Davidson *et al*. (2011) (Figure 3). The eastern site was not resurveyed during the present study.

The significant site is dominated by a relatively flat benthos, characterised by silt, sand and shell material. Biogenic clumps were widespread and ranged from 0 to 30% cover over the underlying substratum (Plates 5 and 6). When present at >5% cover, their mean percentage cover was estimated at 8.6% ($^{+}$/- 5.9 SD).

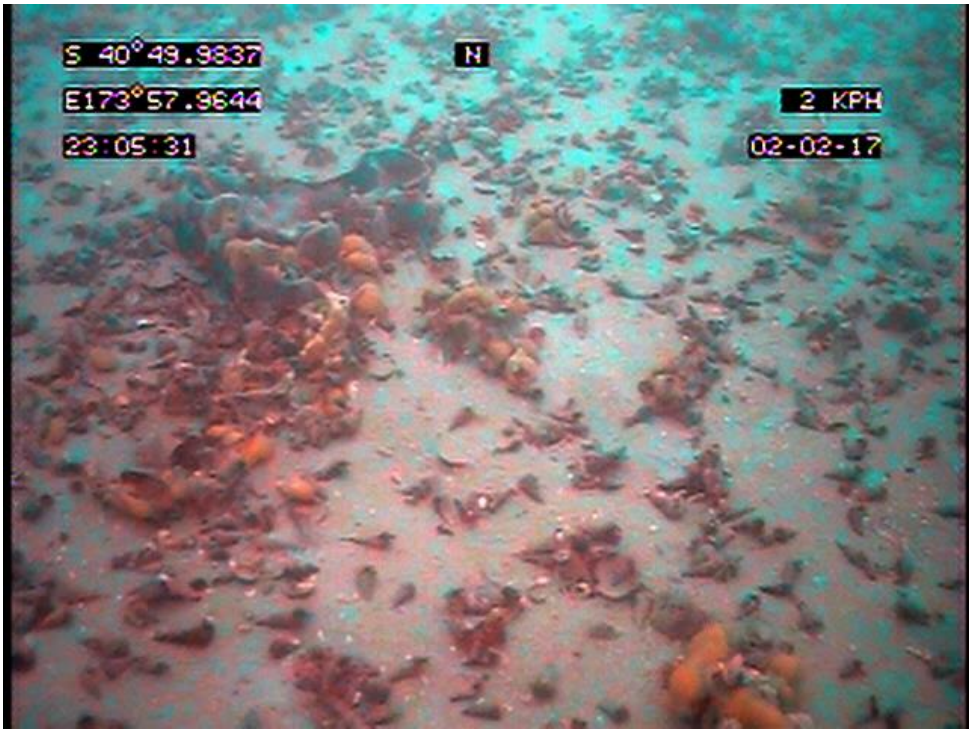

Plate 5. Sponges, ascidians and hermit crabs (Photo 2, 26.1 m depth).

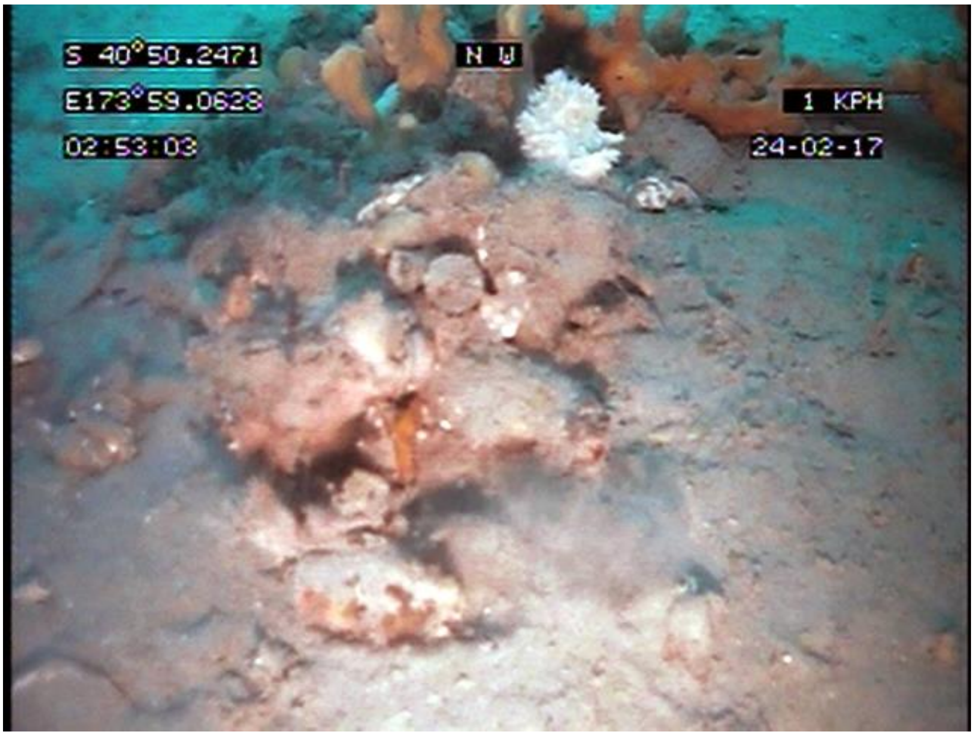

Plate 6. Sponges, bryozoans, ascidians and tubeworms (Photo 67, 30 m depth).

Figure 4. Original Site 2.10 described in Davidson *et al.* (2011) (left pink line) and the suggested revised boundary (green).

The site is characterised by expansive soft sediments and is therefore vulnerable to physical damage from activities such as dredging and trawling. Biogenic type habitats growing on soft substrata are relatively uncommon compared to biogenic communities growing on, or adjacent to, rocky habitats (Table 8). This pattern is likely to be related, at least in part, to soft substrata being more suitable for dredging and trawling; rocky substrata deters such activities.

Some photos showed isolated large biogenic clumps (Plate 6). Their presence suggests the site may once have supported more widespread and larger biogenic structures than the present small and faster-growing species such as sponges and ascidians (Plate 5). Unfortunately, no historic data exists for this area apart from photos collected by Davidson *et al*. (2011).

Table 8. Assessment of anthropogenic impacts for Site 2.10 (Trio Islands (west)).

Original area of significant site (ha)	558.5
Recommended area of site (ha)	1017.3
Change to original site	Increase
Change (ha)	457.8
Percentage change from original (%)	81.8
Human Use	Low-moderate (the site is dredged and trawled by commercial fishers at an unknown frequency)
Vulnerability	High (site is dominated by soft substratum and highly accessible to trawling and dredging). Sedimentation levels are likely to be low.
Impact observed	Isolated large biogenic clumps suggest physical disturbance

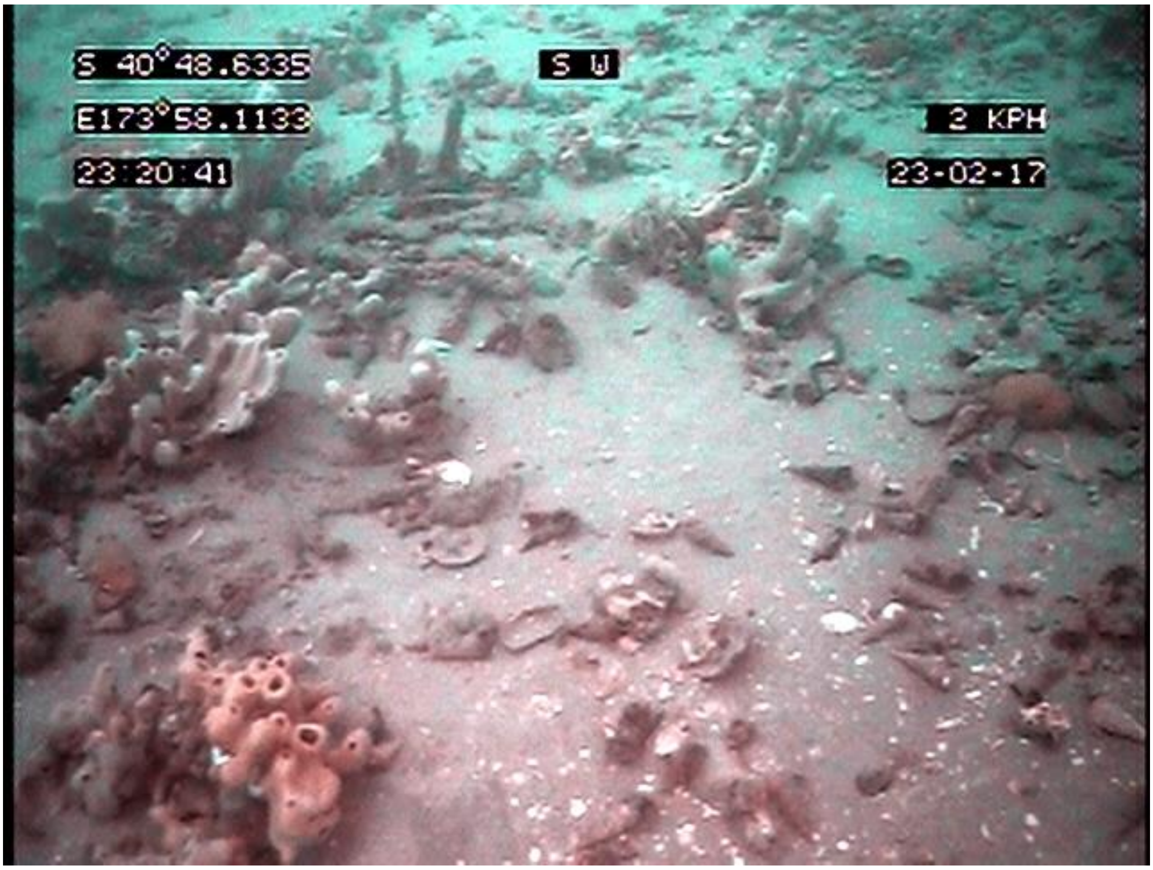

Plate 7. Sponges, bryozoans, ascidians and tubeworms (Photo 27, 26.4 m depth).

4.5.4 Site 2.27 Titi Island (biogenic communities)

Titi Island is located approximately 4.3 km east of Forsyth Island in the outer Marlborough Sounds. The island is 24 ha in size and has a circumference of approximately 3.3 km, and is approximately 1.2 km long and 300 m wide (Figure 5). A brief investigation of the north-western offshore area of the subtidal environment was conducted by Davidson *et al*. (2011) and a significant site was proposed. Davidson *et al*. (2011) stated the soft sediment seafloor along the northern shoreline of Titi island supported a variety of biogenic habitat-forming species including horse mussels, hydroids, sponges and bryozoans. The authors also stated horse mussels, hydroids and sponges were relatively common at the north-western end of the island in water 20 to 30 m deep. Large colonies of the Separation Point coral were also reported at depths >30 m along the northern side of the island. The present investigation collected more data from most of the island's circumference.

Plate 8. Titi Island taken from a position north-west of the island, looking south-east.

The present survey confirmed the presence of a range of biogenic habitats including sponges, anemones, bryozoans, hydroid gardens and ascidians (Plate 15). Blue cod were numerous, especially in current-swept locations. The present survey provided improved resolution of biogenic habitats and amended boundaries for the significant site are suggested (Figure 5). Drop camera photos suggest that areas north-west of the Titi Island now have fragmented values, with much of that area no longer supporting biogenic communities. The reason or reasons for this change is likely due to physical disturbance.

Three new polygons have been suggested (2.27a = 4.3 ha, 2.27b = 13.5 ha, 2.27c = 20.3 ha; total area = 38.1) (Figure 4). Site 2.27a is centred around a current-swept reef supporting biogenic communities. Dense gardens of hydroid trees were observed in areas around the rocky substrata. Site 2.27b is a current-swept area at the western end of Titi Island and is dominated by cobbles and boulders encrusted with biogenic communities (Plates 9 and 11).

Isolated rock outcrops also occur in the area. Site 2.27c is a large rocky reef located at the eastern end of Titi Island. Biogenic communities including hydroid gardens are located along its deeper slopes and edges (Plate 12).

Plate 9. Current-swept cobbles supporting biogenic communities dominated by sponges, ascidians and hydroids.

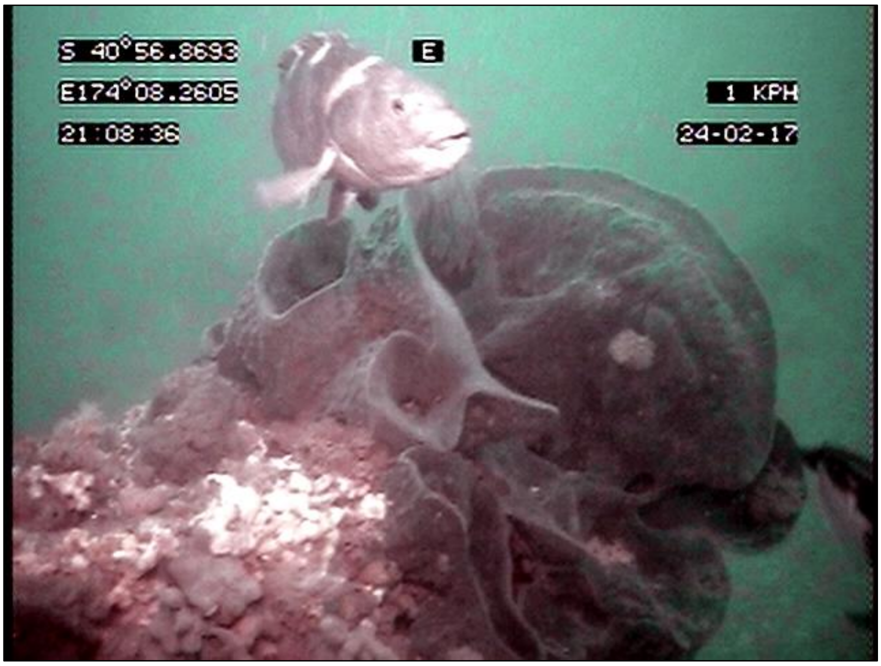

Plate 10. Large *Ancorina* sp. sponges growing on rock at site 2.27a (Photo 7, 28 m).

Plate 11. Biogenic community associated with cobbles and boulders at the western end of Titi Island at site 2.27b (Photo 43, 22.6 m).

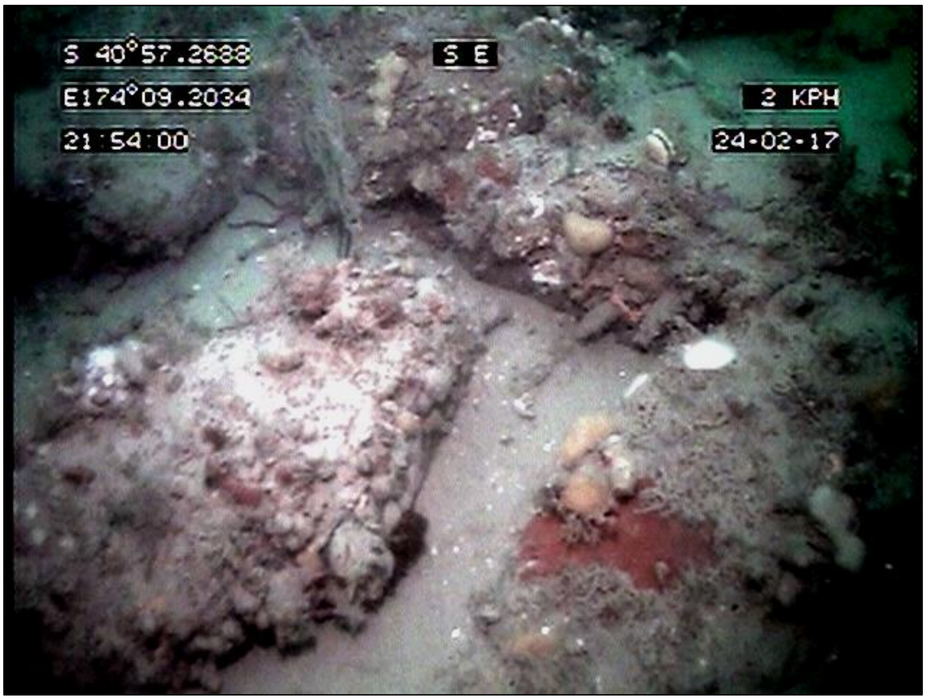

Plate 12. Biogenic community associated with deeper areas of the eastern reef at site 2.27c (Photo 24, 30.6 m).

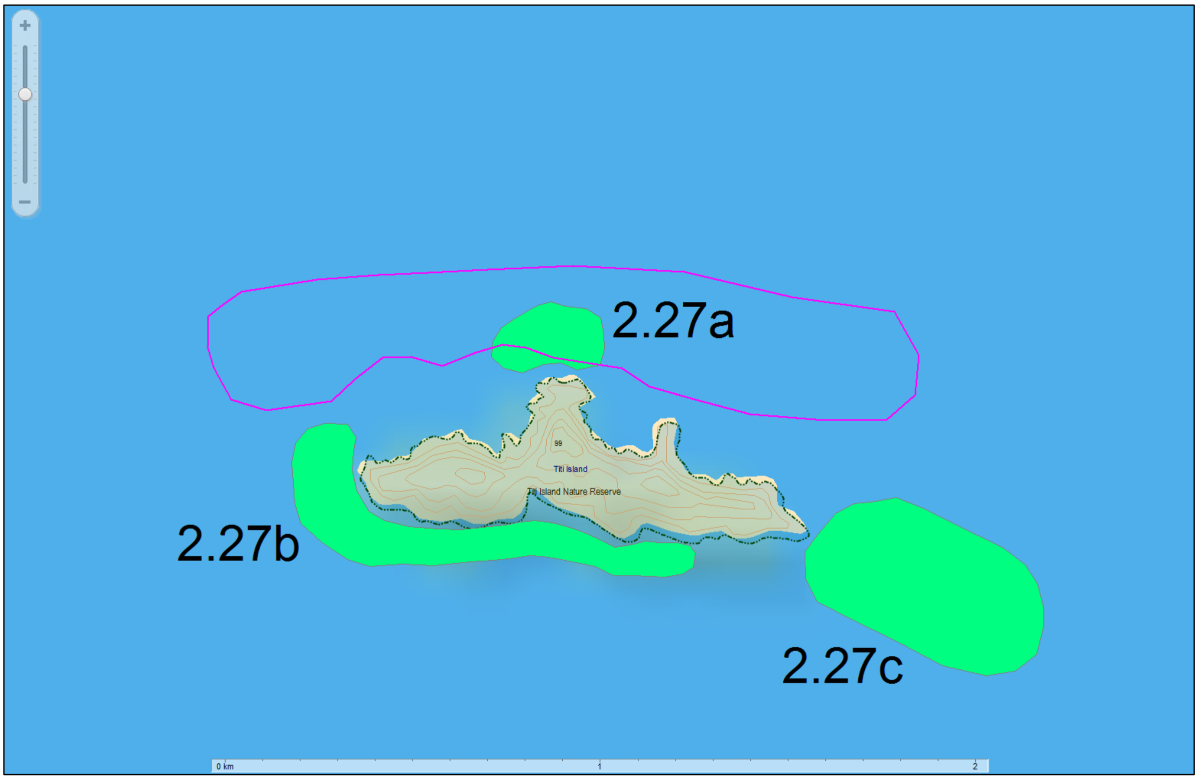

Figure 5. Original site 2.27 described in Davidson *et al.* (2011) (pink line) and suggested revised site boundaries (green).

The presence of rocky substratum at this site reduces the chance of physical damage from dredging and trawling. Their location in a current-swept position in the outer Sounds also means sedimentation is unlikely to have an adverse impact on the site's biological values.

The site is a popular location for recreational fishers. The impact of this fishing activity on habitats is low compared to many other anthropogenic activities in the marine environment (Table 9). Lobster potting is an uncommon activity at this location (pers. obs.), however, it likely causes small and localised damage to some biogenic species.

Table 9. Assessment of anthropogenic impacts for Site 2.27 (Titi Island).

Original area of significant site (ha)	52.5
Recommended area of site (ha)	38.1
Change to original site	Decrease
Change (ha)	14.4
Percentage change from original (%)	-27.4
Human Use	Low-moderate (the site is a popular site for recreational fishers, but it is remote, the impact of this activity on habitats is likely low). Trawling close to the island has likely removed biogenic habitats.
Vulnerability	Low (rocky reef habitats deter dredging and trawling activities). Sedimentation levels are likely to be low.
Impact observed	Loss of some biogenic habitats in the north-western area.

4.5.5 Site 2.30 Waitui Bay (biogenic communities)

Waitui Bay is a remote and large north-facing bay located between Cape Lambert and Alligator Head (Figure 6). The bay opens directly into Cook Strait and has a coastline of approximately 13.28 km, a sea area of 1310 ha and a mouth approximately 6.2 km wide (Plate 13).

Plate 13. Outer Waitui Bay as viewed from Alligator Head.

Davidson *et al*. (2011) reported that a historic study by Cameron Hay (DSIR) found a large area of central Waitui Bay supported a horse mussel bed with associated encrusting species. Davidson *et al*., (2011) stated this bed was one of the two largest horse mussel beds in the biogeographic area, the other being in the adjacent Port Gore.

Inner and central areas of Waitui Bay were characterised by a low gradient featureless soft substratum. Depths were ideal for horse mussels (i.e. 16 m to 20 m depth). No horse mussels or biogenic habitats were observed from photos collected from the large relatively flat benthos. Outer north and north-western areas where depths varied did support remnant horse mussel and biogenic clumps (Plates 14 and 15). Horse mussels were ranked as occasional - common in abundance, but no areas supporting high numbers of horse mussels was observed. When present, biogenic clumps ranged from 1-20 % cover (Mean when present at >5% cover = 9.6, $^{+}$/- 4.98 SD). Biogenic clumps appeared as isolated clumps and mounds and, where present, were uncommon. The fragmented and patchy cover of these current swept community types suggest that area has likely been impacted by dredging and trawling activities.

Plate 14. Horse mussels with a variety of associated biota from outer Waitui Bay (Photo 17, 22 m).

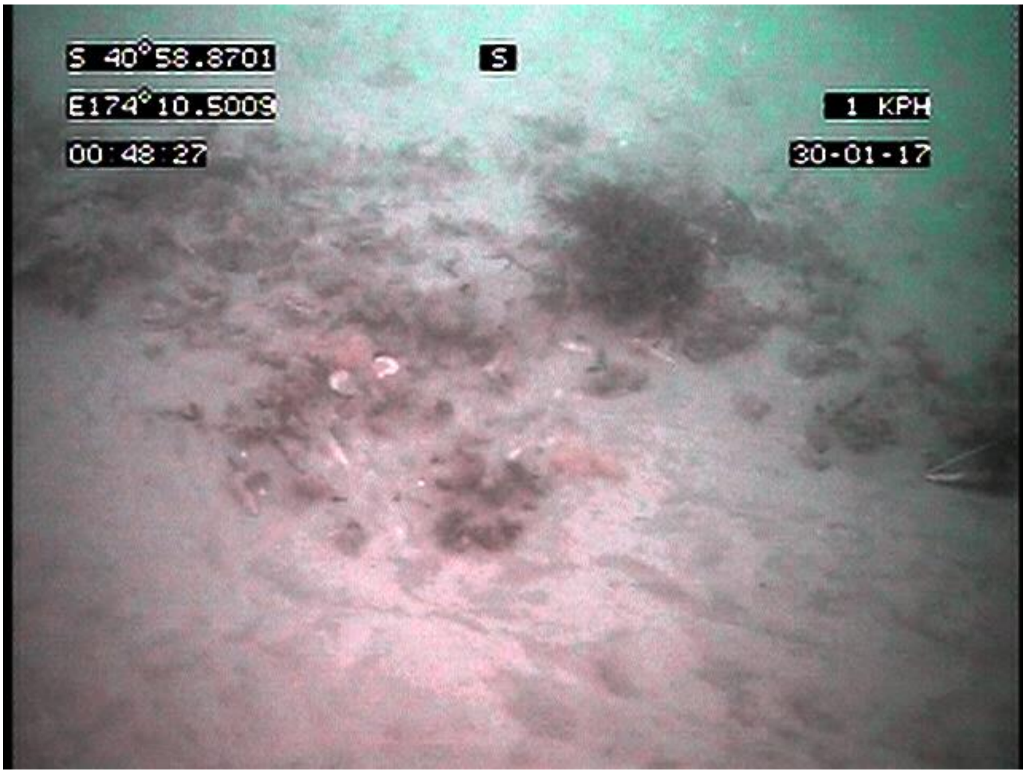

Plate 15. Biogenic community on soft substratum in Waitui Bay (photo 35, 22.5 m).

The present survey provides the first results since the original work conducted by Cameron Hay in the 1980's. The present survey provides an improved level of detail; however, most horse mussel beds originally described no longer exist. It is recommended that the original significant site be reduced in size to encompass the remnant areas that still support fragmented biogenic habitat (Figure 6).

These remaining communities were found on soft substratum and as such are vulnerable to physical damage from dredging and trawling (Table 10). Detailed data on the occurrence and frequency of such activities in this area is not publicly available. The site is seldom visited by recreational fishers.

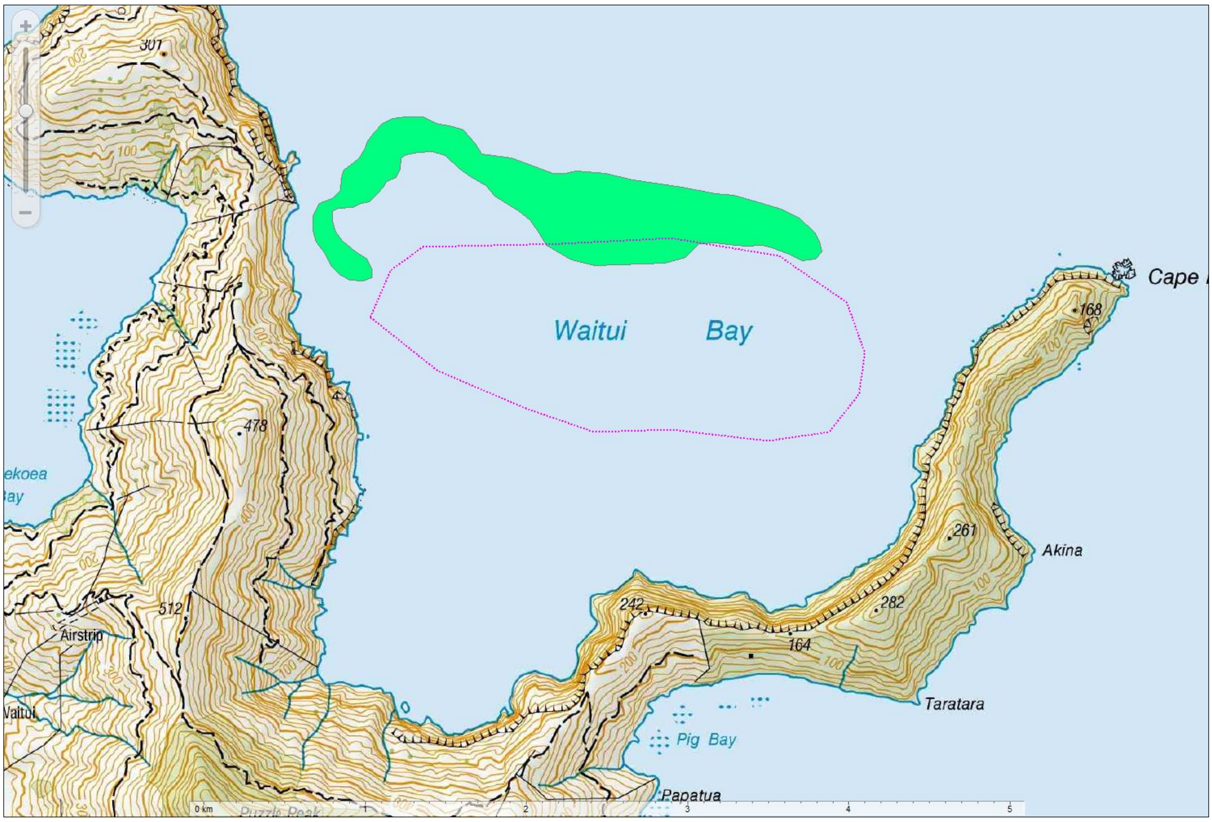

Figure 6. Original site 2.30 described in Davidson *et. al.* (2011) (pink line) and the suggested revised boundary (green).

Table 10. Assessment of anthropogenic impacts for Site 2.30 (Waitui Bay).

Original area of significant site (ha)	294.9
Recommended area of site (ha)	112.8
Change to original site	Decrease
Change (ha)	-182.1
Percentage change from original (%)	-62
Human Use	Moderate (the area is remote and seldom visited by recreational fishers, the level of use by commercial fishers indicates a moderate level of activity on the MPI website)
Vulnerability	High (the rocky reef deters dredging and trawling activities. Soft substrata areas are vulnerable to physical disturbance).
Impact observed	Horse mussel beds reduced, remaining communities fragmented

4.5.6 Site 2.33 Hunia Coast (tubeworms)

Previously, Davidson and Richards (2015) described three sub-sites supporting tubeworms *Owenia petersenae* from the Hunia (north) coast in Port Gore (Figure 7, Plate 16). The authors stated tubeworms were most abundant between 11 m and 14 m depth and were found on gently sloping shores. They also noted another tubeworm zone is known from significant site 2.34 at Gannet Point (south-eastern Port Gore) and suggested the area to the north of the Hunia sub-sites may contain further tubeworm beds. The present survey investigated this latter area by extending the survey area northwards into Pig Bay proper.

During the present survey, one new bed (1 ha) with the same tubeworms was found in northern Pig Bay (Figure 8). This 1 ha sub-site is located on a shallow sill that extends southwards from the shore (Plate 17). The mean percentage cover of tubeworms from 5 photographs collected from within the bed was 30% (+/- 23.18 SD). No other tubeworm beds were observed from the areas surveyed along this coast.

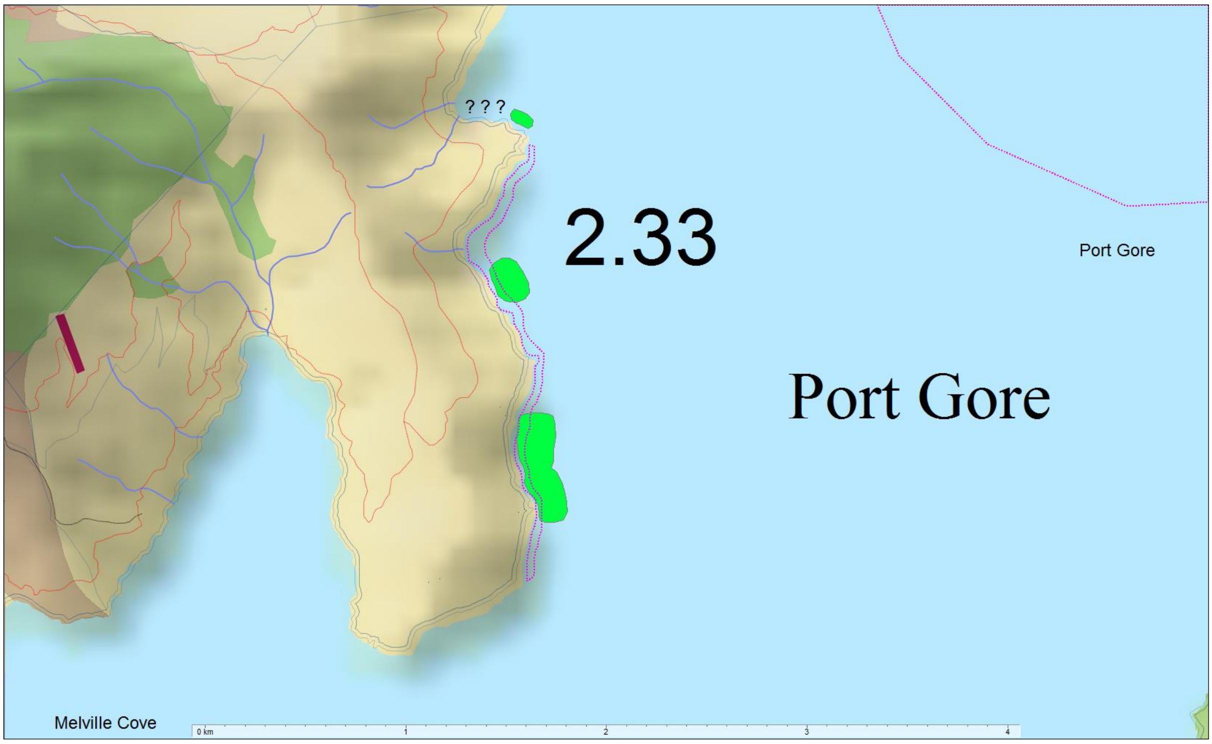

Figure 7. Tubeworm sites described in Davidson and Richards (2015) (green). (??? = area not surveyed but considered likely to support tubeworms).

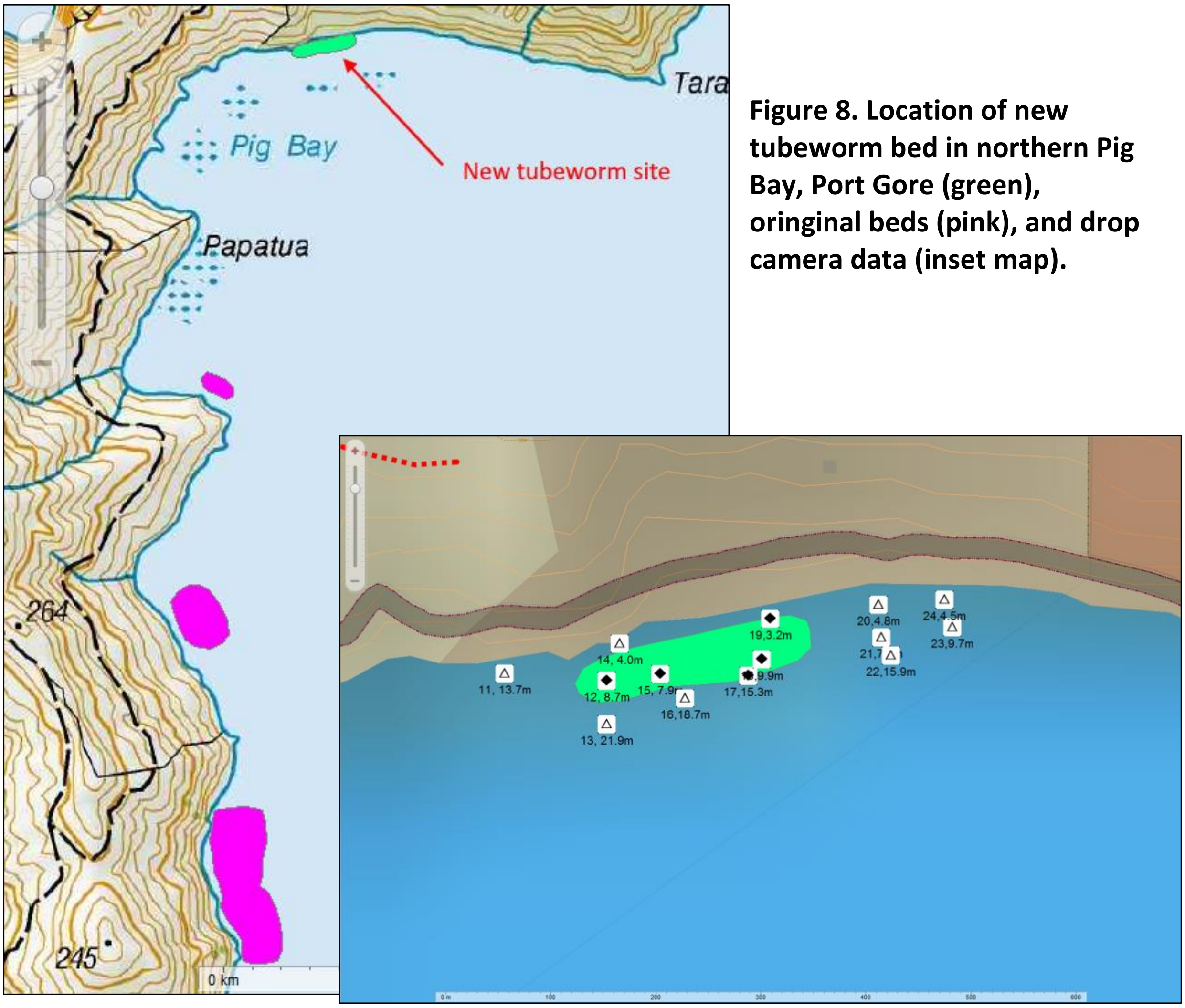

Figure 8. Location of new tubeworm bed in northern Pig Bay, Port Gore (green), oringinal beds (pink), and drop camera data (inset map).

Plate 16. Area of the new tubeworm bed in Pig Bay.

Tubeworm beds are found on soft substratum and are therefore vulnerable to sedimentation, smothering and physical damage (Table 11). This bed is located 70 m distance inshore of an operational mussel farm. This distance is outside the recorded distance of mussel farm impacts on the environment (Keeley *et al*., 2009).

Table 11. Assessment of anthropogenic impacts for Site 2.33 (Pig Bay).

Original area of significant site (ha)	17.52
Recommended area of site (ha)	18.52
Change to original site	Increase
Change (ha)	1
Percentage change from original (%)	5.7
Human Use	Low (the area is occasional visited by fishers and divers, mussel marine farm vessels transit the offshore area)
Vulnerability	High (tubeworms are vulnerable to physical disturbance and smothering by sediment).
Impact observed	None

Plate 17. Tubeworm bed in Pig Bay (photo 19, 3.2 m).

4.5.7 Site 3.1 Harris Bay (algae)

Harris Bay is on the western side of the entrance to Pelorus Sound, immediately south of Paparoa and 54 km by sea from Havelock. Harris Bay has 1.7 km of coastline and a sea area of 37.5 ha (Plate 18). The northern side is relatively shallow and supports a bed of red algae located in the 5-22 m depth range (Davidson *et al*. 2011).

Plate 18. View of the northern side of Harris Bay, Pelorus Sound.

During the present investigation, 32 drop camera photos were collected from the northern side of Harris Bay (Figure 9). A total of 26 of the 32 photos supported red algae ranging from 1 to 70 % cover (Plate 19). Where present in photographs, the mean cover of macroalgae was 12.5% ($^{+}$/- 16.01 SD). Nine of the present photos targeted locations where photos had been previously collected by Davidson *et al*. (2011). Due to tide and wind it is impossible to place the drop camera in the same exact location, but it is likely photos will be within +/- 10 m of the original station. The nine comparable locations showed a decline in the mean algal percentage cover (Table 12). It is of note that some stations supported very high cover in 2011 (e.g. up to 90%) but in 2017 were considerably lower.

Table 12. Percentage cover estimates of red algae from comparable sites (2011 and 2017).

Site number 2011	Site number 2017	Red algae % cover 2011	Red algae % cover 2017
1, 9 m	4, 7.8m	60	5
2, 9 m		90	NA
3, 8 m	7, 7.6m	0	4
4, 12 m	19, 11m	0	0
5, 13 m	18, 11.9m	1	0
6, 14 m	16, 13.3m	20	1
7, 16 m	14, 15.5m	10	4
8, 23 m	12, 22.3m	10	0
9, 10 m	9, 5.4m	2	20
10, 11 m	10, 10.7m	80	40
Mean		27.30	8.22
SD		35.36	12.95

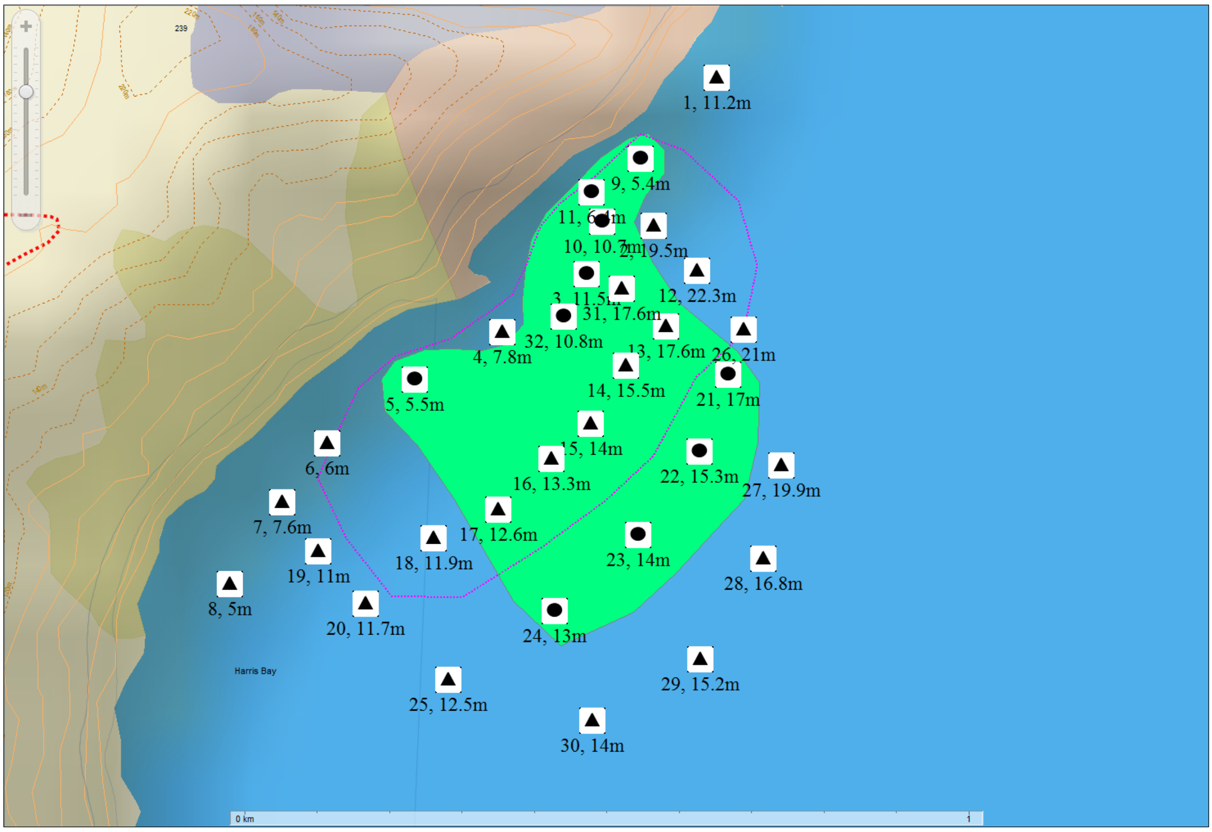

Figure 9. Revised Harris Bay red algae bed (green,pink line = 2011).

The reason for the decline in the mean percentage cover of red algae between 2011 and 2017 is unknown. Macroalgae, including red algae, is often variable in cover and extent between seasons and years and may be influenced by environmental variable such as nutrients, temperature, grazing and sunlight (Taylor, 1997; Mathieson and Burns, 2003; Davidson and Richards, 2017). It is therefore likely that the algae bed may vary from year to year.

Plate 19. Small patch of red algae on silt and clay substrata (photo 22, 15.3 m).

No human impacts were observed from photos collected from Harris Bay (Table 12). The algal bed is located inside Harris Bay and there is no evidence of commercial dredging or trawling. No recreational dredging has been observed in this area (authors pers. obs.). Any dredge would quickly become clogged with algae. Occasional anchoring probably occurs in this area as the bay provides shelter on a north-west wind, however, it is unlikely occasional anchoring would adversely impact on red algae in this area.

Table 12. Assessment of anthropogenic impacts for Harris Bay red algae bed.

Original area of significant site (ha)	20.5
Recommended area of site (ha)	19.4
Change to original site	Decrease
Change (ha)	-1.1
Percentage change from original (%)	-5.4%
Human Use	Low (recreational fishers occasionally anchor in this area)
Vulnerability	Moderate to low (red algae is relatively resilient and can recover quickly)
Impact observed	None

4.5.8 Titi Island Rock (biogenic communities)

An unnamed rock is located 2.5 km northwest of Titi Island (Figure 10). No previous biological data have been collected from this deep rocky site. This site was briefly visited during the present study and 21 drop camera images were collected and the position of the rock confirmed.

This rock is deep with no shallow or intertidal component. It is also separated from other rocky reef habitats by approximately 2.5 km of soft substratum. The rock appears to be swept by regular tidal currents and is covered with biogenic communities; the most notable being a range of large sponge species (Plates 20 to 22). Blue cod, tarakihi and sea perch were common in drop camera images.

The rock is relatively remote and is not physically marked due to its depth. It appears to be seldom visitied by recreational fishers. Anchoring at this site is unlikely due to the depth, wind and currents. Dredging and trawling is also unlikely due to the risk of damage or loss of gear. The level of anthropogenic related impacts is therefore low (Table 13).

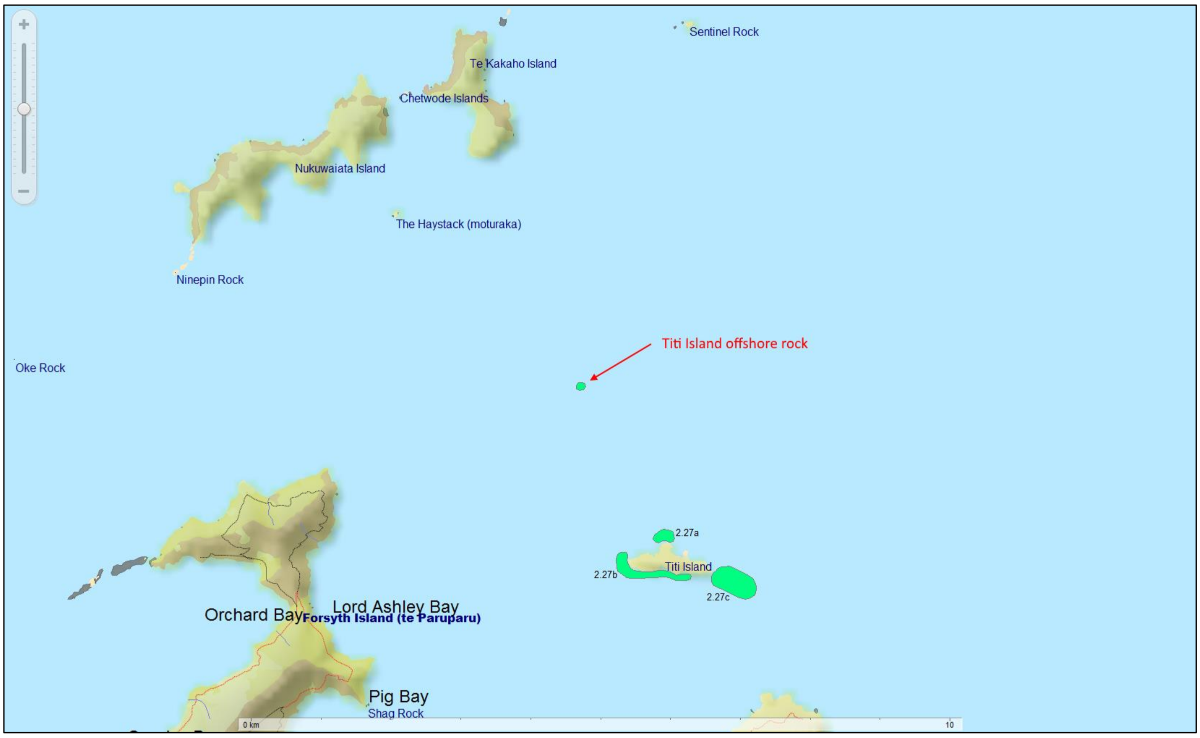

Figure 10. Location of Titi Island Rock (red arrow).

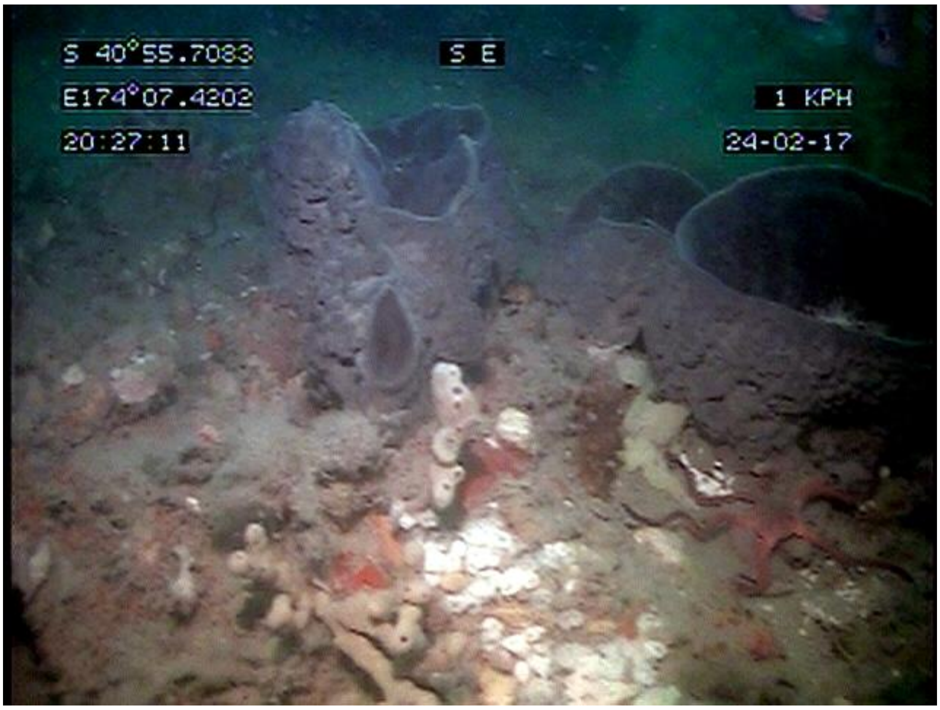

Plate 20. Biogenic community dominated by sponges on bedrock substrata at Titi Island Rock.

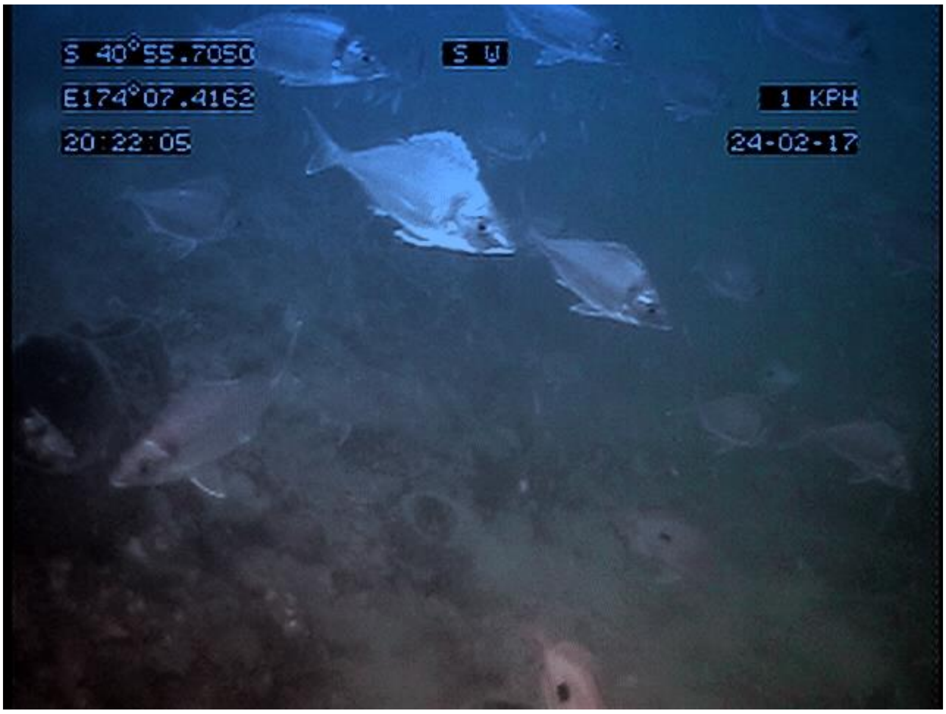

Plate 21. School of juvenile tarakihi from Titi Island Rock.

Plate 22. Sea perch on biogenic community at Titi Island rock.

Table 13. Assessment of anthropogenic impacts for Titi Island rock.

Original area of significant site (ha)	NA
Recommended area of site (ha)	1.2 (approximate)
Change to original site	Increase
Change (ha)	1.2
Percentage change from original (%)	100%
Human Use	Low (recreational fishers rarely if ever anchor)
Vulnerability	Low (the rocky substrata protect the area from dredging and trawling. Anchoring would cause damage.
Impact observed	None

4.5.9 Bonne Point (rhodolith bed)

A new rhodolith bed was discovered adjacent to Bonne Point, eastern D'Urville Island (Figures 11 and 12, Plate 23). The present survey located this bed, mapped its extent and outlined the percentage cover of rhodoliths for future monitoring purposes.

Bonne Point is located on the northern, outer side of Catherine Cove Peninsula, some 9.8 km north-east of French Pass. This associated rhodolith bed is the second known from the Two Bay Point to Jackson Bay biogeographic area; the other location being site 2.13 (sub-sites a, b and c) located in Catherine Cove. Despite the Bonne Point bed being small, the percentage cover values were relatively high (mean = 86% cover, SD = $^{+}$/- 13.4).

The rhodolith bed was located between the main reef associated with Bonne Point and a small reef to the east. The existence of rocky substrata on either side of the rhodolith bed has probably protected it from physical damage.

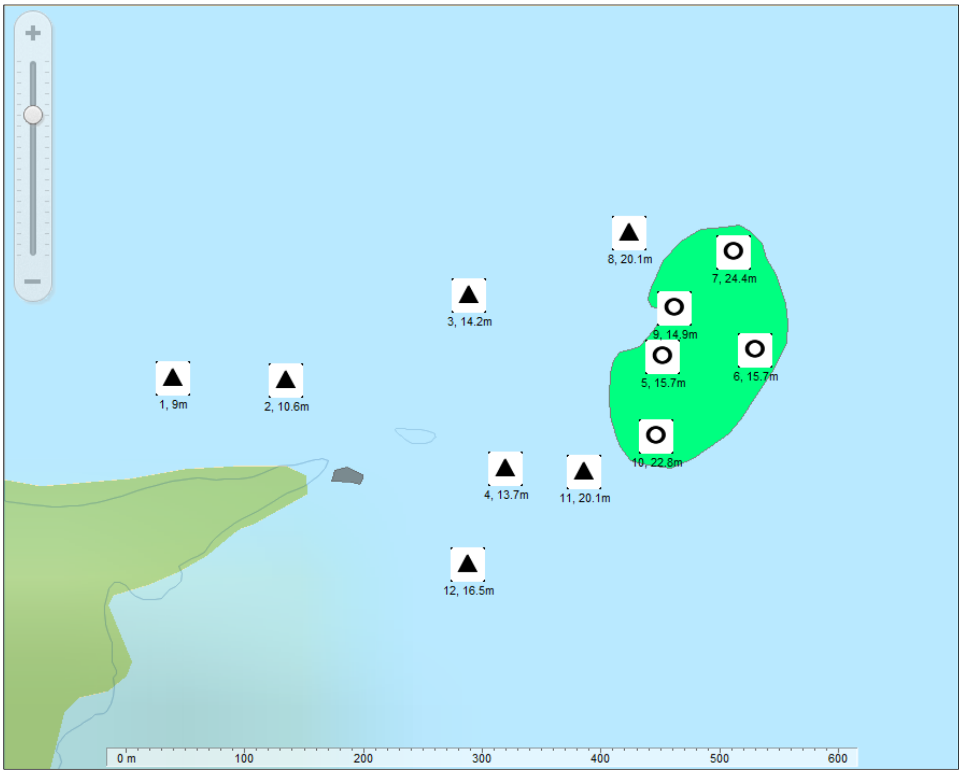

Figure 11. Bonne Point rhodolith bed, eastern D'Urville Island.

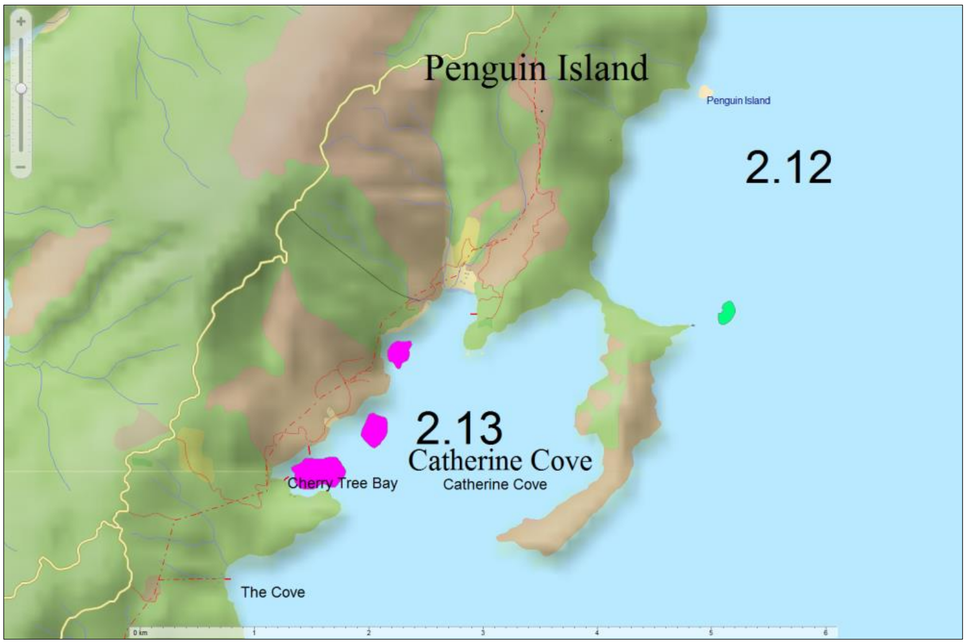

Figure 12. Location of Bonne Point rhodolith bed (green) and Catherine Cove beds (pink).

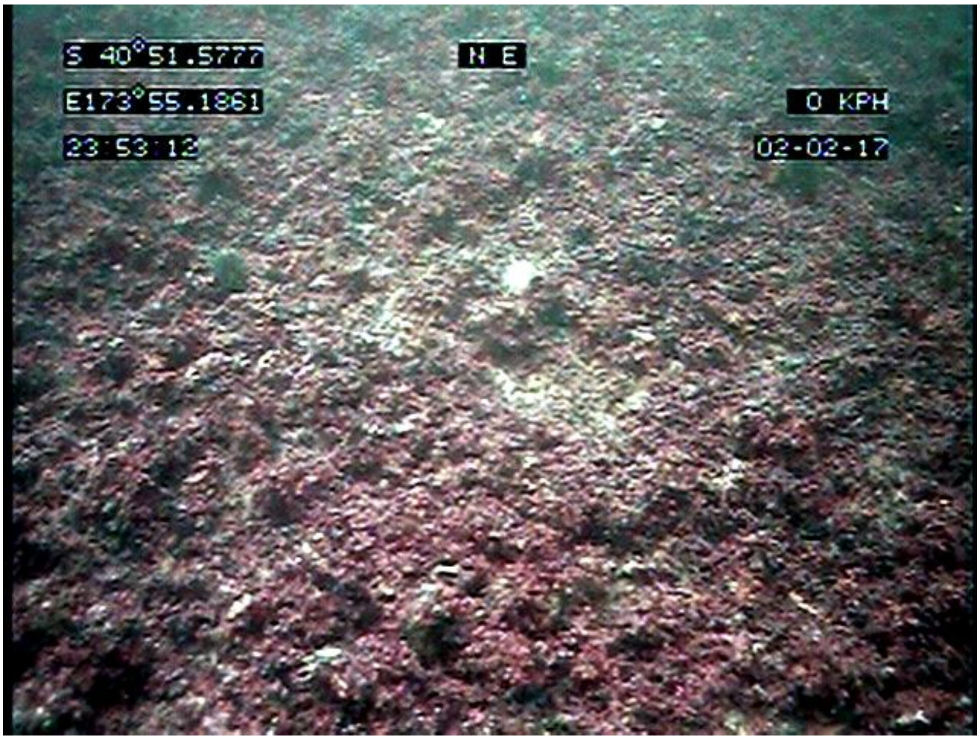

Plate 23. Rhodoliths from Bonne Point, D'Urville Island.

No human impacts were observed from photos collected within the Bonne Point rhodolith bed (Table 14). The bed is located between two reef structures that likely provide protection from commercial dredging and trawling. Occasional anchoring occurs in this area by recreational fishers. Most people, however, anchor further north near the end or along the main reef. It is recommended that the site be protected from all forms of physical disturbance including anchoring.

Table 14. Assessment of anthropogenic impacts for Bonne Point rhodoliths).

Original area of significant site (ha)	NA
Recommended area of site (ha)	4.68
Change to original site	NA
Change (ha)	NA
Percentage change from original (%)	NA
Human Use	Low (recreational fishers occasionally anchor in this area)
Vulnerability	High (rhodolith communities are fragile and vulnerable to physical disturbance and smothering by sediment)
Impact observed	None

4.5.10 Tawhitinui Bay (king shag)

Tawhitinui Bay is a small bay at the eastern end of Tawhitinui Reach, Pelorus Sound, Tawhitinui Bay approximately 36.5 km by sea from Havelock. It has a coastline length of approximately 2.9 km and covers about 80 ha. The 0.16 ha king shag site is located around the eastern coastline of outer Tawhitinui Bay (Figure 13, Plate 24).

This site was briefly visited on two occasions during the present study (August 2016 and January 2017) and photos were collected. A previous aerial survey funded by New Zealand King Salmon, counted 43 birds and 16 active nests (Schuckard *et al*., 2015). The next aerial survey is due in the summer of 2018. During the present survey visits, a total of 19 adults and chicks on nests were counted in August 2016, while only 7 birds were observed in January 2017. Both visits were conducted through the middle of the day and therefore should not be regarded as a population count.

The New Zealand king shag is endemic to New Zealand, only occurring in the Marlborough Sounds. Subfossil bone deposits indicate two regional haplogroups, from the Cook Strait region and northern North Island. However, king shags have been confined to the outer Marlborough Sounds for at least 240 years (NZ birds online). King shags are restricted to the outer Marlborough Sounds, from the west coast of D'Urville Island east to where Queen Charlotte Sound and Cook Strait meet. About 85% of all existing birds are located at five colonies: Rahuinui Island, Duffers Reef, Trio Islands, Sentinel Rock and White Rocks. The shags feed up to 25 km distance in a predominantly southwest direction from the main colonies, mainly in waters up to 50 m deep (diving in deeper waters has been recorded). The foraging area of king shag is estimated to be 1300 km^2. Away from the Marlborough Sounds, there are records of single king shags from Wellington Harbour (July 2002) and Kaikoura (October 2011). In 2015 and 2016, seven individual king shags, mostly 1st and 2nd year birds, were recorded from Abel Tasman National Park.

The International Union for Conservation of Nature threat classification is "Vulnerable to extinction" and, under the New Zealand Threat Classification System, the species has the status "Nationally Endangered". This means the species is considered threatened with extinction due to its low population numbers, the limited area of occupancy (usually considered to be the nesting habitat of seabirds), and limited extent of occurrence (foraging range at sea). The total population of king shags is likely to be less than 1000 birds and more than 800. The most recent published full population census in February 2015 identified 839 birds (Schuckard *et al*., 2015).

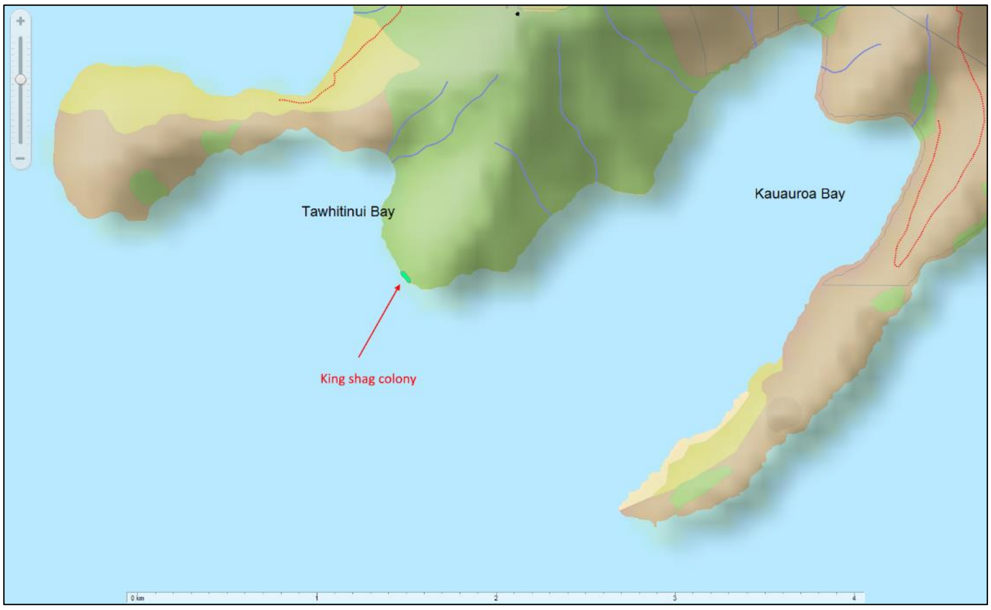

Figure 13. Location of king shag site at Tawhitinui Bay (green polygon with red arrow).

Plate 24. Part of the king shag colony at Tawhitinui Bay (Photo: Rachel McClellan, 22 08 2016).

The king shag colony at Tawhitinui Bay is located centrally in Pelorus Sound. The wider area is regularly transited by commercial and recreational vessels. The coastline between Tawhitinui and Kauauroa Bays is regularly visited by recreational fishers. Vessels also transit along this coast when heading from Waitata Reach to Kauauroa and Beatrix Bays. Provided transiting vessels remain distant from the coast, they do not appear to influence king shags (authors, pers. obs.).

The colony is vulnerable to disturbance from humans that approach close and cause birds to panic. This can occur when recreational fishers drift and anchor along this coast. Panic can cause chick mortalities during the breeding season due to predation from black-backed gulls (Table 15). A guideline outlining a minimum recommended approach distance to king shag colonies is recommended plus ongoing public education.

Table 15. Assessment of anthropogenic impacts for Tawhitinui Bay king shag colony.

Original area of significant site (ha)	
Recommended area of site (ha)	0.16
Change to original site	Increase
Change (ha)	0.16
Percentage change from original (%)	100
Human Use	Moderate (the area is often visited recreational fishers)
Vulnerability	High (king shags are easily disturbed and this can result in chick and egg mortalities).
Impact observed	No

5.0 Discussion

5.1 Significant site changes (2011 to 2017)

5.1.1 Reasons for change

Davidson and Richards (2015) stated change to significant marine sites and sub-sites can be due to:

(1) Discovery
A new site that supports biological features with a medium or high ranking.

(2) Rejection
The site no longer supports biological features with a medium or high ranking.

(3) Reduction
Part of the significant site does not support biological features with a medium or high ranking.

(4) Addition
An area adjacent to or contiguous with an existing significant site supports the same or comparable biological features with medium or high ranking.

(5) Rehabilitation/recovery
Biological values increase to a medium or high-ranking due to recovery or rehabilitation of biological values.

5.1.2 Confidence around change and the reasons for loss of biological values

Changes to a significant site must be based on good quality data enabling reassessment of a site's biological ranking. It is noted, however, that because most significant sites are subtidal, temporal knowledge of biological value is usually patchy and infrequent leading to a degree of "uncertainty" regarding the level of change over time. Historically, this issue is almost always compounded by a complete lack of "before" data prior to human activities.

For significant sites that have changed solely because of data quality, there is no need for "before" data. An increase to a site supported by a good quality data is not dependent on historic information. The issue of change becomes more complex when a decline in size may be due wholely, or in part, to perceived anthropogenic activities. Historically, scientists have collected little data on biological natural history in New Zealand. When available, data are often poor quality or lacking good spatial resolution. Despite these issues, these data can still indicate the presence of biological features of medium or high quality. These data are usually unsuitable to provide a scale or intensity of change; however, they can confirm a change from a previous state to a totally new state (e.g. rhodolith bed replaced by uniform mud).

A site's boundaries or significance may change based on: (1) published literature, (2) personal experience of researchers or the expert peer review panel, and/or (3) a comparison of before and after data. For example, Davidson and Richards (2015) surveyed an offshore soft bottom site in outer Queen Charlotte Sound and reported few horse mussels. Historically, this site was known to support horse mussels in densities that would have warranted classification as a "horse mussel bed" (Hay, 1990, Davidson *et al*., 2011). No data exist to show an incremental loss over the intervening years, however, based on the literature, the most likely cause for the decline is physical damage from scallop dredging and trawling. Dredging has been regularly observed in outer Queen Charlotte Sound and the literature shows species like horse mussels and the benthic community can be significantly degraded by such activities (Thrush *et al*., 2001).

5.1.3 Area increases

Of the 10 individual sites within the total of 15 candidate sites and sub-sites, three sites increased in total size compared to the original values reported in Davidson *et al.* (2011) or Davidson and Richards (2015). A further three small, new sites were documented, totalling 6.04 ha. Altogether, an increase of 589.34 ha was documented in the present study. Apart from the new sites, the increases are believed to be due to improved coverage and detail resulting in better resolution and precision. For example, new sub-sites were documented near existing significant sites.

5.1.4 Area decreases

Changes to benthic biological quality due to anthropogenic impacts has been documented elsewhere in and around the Marlborough Sounds (Stead 1971, Handley 2015, 2016; Handley *et al*., 2017) and from the wider New Zealand (MacDiarmid *et al*., 2012; MFE, 2016) (see Section 5.4).

In the present study, four sites were found to be smaller in size (total reduction of 458.9 ha). Davidson and Richards (2015) considered many declines on offshore soft substratum sites was a result of physical damage, primarily from trawling and dredging. During the present study, most observed declines are likely due to improved accuracy of data. However, the most probable explanation for declines at 2.27 and 2.30 is historical physical damage from dredging and/or trawling.

At site 2.30 (Waitui Bay) a large horse mussel bed described in the 1980's was no longer present. At site 2.27 (Titi Island), the north-western biogenic habitat outlined in Davidson *et al.* (2011) were still present, but were patchy.

5.2 Information issues (plan updates, data management)

5.2.1 Planning and Resource Consenting

The present study is the third MDC and DOC funded survey since Davidson *et al.* (2011). Like the previous surveys conducted by Davidson and Richards (2015, 2016), most surveyed sites changed in size, shape and/or attributes/values compared to original sites described by Davidson *et al.* (2011). It is certain that further changes will occur documented in future surveys. An important issue is, therefore, how to integrate these changes into the Marlborough District Council planning and Resource Consent processes. One options would be by enabling the update of significant sites in the Marlborough Environment Plan to list where significant sites are located and their biological ranking.

5.2.2 Data management and raw data

Survey data from the 2016-2017 survey are summarised in the present report. Detailed data (maps, photos, video, sonar) are either produced or listed in separate Excel spreadsheets. All media, raw data and spreadsheets have been supplied to MDC to be stored in an MDC database. The present report should be regarded as a summary or front end to all the raw data and the summary spreadsheets.

5.3 Review and assessment of sites

Following approval and acceptance of the present report by the MDC Environment Committee, the significant site expert peer review panel will assess the new data and review and rank sites and sub-sites. A report like Davidson *et al*. (2015, 2016) outlining the expert peer review findings will be produced in due course.

Based on data collected during the present study, each site has a recommendation to the review panel. It is important to note that these are only recommendations and may not necessarily be adopted by the expert panel (see Davidson *et al.* 2013 for process).

5.4 Protection and protection initiatives

5.4.1 Anthropogenic impacts

Airoldi and Beck (2007) stated: "Nowadays less than 15% of the European coastline is considered in 'good' condition. Those fragments of native habitats that remain are under continued threat, and their management is not generally informed by adequate knowledge of their distribution and status". The authors stated for European "biogenic habitats, such as oyster reefs and maerls (rhodoliths), some of the greatest impacts have been from destructive fishing and overexploitation. Coastal development and defence have had the greatest known impacts on soft-sediment habitats with a high likelihood that trawling has affected vast areas. The concept of 'shifting baselines', which has been applied mostly to the inadequate historical perspective of fishery losses, is extremely relevant for habitat loss more generally. Most habitat loss estimates refer to a relatively short time span primarily within the last century. However, in some regions, most estuarine and near-shore coastal habitats were already severely degraded or driven to virtual extinction well before 1900."

The greatest sources of anthropogenic impacts in New Zealand's marine environment come from external sources (MacDiarmid *et al*., 2012; MFE, 2016). Climate change, ocean acidification and catchment inputs were considered the largest threats. MacDiarmid *et al.* (2012) ranked catchment effects, such as the introduction of sediment, as one of the most important local issues leading to serious impacts in the marine environment.

In a recent study of sedimentation rates over the past 1000 years in Pelorus Sound, Handley *et al*. (2017) stated: "*The results reflect the history of changing land-use from forest clearance in the 19th and early 20th centuries, followed by extensive sheep farming with regular burning of scrub and application of superphosphate through the middle years of the 20th century, widespread regeneration of native forest as pastures were abandoned over the last 30-40 years, and increasing areas and density of pine plantings from the turn of the 20th century to today*." Further, the authors state "*Prior to European settlement, time-averaged sediment accumulation rates were in the order of 0.2 to 1.2 mm/yr throughout the Kenepuru Sound. The main sources were the inflow from the Pelorus and Kaituna Rivers ('Havelock inflow'), subsoils from natural slips, and sediment generated from bracken, beech forest, and ponga/podocarp forest. The ecosystem had co-evolved with the fluctuations of sediment from periodic storms and episodic disturbances. Post-European settlement, sediment accumulation rates have increased to 1.8 to 4.6 mm/yr, with the contribution of the 'Havelock inflow' to the volumes of sediment deposited on the seabed increased well above historic levels, reflecting pastoral catchment practices as land was cleared and pastures maintained. This has continued* *to the present time. Slips associated with farming and roading also rose above historic levels. Pine-derived sediment was detected from the early 20th century, periodically was the dominant contaminant source, and has risen at most coring sites in both Kenepuru and Beatrix Bay since the 1990s. This is despite pine plantations representing less than 15% of the study region. Pine-derived sediment was also detected in samples taken from underneath mussel farms*." The authors concluded, "*What has changed since European settlement has been the significant increase in annual or chronic sediment inputs, which have caused significant ecosystem effects and contributed to a decline in benthic biodiversity. This adds weight to the argument that an integrated range of improved land-use controls, particularly for forestry, in the Marlborough Sounds and the Pelorus and Kaituna River catchments, are required to mitigate chronic sediment inputs to benefit the health of the ecosystem and assist future restoration efforts*."

As well as catchment effect, MacDiarmid *et al*. (2012) also ranked direct physical disturbance of the seafloor from activities such as the use of bottom-towed fishing gear as an important anthropogenic effect on marine environments. Cranfield *et al*., (2003) investigated the impacts of dredging on habitats in Foveaux Strait and reported that "*Initial dredging of a bryozoan biogenic reef destroys and/or removes much of the epifauna, and once the reef surface is broken up, loosened epifauna can be swept away by tidal currents and wave action. With the loss of the baffling effect of epifauna, fine sediments are then subject to transport and may be removed from the area entirely.*"

Davidson and Richards (2015) reported a decline in the area supporting significant sites particularly at offshore soft bottom areas in the Marlborough Sounds. For example, at Perano Shoal, the authors reported the presence of dense tubeworm mounds that are fragile and susceptible to physical damage from anchoring activities. They argued that, if left unprotected, Perano Shoal would eventually lose its status as a significant site. Many of the sites and sub-sites investigated during the present study also supported biogenic habitats that are considered fragile and easily damaged or destroyed, notably those occurring on soft substrata (Plate 25). Like Europe, relatively little of Marlborough subtidal environment remains in a "good" state (Davidson and Richards, 2015). Significant sites are often the last remaining areas of their type and therefore require immediate protection before they too are degraded or lost.

5.4.2 Historic change and the need for protection

The amount of change that has occurred to New Zealand's marine environment since humans arrived is difficult to quantify due to a lack of before, during and after data. The scale of environmental change due to poor documentation, poor recollection, and consequently inter-generational loss of knowledge (i.e. shifting baseline) remains unquantified. Nevertheless, it is clear from historical accounts that large changes have occurred. Handley (2016) cited a statement calling for habitat protection from physical disturbance in the Sounds as early as 1939:

> Sir Harry Twyford, in 1939 on a return visit to New Zealand after a 35-year absence, lamented "a great deterioration of sea fishing at Cable Bay and in Queen Charlotte Sound" and the "loss of bush on the country that does not look good for grazing or anything else". Sir Harry Twyford also stated "fishermen blamed trawlers for destroying breeding grounds" and suggested an exclusion of commercial trawlers from the Sounds.

Some early scientific publications investigated resources such as commercially viable intertidal mussel beds and subtidal scallop and horse mussel beds in the Pelorus Sound (Stead 1991). Widespread subtidal mussel beds in the Firth of Thames also collapsed due to dredging by 1965 (Paul, 2012). Both Marlborough and Firth of Thames mussel beds have not recovered. Another indication of the effect of anthropogenic activities on the marine benthos can be derived from locations in New Zealand where biological values remain intact over widespread areas. Paterson Inlet in Stewart Island is a good example where the forest catchments are mostly intact and biological values on the soft bottom habitats of the Inlet are healthy, diverse and widespread (Smith *et al*., 2005; Willan, 1982).

There is evidence that historic human activities have had major and widespread effects on the New Zealand (and Marlborough) marine environment resulting in the loss of many areas with high biological value (Turner *et al*., 1999; Cranfield *et al.,* 2003; Morrison *et al*., 2009; NIWA, 2013; Morrison *et al*., 2014 A and B; Handley, 2015, 2016; MfE, 2016; Handley *et al*., 2017). Anthropogenic impacts in Marlborough's marine environment have resulted in ongoing biological loss, leaving only remnant areas of some particularly sensitive habitats.

Despite the intense and widespread human pressure and the knowledge that few significant sites remain, there is a poor record of marine protection in Marlborough. Davidson *et al.* (2011) reported that only one (non-terrestrial) significant site was fully protected (i.e. Long Island-Kokomohua Marine Reserve). This reserve represents approximately 0.1 % of the

Marlborough Sounds marine environment. In contrast, most of the terrestrial sites listed in Davidson *et al*. (2011) were protected under the Reserves or Wildlife Acts (e.g. site 2.6 Titi Island).

Since the previous significant site report was produced (Davidson and Richards, 2016), no new protected areas have been established in Marlborough. While there are a variety of partial protection mechanisms (notably fisheries regulations), these focus on the activity of fishing *per se* and do not provide comprehensive protection to vulnerable marine habitats.

The current draft Marlborough Environment Plan aims to provide a level of protection for significant sites under the RMA. At the time of writing, the ability of the RMA to protect habitats from physical disturbance is being tested in the Court of Appeal (Attorney-General versus the Trustees of the Motiti Rohe Moana Trust and others).

5.4.3 Protection of habitats

In terrestrial ecology, it is accepted that protection of a species cannot occur without protection of their habitat. In the marine environment, this link is often ignored. A similar issue in relation to the lack of connection between habitat and fisheries management has been reported in Canada (McCain *et al*., 2016).

For example, in Marlborough, considerable attention has been given to blue cod stocks. Most focus has been on recreational fishing rules such as size limits, fishing seasons and bag limits. Little attention has been given to the protection of adult and juvenile blue cod habitat.

Blue cod regularly inhabit soft bottom biogenic habitats with juveniles <10 cm often preferring sand with a strong component of dead whole shell (Cole *et al.,* 2000; Morrison *et al*., in prep.). Carbines *et al*. (2004) investigated growth rates of blue cod and stated: “Areas of recovering biogenic reef may, therefore, provide important habitat for the recruitment and early development of blue cod in Foveaux Strait.” The authors suggested that “remedial actions may be required to protect some areas of recovering biogenic reef from further damage, and to allow dredged areas sufficient time to recover if the blue cod fishery and related resources are to be managed effectively.”

In the present study, direct evidence of human damage to significant sites was not observed. At two sites, indirect evidence as indicated by a loss of habitats was recorded. Human activities occur near most of the sites. Some of the significant sites have a level of natural protection due to the presence of physical structures such as rocks or reefs (e.g. parts of Rangitoto Islands, Bonne Point, parts of Titi Island). This does not, however, provide long term certainty from damage should human activities or behaviours change.

In Australia, there exists a network of marine and freshwater protected areas. For example, the 98,000 ha Port Stephens-Great Lakes Marine Park (PSGLMP) was established in 2005 using the Marine Parks Act 1997 (now: Marine Estate Management Regulations 2014). The Act is administered by NSW Department of Primary Industries and Ministry for the Environment, with management oversight from the Marine Estate Management Authority (http://www.marine.nsw.gov.au/advisory-bodies/marine-estate-management-authority).

The guideline document for the Park states: "*The PSGLMP zoning scheme enhances conservation of marine habitats and species by providing various levels of protection whilst allowing for multiple use. The four types of zones that are applied in NSW marine parks are sanctuary zones, habitat protection zones, general use zones and special purpose zones.*

SANCTUARY ZONES *provide the highest level of protection for habitats, animals and plants, ecological processes, natural features and areas of cultural significance by allowing only activities that do not harm plants, animals or habitats. Many recreational activities can be conducted in sanctuary zones including guided tours, boating, surfing, snorkelling, diving and permitted research and educational activities.*

HABITAT PROTECTION ZONES *help to conserve marine biodiversity by protecting habitat and reducing high impact activities. A range of activities that are of social, commercial and economic importance to the area may continue in habitat protection zones, including recreational fishing, some forms of commercial fishing, tourist activities and fishing competitions. Habitat protection zones prohibit fish and prawn trawling and estuary mesh and estuary haul netting.*

GENERAL USE ZONES *provide for a wide range of environmentally sustainable activities including both commercial and recreational fishing. General use zones complement other marine park zones and provide an integrated approach to the management and use of the Marine Park. General use zones allow for a variety of activities including trawling but excluding longlining, set-lining and drop-lining. These zones are also found throughout the inlets, bays, estuaries, rivers, creeks and lakes in the Marine Park.*

SPECIAL PURPOSE ZONES *provide for the specific management of aquaculture, fish-feeding, marinas and other vessel related facilities, commercial and residential facilities, fisheries and aquaculture research at a number of locations throughout the Marine Park*"

(http://www.dpi.nsw.gov.au/fishing/marine-protected-areas/marine-parks/port-stephens-marine-park).

5.4.4 End note

Like similar habitats in Port Stephens-Great Lakes Marine Park in Australia, Marlborough's significant sites are important and worthy of protection. Few significant sites remain and those are under serious threat.

It is strongly recommended their protection is prioritised. Without protection, these habitats will continue to decline or be lost which will influence biodiversity, habitat values, and species (including fish) abundance, size, fecundity and recruitment.

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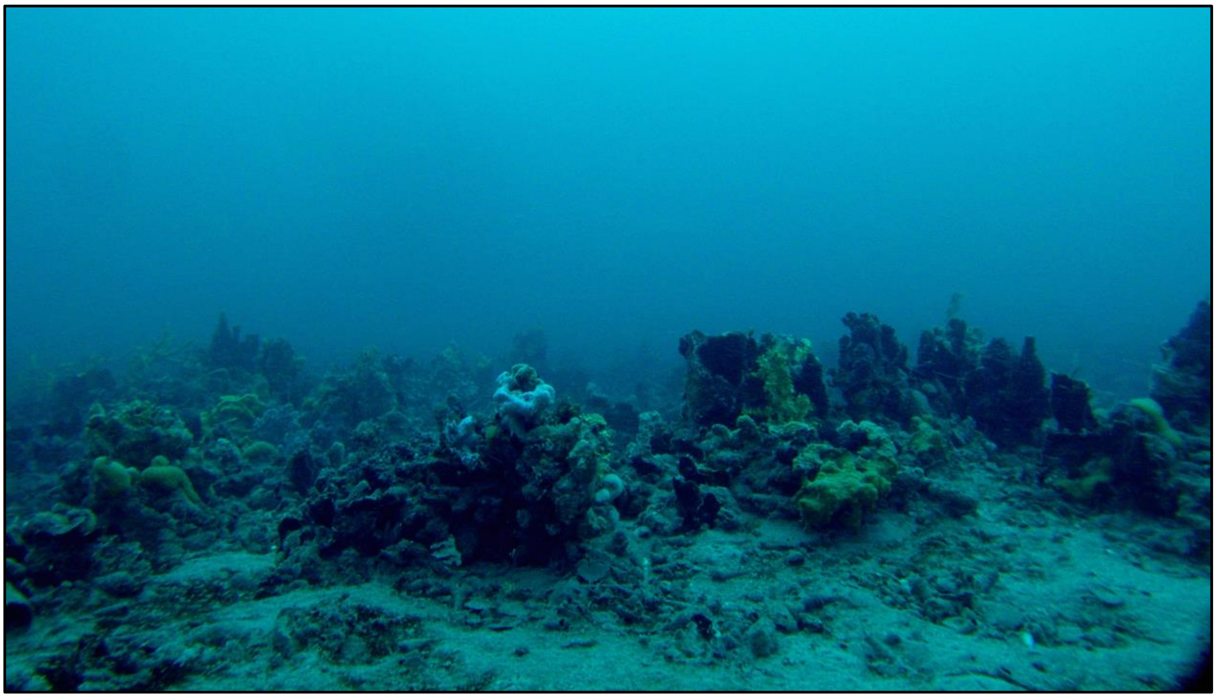

Plate 25. Biogenic community located at north-eastern Rangitoto Passage (6 April 2016).

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