Environment Committee Meeting

15 June 2022

This Report relates to Item 10 in the Agenda

"Significant marine site survey number 7 and the expert panel review (2020-2021): Davidson et al. (2022)"

Davidson Environmental Limited

Significant marine site survey number 7 and the expert panel review (2020-2021)

Research, survey and monitoring report number 1089

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Summary

Fieldwork was conducted in the summer of 2020 - 2021 at 11 sites from Port Underwood, Queen Charlotte Sound (QCS) and Pelorus Sound using a variety of qualitative and quantitative methods (video, high-definition photography, diver investigation, sonar and drop camera). Methods varied between study sites depending on site-specific environmental factors and information needs (see Davidson *et al.,* 2013; 2014) (see Chapter 1 for methods and results).

The ESMS expert panel reviewed the data (Chapter 2) and made the following recommendations:

- Two sites require more data before suggested changes can be approved (Tawero Point, Port Underwood soft tubeworm bed).
- Approve four new reef sites in Pelorus Sound (The Reef, Ketu Bay, Kaitira and Maud Island east).
- Monitor one existing site to determine if it will recover (Puriri Bay red algae bed).
- Adjust the boundary at two existing sites (Perano Shoal, The Knobbys).
- Integrate new data into database for existing sites (Matiere Point, East Bay north coast).

Overall, an additional 32.8 ha of ecologically significant marine sites (ESMS) were described.

Anthropogenic impacts were recorded at some sites resampled in the present study. These include:

- Brachiopods are now rare at Site 4.25 East Bay north. Historically this site supported the highest densities of giant lampshell inside the Marlborough Sounds.
- A decline in red algae at Site 4.22 Puriri Bay over the last three years and an absence of red algae in 2021. Sedimentation covering plants was observed in 2018. This decline and eventual loss coincided with logging in the bay and adjacent catchment.
- Tubeworm mounds have almost disappeared from Site 6.1 (The Knobbys reef). Anchor damage and sedimentation threaten the last mounds.
- Site 4.16 at Perano Shoal has anchor damage. This is the best-known example of a *Galeolaria* dominated site. *Chaetopterus* sp. was observed colonising the area in November 2021. The status (invasive or native) of *Chaetopterus* sp. remains unknown.

Note: Raw data collected during the 2020-2021 season were collated into excel spreadsheets and supplied to MDC for storage (e.g. HD video, photographs). The present report is, therefore, a summary and does not include all raw and compiled data.

1.0 Background information

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)). Policy 11 of the New Zealand Coastal Policy Statement 2010 also identifies where and how adverse effects on indigenous biodiversity must be avoided, remedied or mitigated.

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 applied 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 regularly.

Davidson *et al.* (2013) outlined a protocol for receiving information for new candidate sites and for reassessing existing ecologically significant marine sites. That report aimed 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 "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". That report included surveying and monitoring methodologies, options for prioritizing survey sites and guidance on reporting.

In particular, Davidson *et al.* (2014) aimed to add to the ecologically significant marine sites programme by guiding the collection, storage and publication of biophysical data from potential new significant sites as well as existing sites.

A programme of survey and monitoring has been conducted from 2015 (see Appendix 2 for a summary). Davidson and Richards (2015) conducted the first survey and monitoring programme for Marlborough's significant marine sites programme 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 and third survey events were conducted in the outer north-western Marlborough Sounds and Croisilles Harbour (Davidson and Richards, 2016; Davidson *et al*., 2017). The fourth and fifth survey events were conducted in the summers of 2018 and 2019 and targeted Pelorus Sound (Davidson *et al*., 2018, 2019). In the 2020 study, although only a small amount of fieldwork was possible due to the Covid19 event (Davidson *et al*., 2020), the authors were able to update many sites using data from a NIWA multibeam bathymetric survey. All sites in the 2020 report were from Queen Charlotte Sound, Tory Channel and Port Underwood.

A small number of studies relevant to the ESMS programme continue to occur in the Marlborough Sounds (e.g. Handley *et al*., 2017; Davidson *et al;* 2019c; Anderson *et al*., 2020a; 2020b; Ribó *et al.,* 2021). Aspects of these studies are integrated into the ESMS programme on a site-by-site basis.

A summary of the expert panel recommendations has been included for each site in Appendix 1.

CHAPTER 1: FIELD SURVEY 2020-2021

2.0 Survey programme (2020-2021)

2.1 Field work methods

A variety of standard field 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, water currents, water clarity).

Sonar imaging

Sonar investigations of the area were conducted 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 collected traditional sonar data. Sonar data were converted into Google Earth files and overlayed onto Google Earth imagery.

Drop camera stations and site depths

At each drop camera station, a standard 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.

Underwater HD video and still photography

HD underwater video was collected using a remote GoPro Hero 4 (black), Hero 7 or a Paralenz HD camera. Cameras were either (a) mounted on a purpose-built frame and used in conjunction with the low-definition camera, (b) mounted on a cabled purpose-built tripod, or (c) hand-operated by a diver. The GoPro camera also collected HD still photographs at 5-second intervals. Depending on water conditions, the GoPro Hero 4 or 7 was often fitted with a macro-lens to improve video resolution, especially at close quarters.

When the GoPro's or Paralenz cameras were lowered as remote cameras 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.

All media data were transferred to an MDC database.

Percentage cover estimation

The percentage cover of biological features (e.g. macroalgae, biogenic clumps) from GPS-positioned drop camera images was 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 for all images to ensure consistency. All photo images were numbered and coded for GPS position, depth and a percentage cover score.

Surface photos

A representative surface photo was taken at most sites using a Samsung S20 Note. Normal and panoramic modes were used to collect surface photos. Selected surface photos are included in Excel spreadsheets and all photos are held on the MDC database.

Diver surveys

The Knobbys reef was surveyed by divers in April 2021. Divers qualitatively recorded presence/absence and the health/appearance of tubeworm mounds along the reef structure. Divers also noted damage to mounds.

Historic data and reports

Data from a variety of sources were compiled from previous reports, significant site surveys or other sampling programmes (e.g. marine reserve monitoring; marine farm monitoring, NIWA multibeam bathymetric survey, hydrodynamic models). These data were integrated with other historical data and also integrated with data collected during annual significant site surveys. For example, multibeam depth contour data were used to delineate boundaries for existing sites where drop camera, diver, HD camera or other data had been previously collected. Using this approach new boundaries for previously described sites were able to be fine-tuned (see Chapter 4 for more detail on other studies).

2.2 Excel site sheets and data

Field data collected from sites sampled during the present study were entered using a predesigned Excel template. Datasheets 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).

2.3 Species, communities and habitats

The following major species, community or habitat types have been used as categories in Marlborough's ESMS programme.

1. Bryozoan dominated reef (soft or rocky bottom).
2. Biogenic - mixed species reef (soft or rocky bottom).
3. Brachiopod bed.
4. Shellfish bed (e.g. dog cockle, horse mussel, scallop, cockle).
5. Tubeworm bed (calcareous) (e.g. *Galeolaria hystix*).
6. Tubeworm bed (non-calcareous) (e.g. *Owenia, Spiochaetopterus, Acromegalomma suspiciens, Bispira bispira* spA*)*.
7. Burrowing sea cucumber bed (e.g. *Thyone* spA).
8. Rhodolith bed.
9. Macroalgae forest and/or meadow on rocky bottom (e.g. *Macrocystis, Ecklonia, Lessionia, Carpophyllum, Marginariella, Landsburgia, Durvillaea, Sargassum, Caulerpa* spp., *Caulerpa* spp.).
10. Macroalgae bed on soft sediment (red, green and brown algae, drift algae).
11. Seagrass (eelgrass) (subtidal and intertidal).
12. Fish site (e.g. habitat (lancelet bed), spawning area (elephantfish egg-cases)).
13. Seabird colony.
14. Shell rubble and shell hash.
15. Reef (bedrock, boulders, cobbles).
16. Boulder bank.
17. Cuspate foreland.
18. High current.
19. Native forest catchment.

2.4 Data sources

New data were used to update six existing significant sites (Table 4). Sources of data included, but were not limited to:

- The present study.
- Ribó *et al.* (2021) data were collected in Spring 2018. The work was funded by the University of Auckland Faculty Research Development Fund (FRDF), “Evaluating Suspended Sediment Impacts on Benthic Ecosystems” and by the Sustainable Seas National Science Challenge (Phase II) project “Understanding ecological responses to cumulative effects”. Video and photographic data were collected from many sites in Queen Charlotte Sound. These data when combined with a variety of existing studies on biology, hydrodynamics and hydrographic data allowed the authors to make predictions relating to habitat suitability for shallow-water filter-feeder marine species and communities in Queen Charlotte Sound.
- Anderson *et al*. (2020) undertook video and camera surveys in Queen Charlotte Sound, Tory Channel and Cook Strait to ground truth and visually characterise habitats and communities previously surveyed using multibeam technologies. The authors collected a total of 58 linear kilometres of seafloor video, with 6,251 seafloor characterisations from 358 video sites. Of those, the survey collected 36.6 km of video with 5,062 data points from 149 sites.
- Neil *et al*. (2018a, 2018b) and Watson *et al.* (2020) presented bathymetric data for Queen Charlotte Sound (see MDC Smart Maps website).
- Hydrodynamic models for Queen Charlotte and Pelorus Sounds have been developed by NIWA (Hadfield et al., 2014; Broekhuizen *et al*., 2015).
- Duffy *et al.* (unpublished data) collected presence/absence and qualitative descriptions in 1990 from 360 sites throughout the Marlborough Sounds.
- Davidson *et al*. (2011) produced the first ESMS report.
- Davidson and Richards (2015) produced the first significant site summer survey that included work at Puriri Bay.
- Davidson and Richards (2014) presented an 11-year data set that included a transect located in Puriri and Te Aroha Bays, East Bay.

3.0 Survey results (2020-2021)

The present report provides summary information for 11 study sites investigated in the summer of 2020 to 2021 (Figures 1a, b, c). Data (i.e. maps, photos, video, sonar) have been compiled for each site in separate Excel spreadsheets and stored in the MDC database.

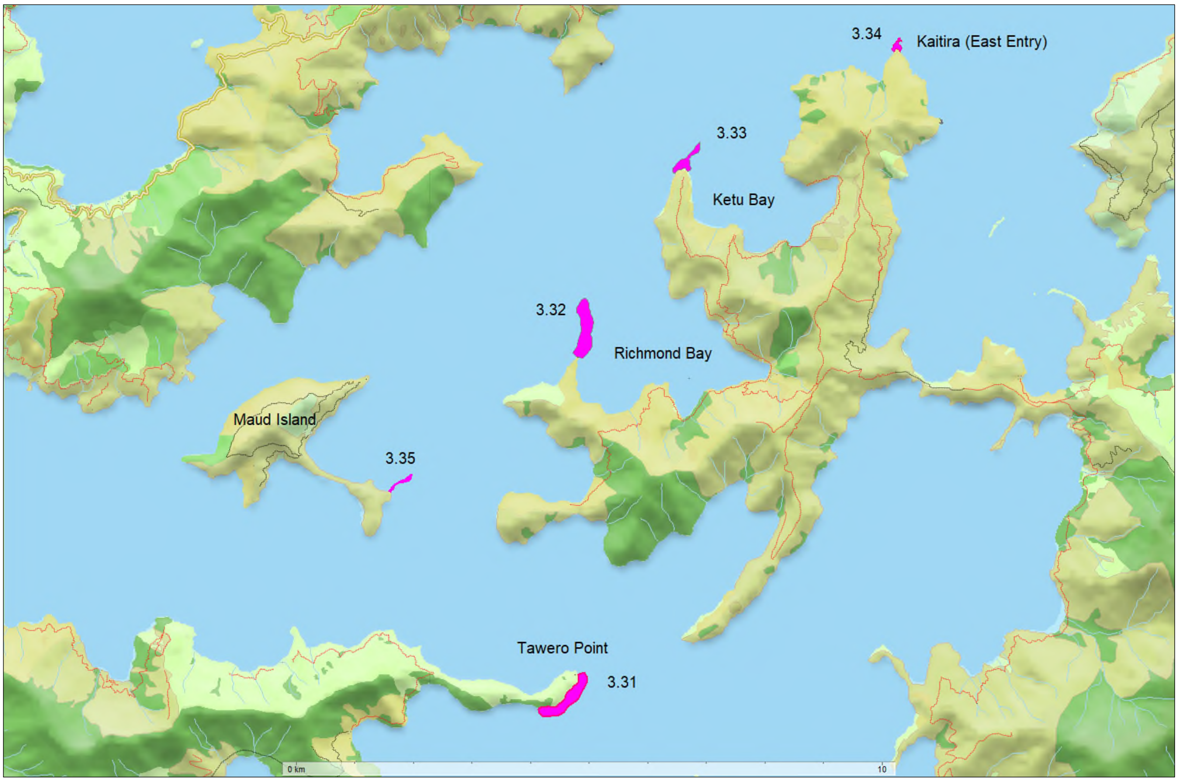

Figure 1a. Location of new sites (2.32, 3.33, 3.34, 3.35) and modified existing site (3.31) (pink polygons) in Waitata Reach, Pelorus Sound.

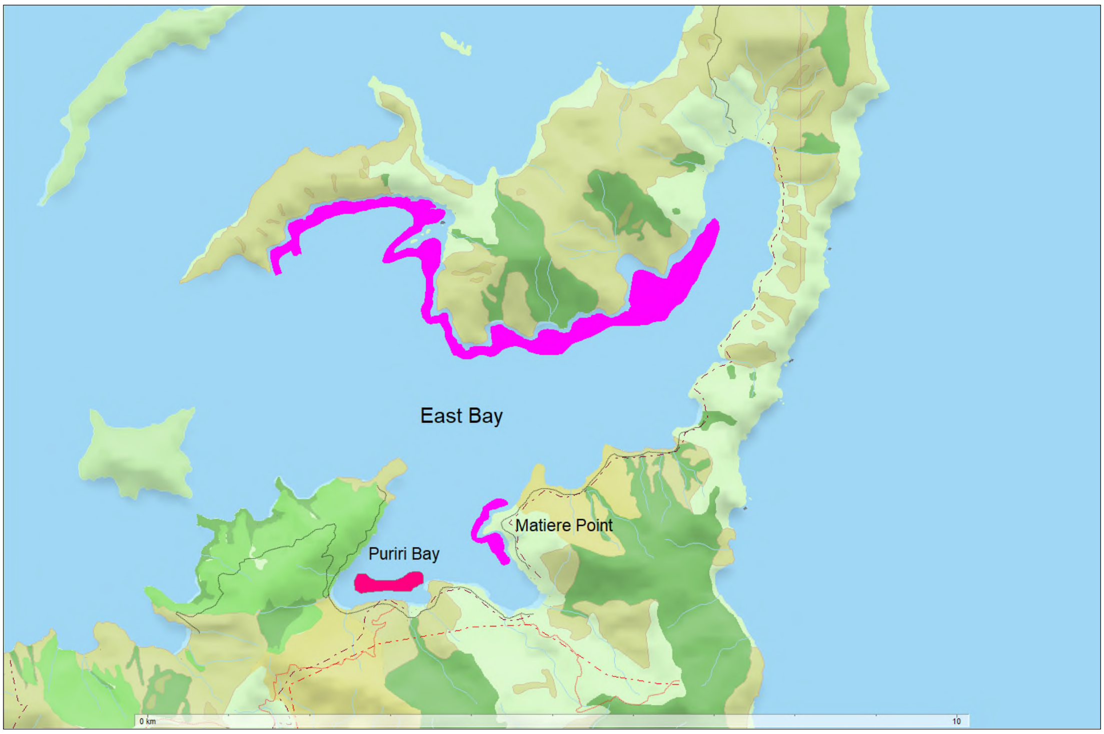

Figure 1b. Location of modified sites (Matirere Point and northern East Bay) and Puriri Bay site (pink polygons) in East Bay, Queen Charlotte Sound.

Figure 1c. Location of existing sites (Perano Shoal and The Knobbys) and a suggested new tubeworm site in Port Underwood (pink polygons).

3.1 Existing sites

Site 3.31 Tawero Point (current swept community)

Location: Tawero Point at the confluence between Popoure Reach and Tawhitinui Reach, central Pelorus Sound is at the tip of a 2.5 km long promontory extending eastwards from northern Wilson Bay (Figure 2). The Point is swept by moderate to strong tides, particularly the outgoing tide (0.3 m/sec) (Broekhuizen *et al.,* 2015).

Features: Tawero Point was first recognised as a significant site in Davidson *et al.* (2011). Initially, Site 3.11 comprised three sites, however, the other two have since been resurveyed and renamed as separate sites. Tawero Point was described in 2011 as supporting "a wide variety of filter-feeding organisms including biogenic habitat formers such as bryozoans, sponges, ascidians, horse mussels and hydroids present at these sites. Fish, particularly blue cod, are common and these communities also provide habitat for juvenile blue cod. These are some of the best examples of tidally swept habitats within the Pelorus biogeographic area".

New data: Detailed bathymetric and multibeam sonar data have been collected from this area by NIWA in 2020. The new depth contour data was used to assist with the collection of new data as part of the present study (Figure 2). A total of 19 drop camera stations were established along this coast and one video station was also sampled.

The site is characterised by a steep shore increasing quickly to 50 m depth. Most of the substrata was either boulder and cobble interspersed by coarse sands and broken and whole shell material (Plates 1 and 2). In many deeper areas, natural shell rubble was widespread (Plate 3). Isolated areas of outcropping bedrock were at isolated locations and were not widespread at this site.

Rocky and whole shell substrata supported a variety of epibenthic species dominated by filter-feeding species. Of note were hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*) and sponges (*Ecionemia alata, Mycale* sp.). Solitary tubeworms and brachiopod (*Terabratella* sp.) were also present. Overall filter-feeding species ranged from occasional to common.

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Plate 1. Steep boulder and cobble bank with sand and shell at 6.5m depth. Note the presence of compound ascidians (*Didemnium* spp.).

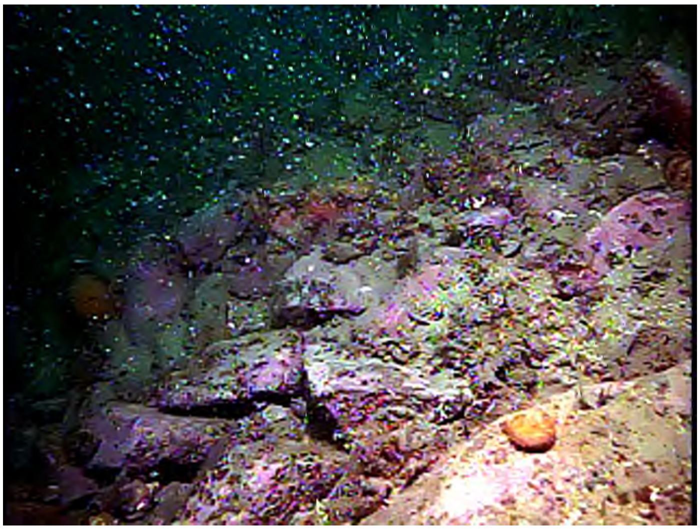


Plate 2. Boulder and cobble bank with sand and shell at 19.6m depth. Note the presence of compound ascidians and sponges.

Plate 3. Silt and natural shell rubbles at 41.5m depth. Note the presence of brachiopods and hydroids.

Ecological relevance: The site is the best-known rock dominated current swept habitat of its kind between Tawero Point and Havelock (i.e. inner Pelorus Sound). Several other sites supporting a higher diversity and abundance of filter-feeding species are known from in central/outer Pelorus Sound.

Anthropogenic Issues: Most of the site is located on a steep rocky slope swept by regular moderate to strong tidal flows. Most fishers do not anchor at this site due to depths, currents and boat traffic (Table 1). Species, habitats or communities present can tolerate low-level anthropogenic seabed disturbance due to the nature of the substrata, community, species and/or hydrodynamic regimes (i.e. tolerant of occasional recreational anchoring). These features are not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops.

The site receives turbid water from the inner Pelorus Sound. The impact of sediment at this site is not known but is likely minimized due to regular tidal currents. In general, fine sediment was most apparent at depths >26m where currents are lower allowing sediment to settle, compared to shallow areas where currents are stronger.

Table 1. Assessment of anthropogenic impacts for Site 3.31 (Tawero Point).

Original area of significant site (ha)	31.26
Previous area of significant site (ha)	
Recommended area of site (ha)	17.5
Change (ha)	-13.76
Percentage change from original (%)	-44%
Sensitivity	Sensitive (B) Supports species, habitats or communities that can tolerate low-level anthropogenic seabed disturbance due to the nature of the substrata, community, species and/or hydrodynamic regimes (i.e. tolerant of occasional recreational anchoring). Not tolerant of dredging and trawling.
Threats	Site is located along and close to a rubble bank thereby reducing the chance of dredging or trawling. Anchoring is possible. The site receives turbid water from inner Pelorus Sound The impact of sediment at this site is not known but is likely minimized due to regular tidal currents.
Impact observed	No damage from anchoring has been previously observed. Fine sediment present at depth.
Suggested buffer	50 m

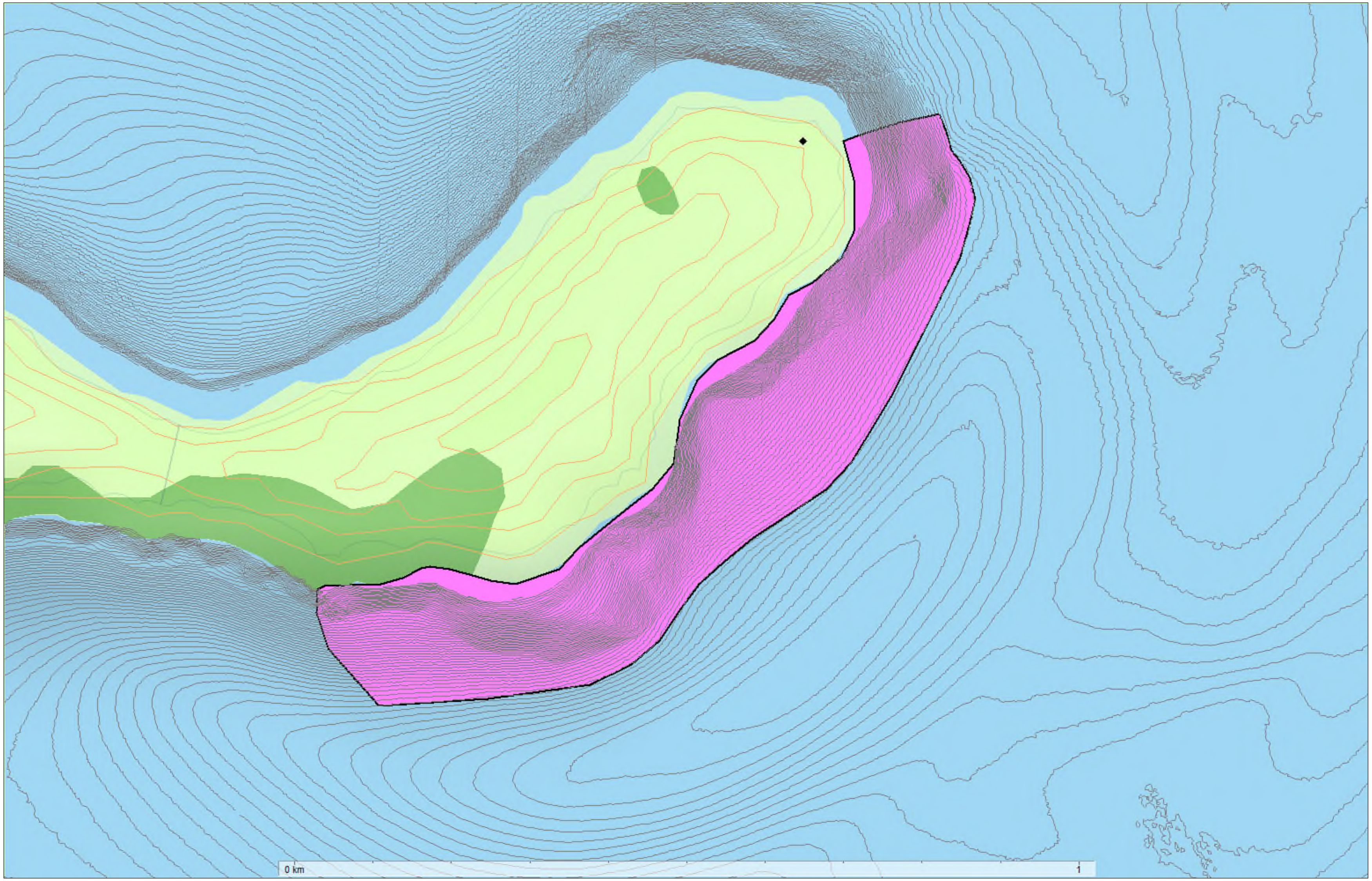


Figure 2. Tawero Point depth contours relative to the presently suggested site boundary (pink) ranging from approximately 0 to 50 m depth.

Site 4.16 Perano Shoal (tubeworm mounds)

Location: Perano Shoal is an offshore rise located in the entrance to Blackwood Bay and adjacent to the smaller Tauranga Bay, 10.7 km north-east of Picton (Figure 3).

Features: The presence of tubeworm mounds was first documented during a dive survey in the early 1990's (Duffy *et al*., unpublished data). The Shoal was included as a significant site because of the high density of tubeworm mounds (Davidson *et al*., 2011). Occasional burrowing anemones have also been seen (Plate 4). The site was surveyed in more detail by Davidson and Richards (2015) and a percentage cover of damage was also established. The authors stated "the top of the shoal is between 5m and 7m depth and is predominantly exposed bedrock with few or sparse mounds. Below and surrounding the bedrock outcrop are areas of shell and fine sand, swept by low-moderate tidal currents (Hadfield *et al*., 2014)". Davidson and Richards (2015) stated Perano Shoal supported a high-density bed of tubeworms dominated by *Galeolaria hystrix*, *Spirobranchus latiscapus* and an unidentified *Serpula* sp. Mean percentage coverage recorded from diver collected quadrats was 76.67%. Perano Shoal.

Plate 4. Burrowing anemone at Perano Shoal.

New data: Anderson *et al*. (2020a) conducted a new survey of Perano Shoal and confirmed the presence of continuous tubeworm mounds from 5.9m to 30m with some mounds extending beyond the base of the reef to 40m depth (Figure 3). The authors also reported live dog cockle beds (*Tucetona laticostata*) along the upper slopes of the Shoal in water depths of 14.1 to 25.5 m. They also suggested these beds have contributed to a shell rubble biogenic habitat located down the flanks of the Shoal. Anderson *et al*. (2020a & b) recommended the existing significant site be adjusted to include these features (Figure 3).

Anderson *et al*., (2020b) also produced a report modelling habitat suitability of bryozoan and *Galeolaria* mounds in the wider Queen Charlotte Sound. This site provided the opportunity to ground truth the model created by Anderson et al. (2020b).

In May 2020, a small number of drop camera and HD still images were collected using a remote video from areas around the southern Shoal (Plates 5a & b). In March 2020 University of Auckland divers collected photos from the same area of the Shoal (Plate 6). Overall diver and camera data showed tubeworms remain healthy and were most abundant around 13 m depth. No major colonisation of the soft tubeworm *Chaetopterus* sp. was observed in 2020 or 2021.

Ecological relevance: Perano Shoal supports a high-density bed of calcareous tubeworms. It is the best-known and largest example of its kind in the Marlborough Sounds and possibly New Zealand. Several other sites supporting high densities of *Galeolaria hystrix* are known from the Sounds. Most beds show damage from human activities, and some are in advanced states of decline (e.g. The Knobbys).

This is the only known locality for a living example of *Protulophila*, a colonial hydroid previously known only from Europe and the Middle East, Jurassic to Pliocene (Dennis Gordon, http://www.niwa.co.nz/news/northern-hemisphere-fossil-discovered-living-in-new-zealand; https://niwa.co.nz/blog/critteroftheweek/124).

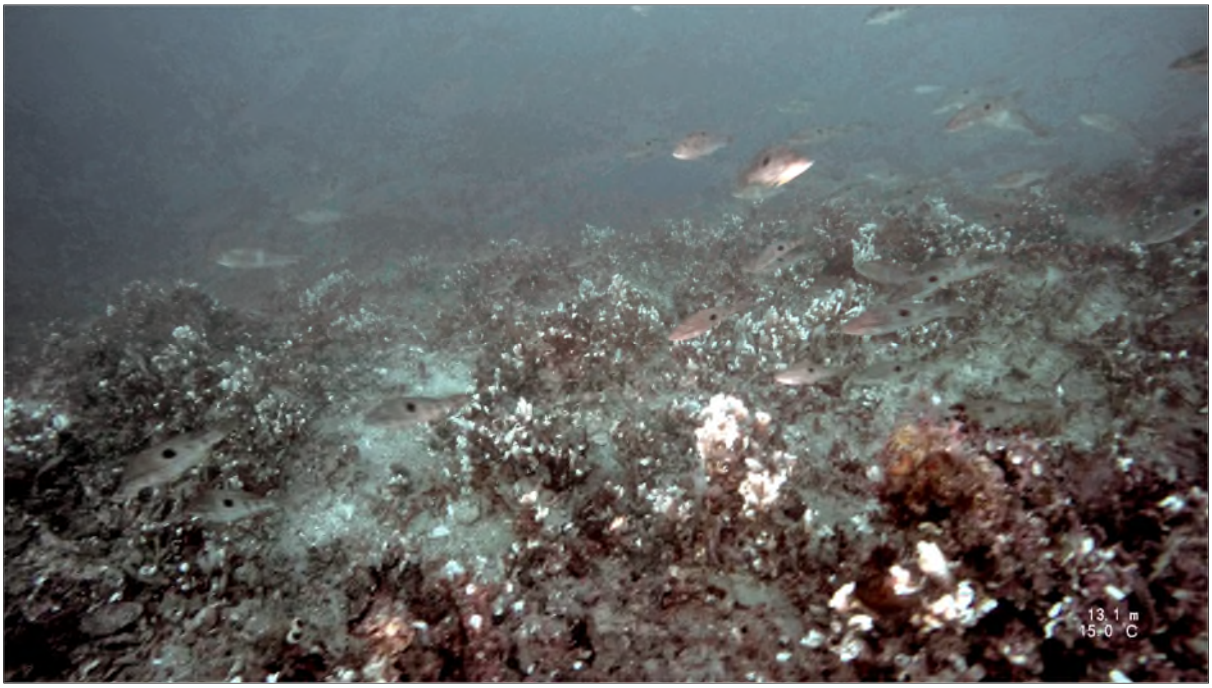
Anthropogenic issues: Davidson and Richards (2015) collected data on tubeworm mound damage from an area at the southern end of the Shoal (Table 2). They observed anchor drag marks running off the high point of the Shoal into deeper waters and reported 13.6% of the substratum sampled was damaged by anchoring activities (Plate 6). Anderson *et al*. (2020a, 2020b) reported widespread damage to *Galeolaria* mounds at 36% of their 47 sample sites where mounds were recorded in Queen Charlotte Sound and Tory Channel.

In November 2021 additional photos were collected from the area. Colonisation by *Chaetopterus* sp. was observed around navigational the safety marker mooring block and adjacent areas (Plates 7a & 7b). Based on observations made where *Chaetopterus* sp. has become prevalent, the Perano *Galeolaria* mounds may become smothered by *Chaetopterus*.

Table 2. Assessment of anthropogenic impacts for Site 4.16 (Perano Shoal).

Original area of significant site (ha)	3.775
Previous area of significant site (ha)	5.463
Recommended area of site (ha)	5.6
Change (ha)	0.137
Percentage change from original (%)	49.1%
Sensitivity	Very sensitive (A) Site support species, habitats or communities that cannot tolerate anthropogenic seabed disturbance (i.e. anchoring, all forms of dredging and trawling).
Threats	Site is located close to a natural reef thereby reducing the chance of dredging or trawling. Anchoring occurs and has resulted in damage. *Chaetopterus* is now present and may smother mounds.
Impact observed	Damage from anchoring has been previously observed and quantitatively surveyed.
Suggested buffer	200 m

Plate 5a. Perano Shoal 13m depth taken in May 2020



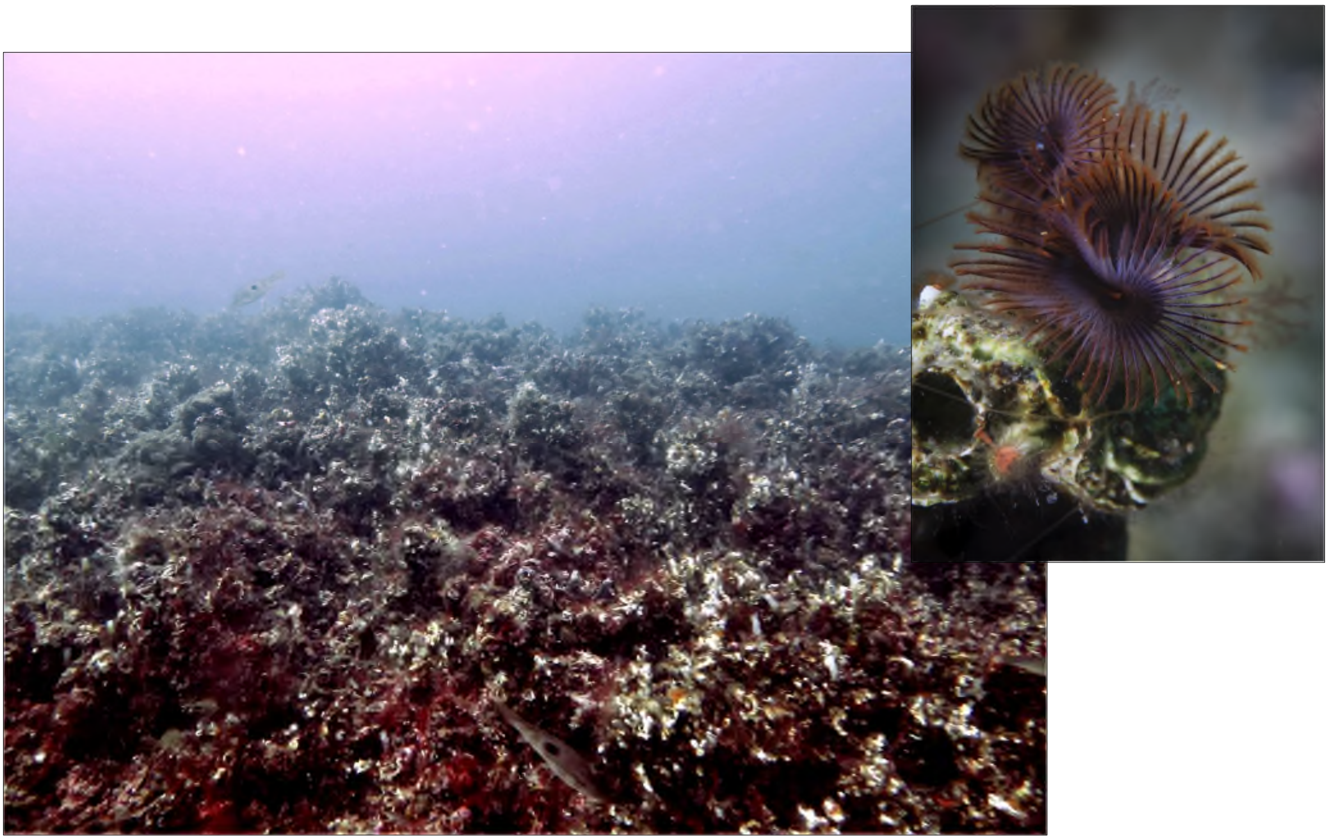


Plate 5b. Perano Shoal tubeworms March 2021 (Photo Jen Hillman). Insert: tubeworm *Spirobranchus* sp. at Perano Shoal (photo Vincent Zintzen).

Plate 6. Damaged and broken mounds as a result of anchor drag (2015).

Plate 7a. Colonisation of *Chaetopterus* sp. in November 2021 (Photo Oliver Wade).

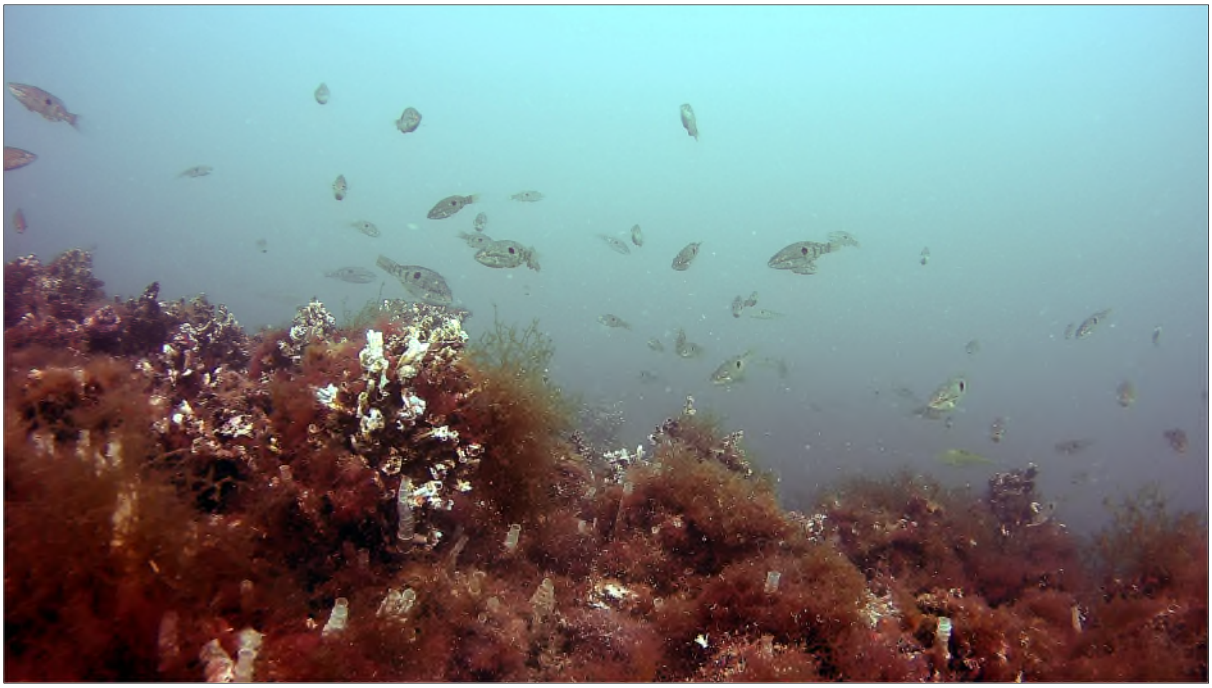


Plate 7b. Colonisation of *Chaetopterus* sp. in November 2021 (Photo Oliver Wade).

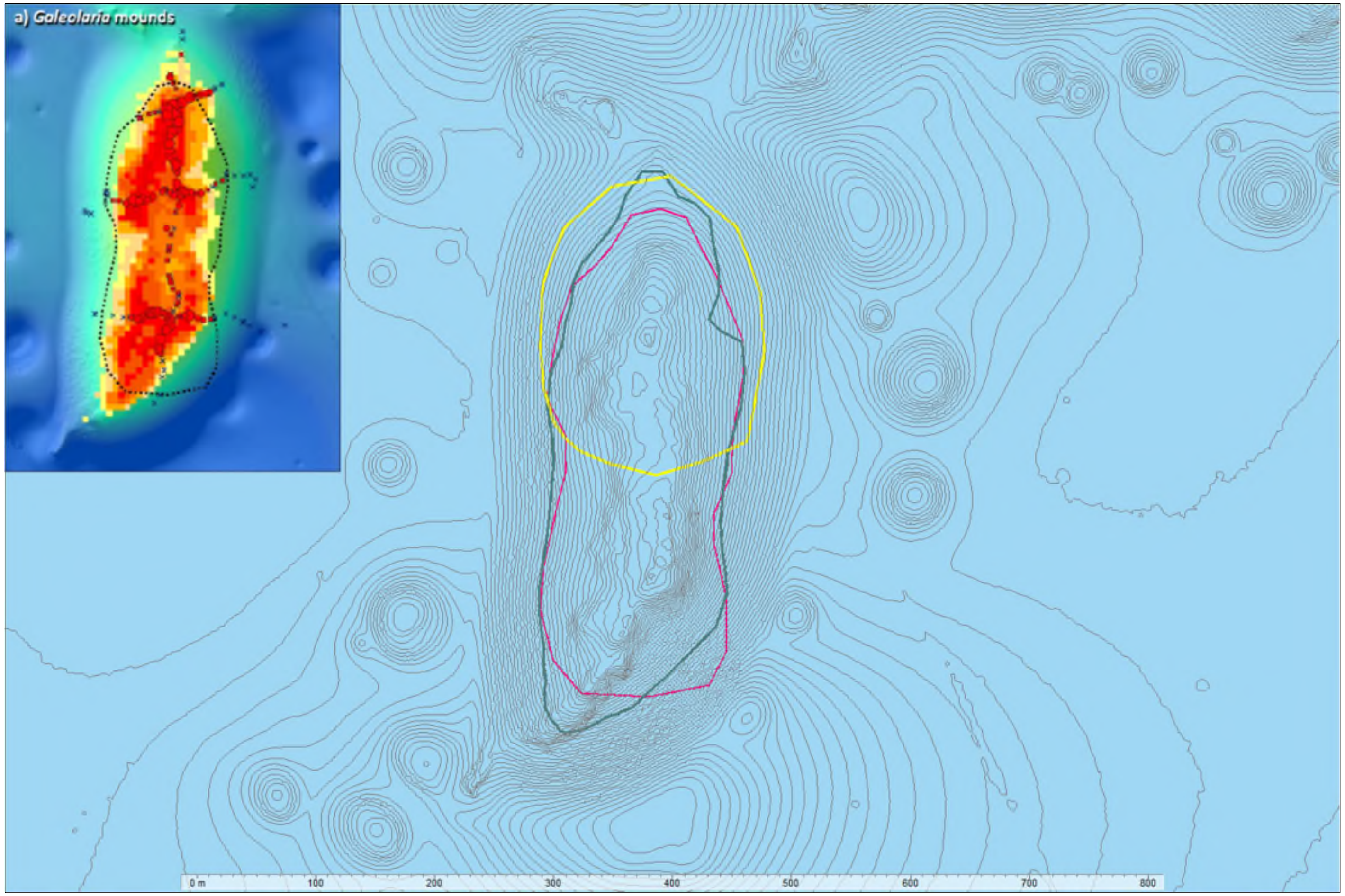


Figure 3. Perano Shoal depth contours relative to 2011 (yellow), 2015 (red) and the presently suggested 40m contour boundary (teal). Insert from Anderson *et al*. (2020b) showing the location of live mounds.

Site 4.22 Puriri Bay (macroalgae bed)

Location: Puriri Bay is a small bay at southern Otanerau Bay, East Bay and has a coastline approximately 2km long, a sea area of 39.4 ha, and is 1 km wide at the bay mouth (Figure 4).

Features: In 2015, the 14.3 ha algae bed was one of the largest known of its kind in Queen Charlotte Sound (Davidson and Richards *et al.,* 2015). The red algae *Adamsiella augustifolia* often covered 100% of the seabed (mean cover = 40-45% cover) in association with a variety of other species including scallops, giant lampshell and horse mussels.

A transect through the algae bed was sampled from 2002 to 2013 by Davidson and Richards (2014) and reported red algae was always present. In the section of the transect where red algae were present, the percentage cover ranged from 30 to 80 % cover over the 11 years (i.e. 100 and 150 m along their transect). Algae percent cover estimates were collected twice firstly in 2002 and separately in 2015.

The extent of the red algae bed in the wider bay was first sampled using a drop camera in November 2008 and these were used to map its boundaries (see Davidson *et al.,* 2011). Photos were collected in January 2015 showed a reduction in the area occupied by red algae compared to 2008 (Plate 8a), however, compared to 2002, the mean increased from 10-15% to 40 to 45% in 2015.

Davidson and Richards (2015) stated the reason for the decline in the area occupied by red algae over the wider bay was unknown and suggested it may be natural as red algae in the western bay were less dense compared to the eastern side of the bay in 2008. The authors of the 2015 report noted recent logging activities in Puriri Bay.

Anderson *et al*., (2020a) sampled Puriri Bay in 2018. The authors reported a further loss of red algae compared to previous surveys reported in Davidson and Richards (2015). The authors commented, "*Adamsiella* at site Q28 is unlikely to fare well under this amount of fine silt, indicating that further losses may occur" (see Plate 8b from Anderson *et al*., 2020a).

New data: The same sites sampled in January 2015 were resampled using a drop camera in April 2021 (Figure 4). The mean percentage cover of macroalgae in 2021 was zero at all but two stations. At most stations, the camera was allowed to drift. No additional areas of macroalgae were observed. Monitoring of a red algae bed in Port Underwood has shown a seasonal change on percentage cover from winter to warmer months, however, percentage covers remain the highest over spring, summer and Autumn (Davidson et al., 2021).

Ecological relevance: This red algae bed was once the largest of its kind known from QCS.

Anthropogenic issues: The site is in a relatively shallow (<21m depth) bay with a gently sloping gradient comprised of fine sands, silt and natural shell substrate around the edges and silt and shell in deeper areas. Levels of catchment derived sediment at this site have not been quantified, but it is likely the bay is susceptible to sedimentation due to its semi-enclosed and low current regime (Table 3). According to 2014 MPI data, the bay has been dredged historically for scallops. Dredging for scallops has not occurred over the past five seasons (2016 onwards).

The reason or reasons for the algae decline after a stable period of several years (2002-2013) is likely associated with increased sedimentation (Plate 8b). Logging within Puriri Bay and beyond has likely increased sediment at the site as reported by Anderson *et al.* (2020).

Table 3. Assessment of anthropogenic impacts for Site 4.22 (Pururi Bay macroalgae bed).

Original area of significant site (ha)	14.3
Previous area of significant site (ha)	
Recommended area of site (ha)	0
Percentage change from original (%)	100%
Change (ha)	-14.3
Sensitivity	Sensitive (B) Supports species, habitats or communities tolerant of low-level anthropogenic seabed disturbance due to the nature of the substrata, community, species and/or hydrodynamic regimes (i.e. tolerant of occasional recreational anchoring). Not tolerant of dredging and trawling.
Threat	The area has supported scallops and has been dredged. The impact of sediment is not known but the site may be susceptible to sediment smothering due to the sheltered and semi-enclosed bay.
Impact observed	The red algae bed no longer is present.
Suggested buffer	100 m

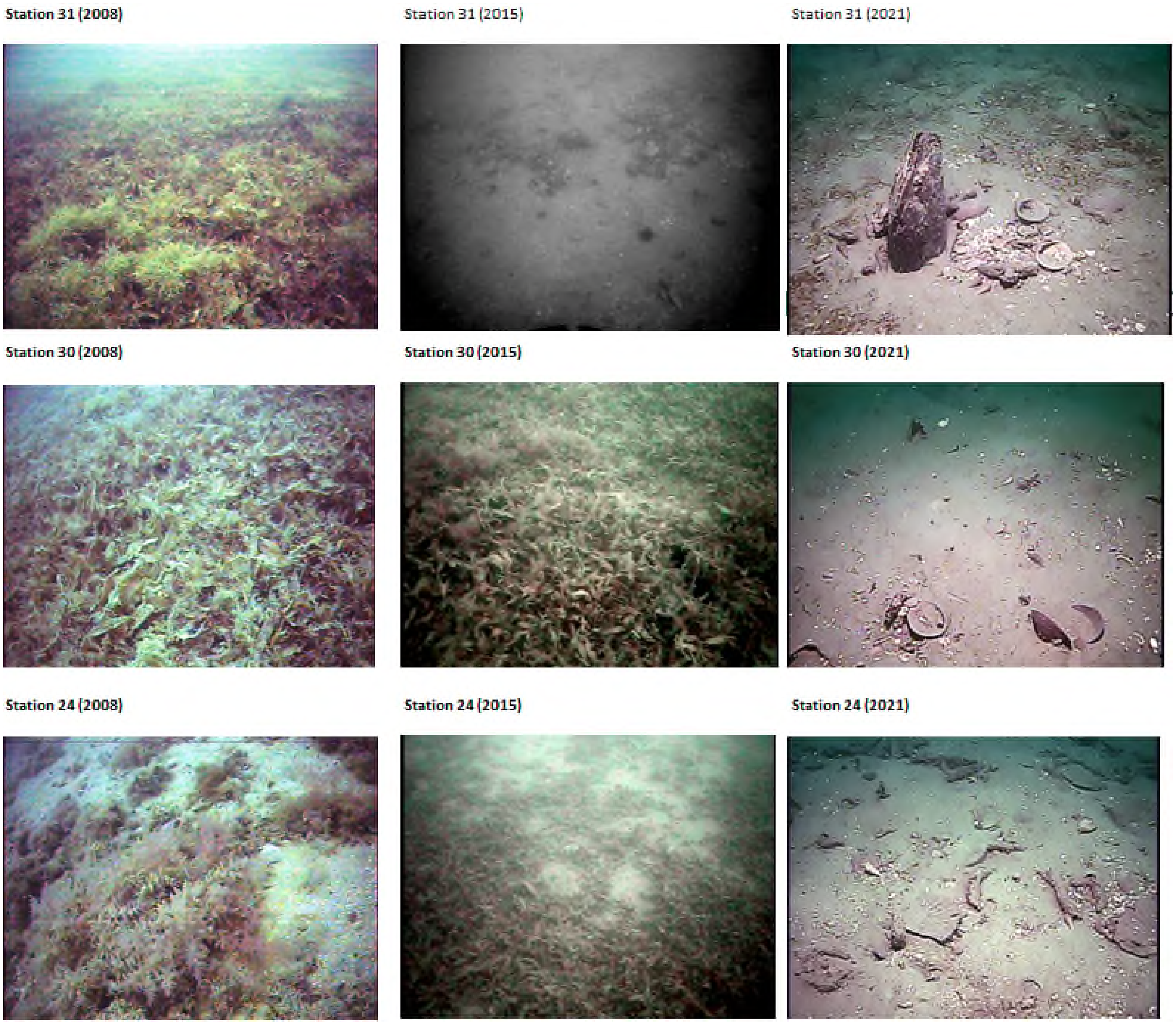


Plate 8a. Time series photos from three stations in Puriri Bay. Note: stations sampled in 2008 are close to but not the exact locations sampled in 2015 and 2021.

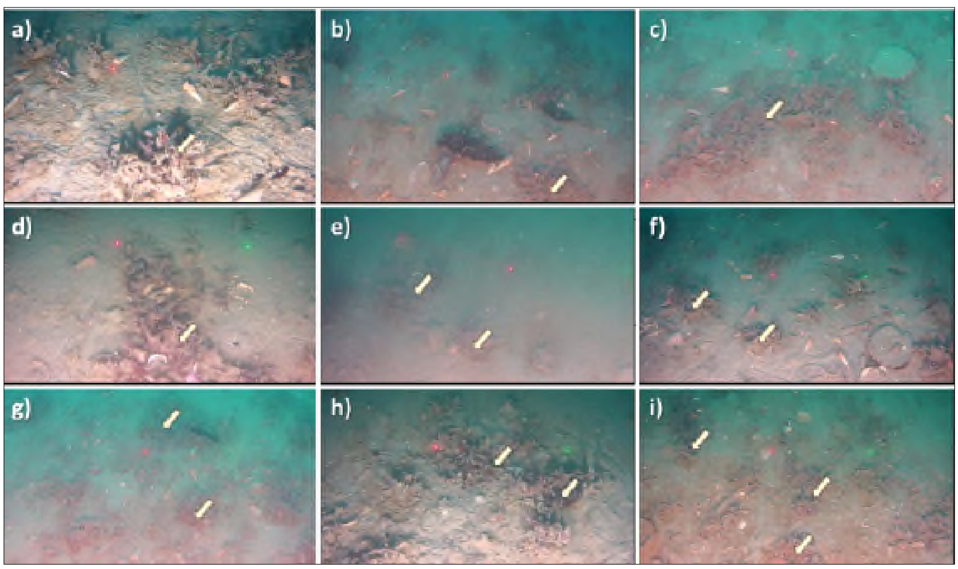


Plate 8b. From Anderson *et al*. (2020). *Adamsiella* patches" (see arrows) in Puriri Bay 2018.

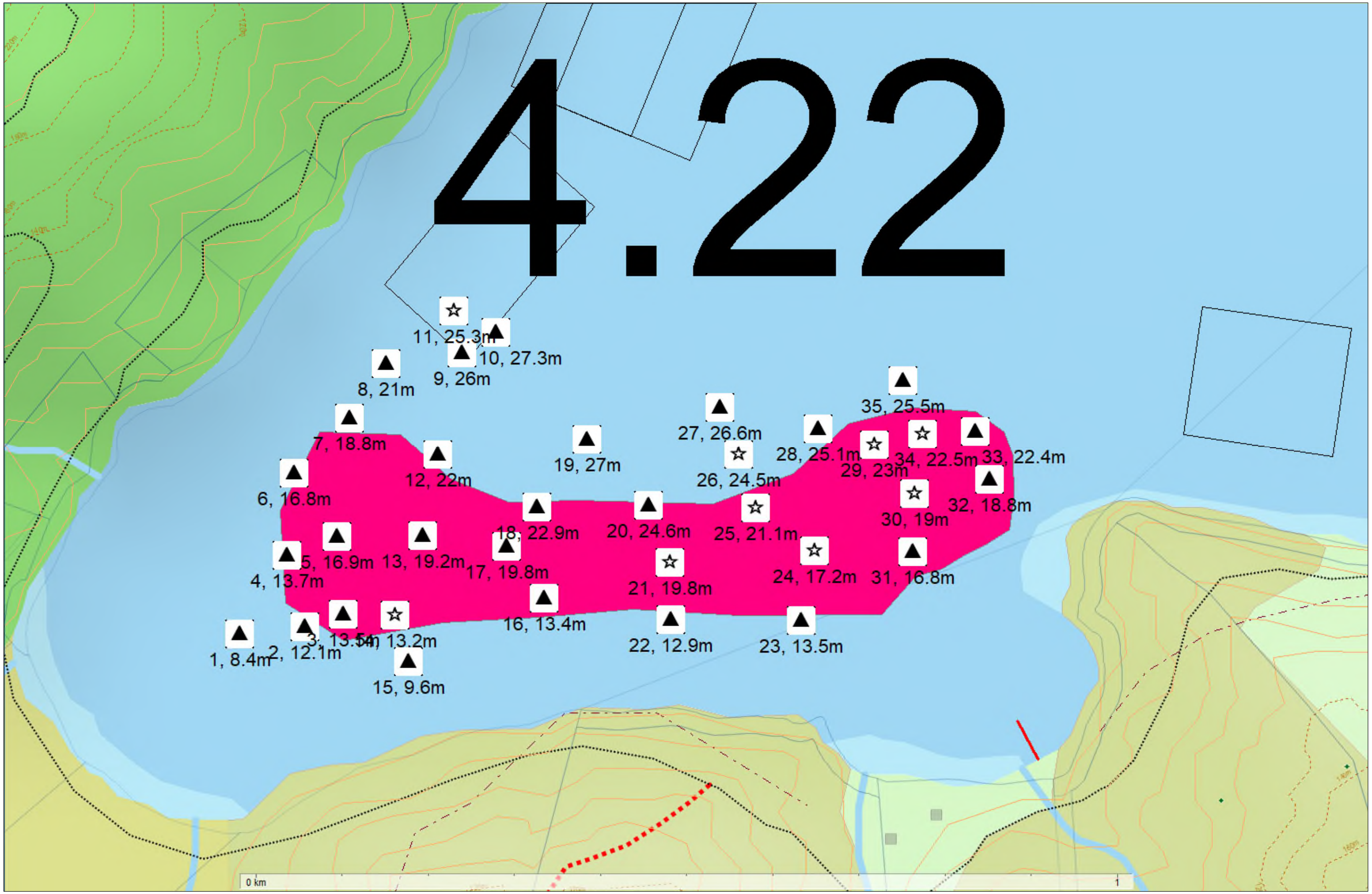


Figure 4. Puriri Bay macroalgae bed in 2008 (red polygons). Open stars are 2015 drop camera stations that supported red algae.

Site 4.23 Matiere Point (subtidal)

Location: Matiere Point coast is located in central East Bay, outer Queen Charlotte Sound (Figure 7).

Features: Southern parts of this site was monitored regularly for 10 years as part of a marine farm recovery study (Davidson and Richards, 2014). Giant lampshells were consistently recorded from the southern transects. Davidson and Richards (2015) found giant lampshells along a new transect on the northern side of Matiere Point, but in lower numbers compared to the southern transects sampled by Davidson and Richards (2014). The authors reported burrowing anemone (*Cerianthus* sp.) regularly between 22m and 28m depth along this northern transect (Figure 5).

Davidson *et al.*, (2020) updated the site polygon based on detailed bathymetric and multibeam sonar data collected from this area by Neil *et al*. (2018a, 2018b) (Figure 5). The new depth contour data were used to improve the accuracy of the depth range where burrowing anemones at this site and other sites in the Sounds (approximately 10m and 28m depth) and giant lampshells in East Bay (approximately 20m to 34m depth) had been previously determined (Davidson and Richards, 2014; 2015).

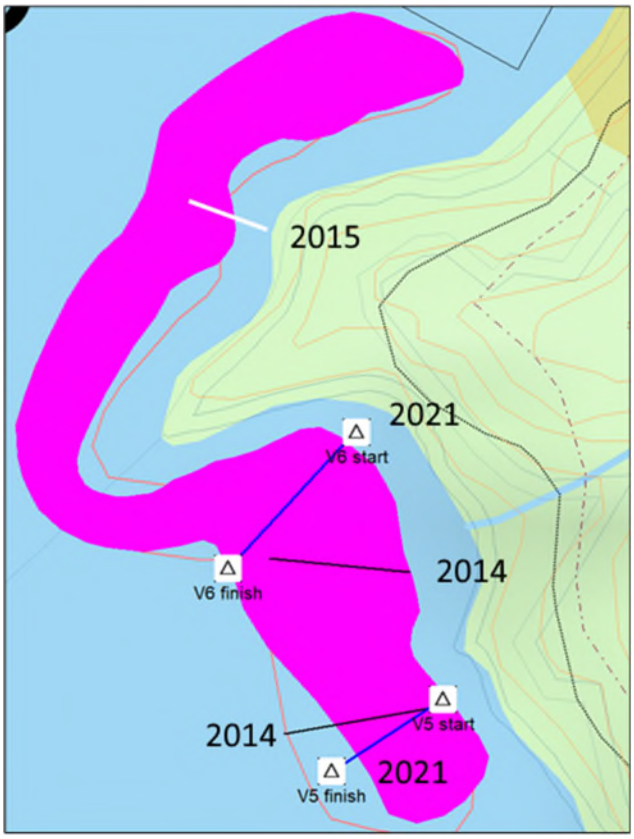


Figure 5. Location of Matiere ESMS (pink polygon) and present video transects (blue) relative to transects sampled by divers (black lines, Davidson and Richards, 2014) (white line, Davidson and Richards, 2015).

New data: Two HD video transects were installed during the present study (blue lines in Figure 5). Video footage confirmed substrata, habitats and species were comparable to those recorded by Davidson *et al.* (2014) with the main difference was the near absence of scallops in 2021. During the Davidson and Richards (2014) study, scallops were uncommon near the start of their study, but densities increased from 2002 to 2013.

In the present study, giant and red lampshells (*Neothyris* and *Terebratella*) and horse mussels were observed in the deeper areas of the video transects (Plates 9 & 10). Another notable species was an occasional burrowing anemone (*Cerianthus* sp.). Blue cod juveniles (<10cm) were also observed from soft substrata in areas with some cover usually in the form of dead whole shells. No change to the existing 2020 boundary is suggested.

Ecological relevance: The area north of Matiere Point supports the highest known abundance of burrowing anemones in the Queen Charlotte Sound. The area south of the Point supports a healthy population of brachiopods (giant and red).

Anthropogenic issues: Most of the site is located close to shore with a reef extending south-west from Matiere Point. The area is seldom fished, however, an occasional recreational dredger has been observed (Table 4). Some anchoring may occur, but this has not been observed. The species, habitats or communities present are likely tolerant of occasional anchoring but not dredging or trawling; however, dredging and trawling would both be restricted by the reef/ridge extending off Matiere Point. The impact of catchment derived sediment at this site is not known. The southern half of the site is likely more vulnerable to sedimentation due to its sheltered aspect compared to the area north-east of Matiere Point.

Table 4. Assessment of anthropogenic impacts for Site 4.23 (Matiere Point).

Original area of significant site (ha)	20.25 (2011)
Previous area of significant site (ha)	12.41 (2020)
Recommended area of site (ha)	12.41
Change (ha)	0
Percentage change from original (%)	0%
Sensitivity	Sensitive (B) Supports species, habitats or communities that can tolerate low-level anthropogenic seabed disturbance due to the nature of the substrata, community, species and/or hydrodynamic regimes (i.e. tolerant of occasional recreational anchoring). Not tolerant of dredging and trawling.
Threats	Site is located along and close to a rubble bank thereby reducing the chance of dredging or trawling. Anchoring is possible. Logging of pine plantation in Puriri Bay has likely increased turbidity in the local area. The impact of sedimentation at this site is not known.
Impact observed	No damage from anchoring has been previously observed.
Suggested buffer	50 m

Plate 9. Silt, fine sand and natural shell (25m deep) with lampshells and horse mussels.

Plate 10. Silt, fine sand and natural shell (26m deep) with lampshells and horse mussels.

Site 4.25 East Bay north (lampshell and burrowing anemone)

Location: East Bay north is a long site that stretches some 7.3 km along the coastline from Onario Point in the west to Paerata Point in the east.

Features: Davidson *et al*. (2011) first described the site. Several unpublished survey dives were conducted along this coast between 1990 to 1994 confirming the presence of giant lampshells (*Neothyrus lenticularis*), burrowing anemones (*Cerianthus* sp.), anemone (*Epiactus* sp.) and *Galeolaria hystrix* tubeworm mounds.

The early unpublished survey data showed giant lampshells were present at an average density of 1.4 per m^2 between 24 and 32 m depth, however, Davidson and Richards (2014) showed giant lampshell can be present in as little as 20m depth in East Bay.

Davidson *et al*., (2020) updated the site polygon based on detailed bathymetric and multibeam sonar data collected from this area by Neil *et al*. (2018a, 2018b) (Figure 8). The new depth contour data were used to improve the accuracy of the depth range where brachiopods and burrowing anemones are expected to occur at this site and other sites in the Sounds (approximately 10m and 28m depth) and giant lampshells in East Bay (approximately 20m to 34m depth).

New data: Five HD video transects were installed (Figure 6). Video footage confirmed the site supports substrata and habitats comparable to those known for other areas in East Bay sampled over an 11-year period by Davidson *et al.* (2014). The five video transects installed during the present study indicated scallop densities were very low. The Davidson and Richards (2014) study showed scallops were uncommon near the start of their study in East Bay, but densities steadily increased over the 11-year sampling period. Galeolaria tubeworm mounds were common around headlands and promontories as moderate to large individual clumps.

Brachiopods (*Neothyris* and *Terebratella*) were rarely seen along video transects in the present study (Plates 11 and 12). Other notable species present were burrowing anemone (*Cerianthus* sp.) and *Galeolaria* mounds, but these also were rarely seen. Blue cod juveniles (<10cm) were regularly observed inhabiting soft substrata where cover (e.g. dead whole shells) were present (Plate 13). Dense beds of *Chaetopterus* sp. have become widespread in shallow areas less than approximately 16 m depth in very recent times (Plate 14).

Figure 6. Location of the eastern part of the East Bay northern coast ESMS (pink polygon) and the location of video transects (blue lines) from the present study.

Ecological relevance: The northern coast of East Bay, historically supported the highest densities of giant lampshell known from shallow areas of the Marlborough Sounds. The coast also has little human development, with large areas in a state of regeneration.

Anthropogenic issues: Most of the site is located relatively close to shore and numerous reefs and cobble banks extend from shore. The area is regularly recreationally fished, and anchoring has been observed (Table 5). Excluding *Galeolaria* mounds, the species, habitats and communities present are likely tolerant of occasional anchoring but not dredging or trawling. Dredging and trawling are unlikely due to the topography and presence of the rocky substrata. The reasons for the decline in lampshell, scallop and burrowing anemone is unknown.

Table 5. Assessment of anthropogenic impacts for Site 4.25 (East Bay north).

Original area of significant site (ha)	120.47 (2011)
Previous area of significant site (ha)	167.07 (2020)
Recommended area of site (ha)	167.07
Change (ha)	0
Percentage change from original (%)	0%
Sensitivity	Sensitive (B) Supports species, habitats or communities that can tolerate low-level anthropogenic seabed disturbance due to the nature of the substrata, community, species and/or hydrodynamic regimes (i.e. tolerant of occasional recreational anchoring). Not tolerant of dredging and trawling.
Threats	Site is located along and close to the reef edges thereby reducing the chance of dredging or trawling. Anchoring occurs. The impact of sedimentation at this site is not known.
Impact observed	No damage from anchoring has been observed but it may occur.
Suggested buffer	50 m

Plate 11. Silt, fine sand and natural shell (25m deep) with blue cod present.

Plate 12. Silt, fine sand and natural broken and whole shell (36m deep). Note: the absence of lampshells.

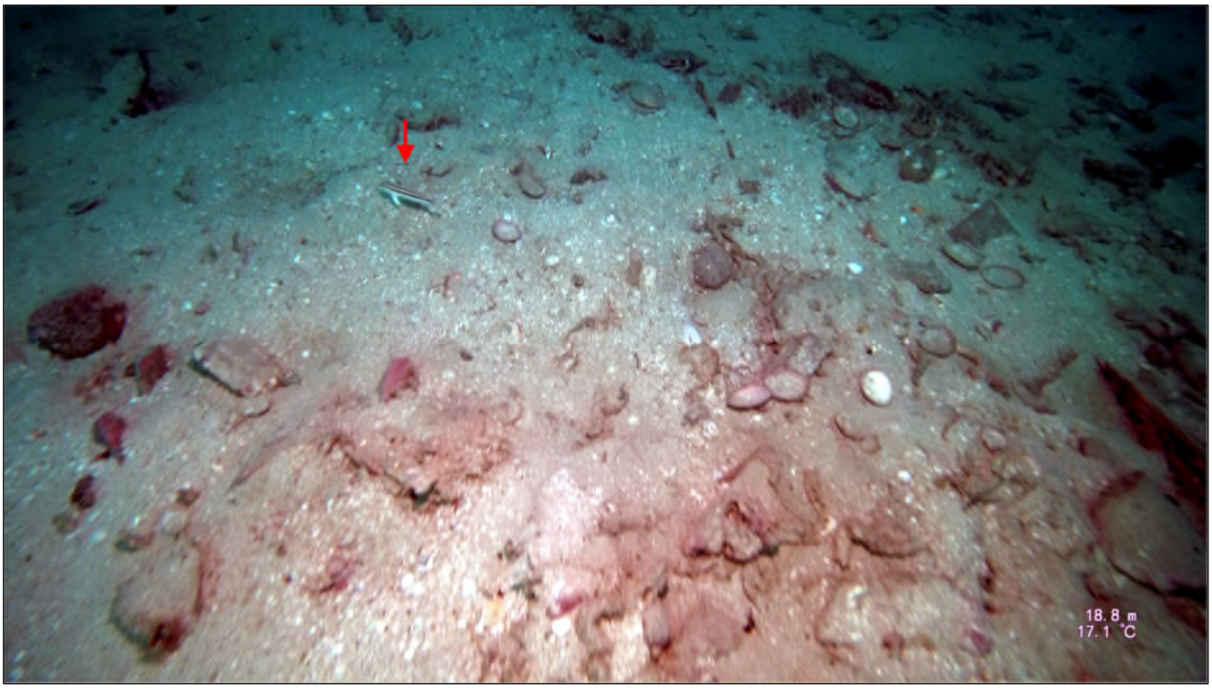


Plate 14. Fine sand, silt and natural broken and whole shell (18m deep). Note: the presence of <10cm blue cod (red arrow).

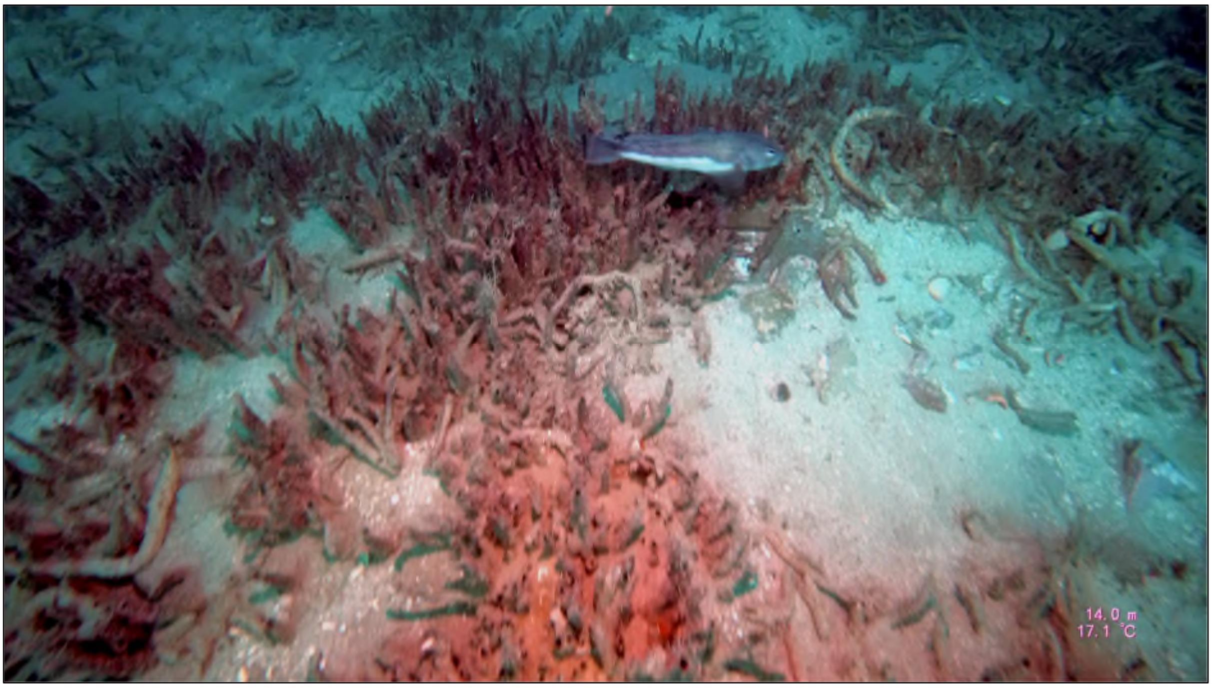


Plate 13. Example of a dense bed of *Chaetopterus* sp. at depths < 16m.

Site 6.1 The Knobbys (tubeworm mounds and reef)

Location: The Knobbys Reef lies approximately 2.5 km from Ngakuta Bay near the head of the eastern arm of Port Underwood and 6.6 km from the seaward entrance to the Port (Plate 17).

Features: The Knobbys is a shallow ridge dominated by pebbles, coarse sands and broken and dead shells with rocky outcrops along its length. The site was first qualitatively described by Davidson (1993) during a marine farm survey. Davidson (1993) stated "most outcropping rock was colonised by very large colonies of tubeworms (*Galeolaria hystrix*) which formed mounds up to 20m x 10 m diameter and up to approximately 3 m in height. These colonies appeared healthy with few areas of dead worms. Extensive shallow beds of red algae (*Adamsiella* spp.) were recorded over soft substrates along much of the reef." The author also noted the presence of the adventive alga *Chnoospora minima* (Nelson and Duffy, 1991) that formed a mat over the benthos south-east of the reef.

Davidson *et al*. (2011) stated these described mounds were some of the largest known from Marlborough and one of two areas of dense colonies known from Port Underwood. In 2020 the site was investigated using sonar and a drop camera as (Davidson *et al*., 2020). The extent of the reef structure was found to be longer than originally described (Plates 15 & 16). Calcareous tubeworm mounds were observed from four of the 19 photos. Most photos showed a high cover (usually 100%) of macroalgae (*Adamsiella* spp.; *Choospora minima*). The authors stated it was possible macroalgae beds obscured the detection of more tubeworm mounds and a dive inspection was recommended.

New data: The site was investigated using divers in April 2021. Divers worked their way along the reef and collected footage of the reef using a GoPro Hero 7. Tubeworm mounds were observed from deeper parts of the reef where the previous year's drop camera detected mounds (Plate 15). Divers described the reef as a long ridge comprised of cobbles, pebbles, coarse sand, silt and shell with patchy rock outcrops along its length. *Carpophylum flexuosum* dominated areas of hard substratum, while extensive areas of red algae were present on soft substratum. Tubeworms were observed on a deeper part of the reef covering an area of approximately 5m^2. The tubeworm mounds were fragmented, comprising some healthy patches with other areas showing physical damage and dead tubeworms (Plate 19). Red and filamentous algae were common in this deeper area (Plate 18).

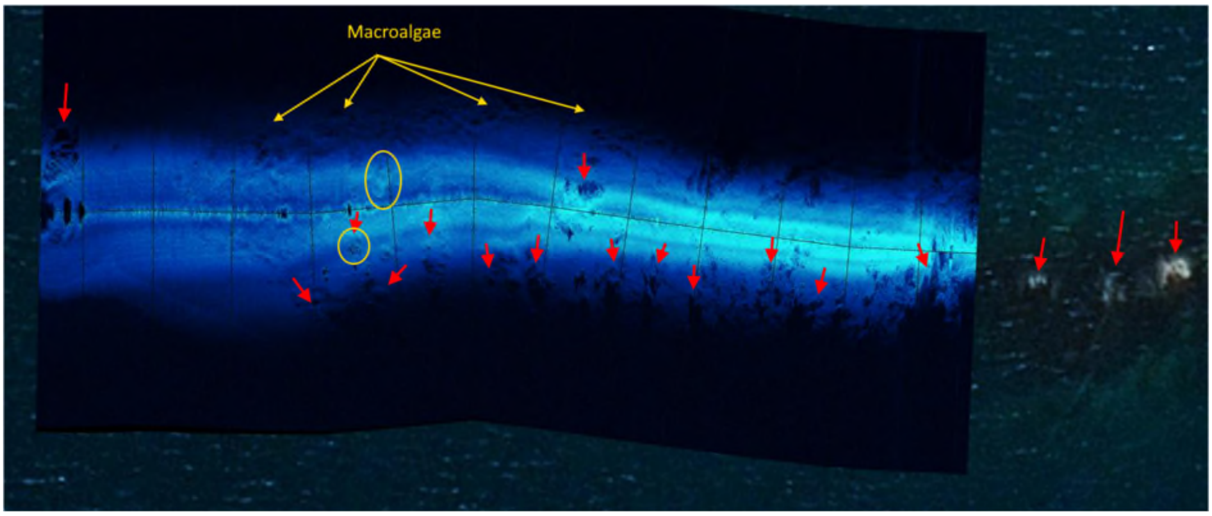


Plate 15. Sonar data collected from The Knobbys in April 2021 showing the reef (red arrows), areas where tubeworms mounds were observed and adjacent macroalgae beds (yellow arrows).

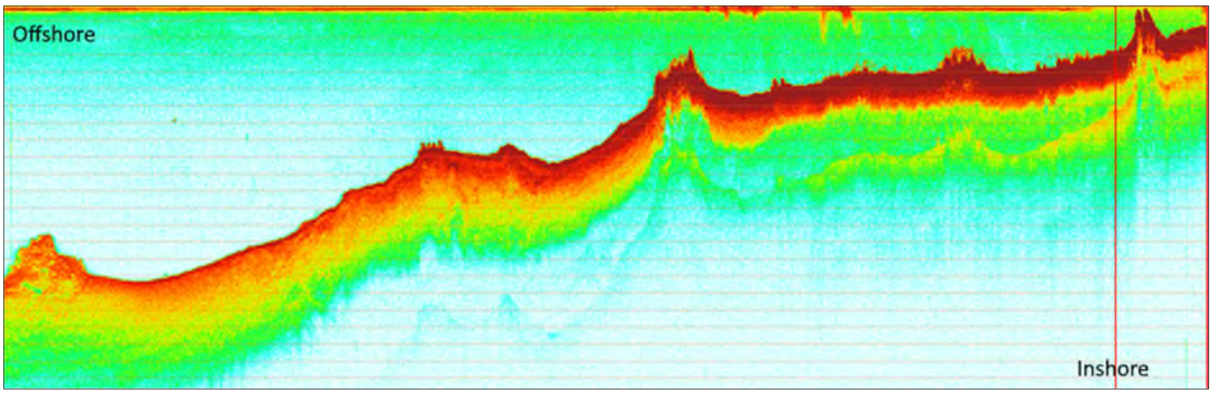


Plate 16. Downscan profile of the Knobbys reef. The profile extends from the offshore (western tip) to a point close to the western end of the intertidal reef.

Ecological relevance: The Knobbys once supported the largest known calcareous tubeworm bed in Port Underwood. It now supports a small patch of tubeworms. It is noted it remains the second largest documented bed of its kind in the Port.

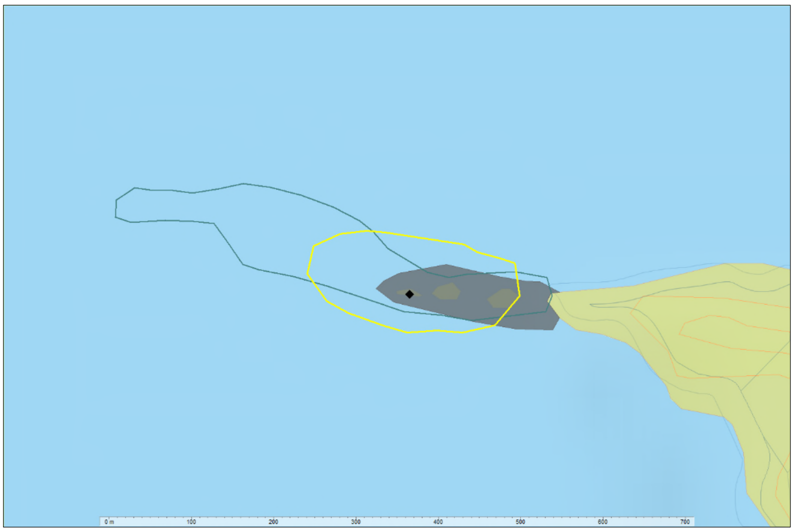


Figure 7. The Knobbys original 2011 significant site (offshore yellow polygon) and the presently suggested boundary (teal polygon).

Anthropogenic issues: The site supports tubeworm mounds that have been recognised as being a very sensitive biogenic habitat. The remainder of the reef supports macroalgae beds comprised of native and an introduced species.

Threats to this site are most likely from physical damage and sediment smothering (Table 6). Much of the hillsides surrounding Port Underwood have been logged over the last 10 years (Plate 17). Some recreational fishing occurs in the Port and occasional anchoring may occur at The Knobbys and appears to have resulted in physical damage (Plate 19). Dredging and trawling are unlikely due to the presence of the reef structure. The adjacent marine farm does not appear to have impacted the reef. Macroalgae beds may tolerate low level disturbance, but are likely to be intolerant of sediment smothering and shading.

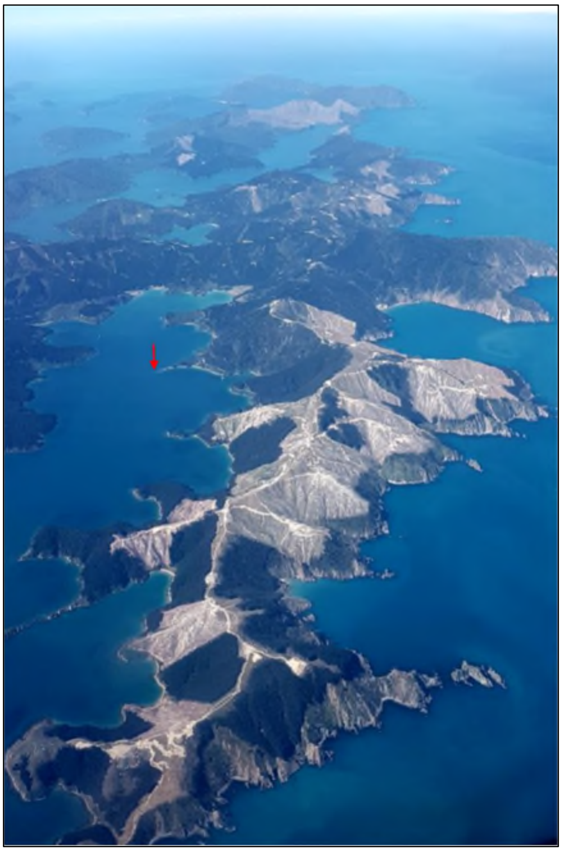


Plate 17. Aerial photo of eastern Port Underwood and The Knobbys (red arrow) (L. Richards, 2017).

Plate 18. Tubeworm mounds with filamentous red algae growth (photo: Tom Scott-Simmonds).

Plate 19. Damage to tubeworm mounds due to physical disturbance (photo: Tom Scott-Simmonds).

Table 6. Assessment of anthropogenic impacts for Site 6.1 (The Knobbys).

Original area of significant site (ha)	2.42
Previous area of significant site (ha)	
Recommended area of site (ha)	3.41
Change (ha)	1
Percentage change from original (%)	41.2%
Sensitivity	Very sensitive and sensitive (A & B) The site supports tubeworm mounds that cannot tolerate anthropogenic seabed disturbance (i.e. anchoring, all forms of dredging and trawling). Trawling is unlikely due to the presence of the reef. Damage likely from anchoring was observed by divers. Macroalgae beds can tolerate low-level disturbance but are likely to be intolerant of sediment smothering and shading.
Threats	Recreational fishers anchor. Sediment levels are likely elevated due to recent forest logging.
Impact observed	Yes, sediment was observed on algae foliage. Physical damage observed.
Suggested buffer	200 m

3.2 Suggested new sites

Site 3.32 The Reef, Richmond Bay (current swept community)

Location: Richmond Bay is located along the eastern side of Waitata Reach, Pelorus Sound. The Reef extend almost 1 km from the adjacent promontory located at the southern entrance to the Bay (Figure 8).

Features: The presence of a reef at this location has long been recognised but the site has not previously been biologically surveyed.

New data: New bathymetric data collected by NIWA (2020) enabled more accurate mapping of the reef's extent (Figure 8).

Video and drop camera images from the present study confirmed the site is dominated by a bedrock reef that extends north from a large promontory in southern Richmond Bay. Boulder and cobbles were also present along the edges of the main reef ridge (Plates 20 & 21). At the base of the reef, its edges were surrounded by coarse soft substratum.

Encrusting biogenic current swept communities on The Reef had moderate to high levels of diversity and abundance. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians (*Cnemidocarpa bicornuta*), anemones (*Anthothoe albocincta*) and sponge (*Ecionemia alata).* Overall filter-feeding species ranged from occasional to abundant.

Ecological relevance: The Reef is one of several current-swept reef habitats located along Waitata Reach. These reef structures support a high diversity of species, often in high abundance. The biogenic structures that form on these reefs provide habitat for many smaller organisms that in turn become food for larger species such as fish.

Plate 20. Bedrock, boulder, cobbles and sand and shell at 19 m depth. Note the presence of compound ascidians and hydroids.

Plate 21. Bedrock reef at 21.9m depth. Note the presence of sponge (*Ecionemia alata*) and numerous solitary ascidians (*Cnemidocarpa bicornuta*).

Anthropogenic issues: Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. Most fishers drift fish at this site, but some anchoring may occur (Table 7). Species, habitats or communities present are intolerant of physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops.

The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site (Table 9). In general, fine sediment was most apparent at a greater depth (approximately >26m depth) where currents are lower compared to shallow parts of the reef.

Table 7. Assessment of anthropogenic impacts for Site 3.32 (The Reef, Richmond Bay).

Original area of significant site (ha)	
Previous area of significant site (ha)	
Recommended area of site (ha)	20.8
Change (ha)	20.8
Percentage change from original (%)	NA
Sensitivity	Very sensitive (A) Supports species, habitats or communities that are not tolerant of anthropogenic seabed disturbance. Not tolerant of dredging, trawling or anchoring.
Threat	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sedimentation at this site is not known.
Impact observed	Some fine sediment at approx. >26m depth.
Suggested buffer	200 m

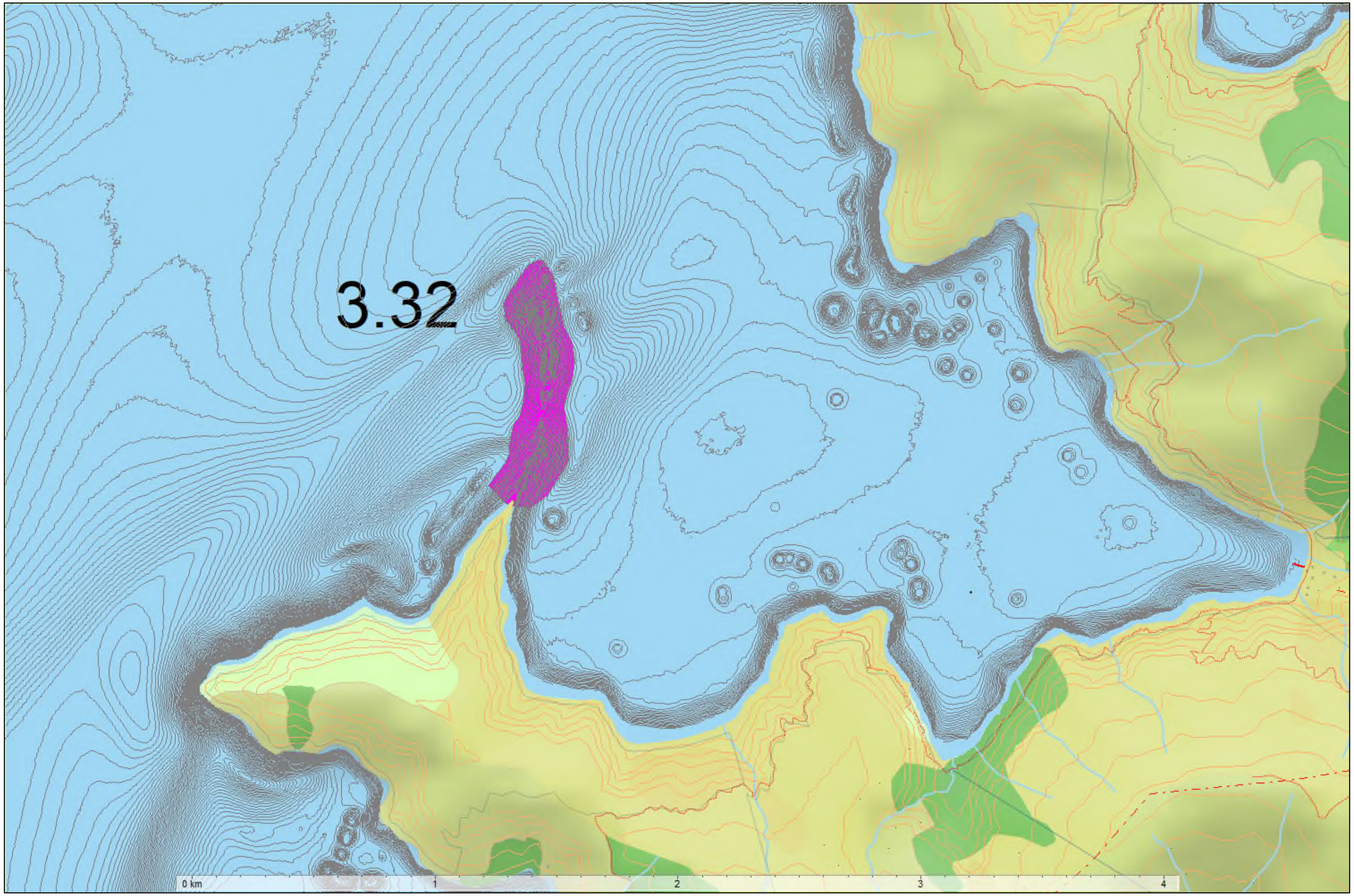


Figure 8. Richmond Bay reef with depth contours. Suggested significant site 3.32 ranging in depth from 0 to approximately 40 m depth (red polygon).

Site 3.33 Ketu Bay reef (current swept community)

Location: Seabed located on and adjacent to a reef that extends northwards from the southern entrance to Ketu Bay, on the eastern side of Waitata Reach, Pelorus Sound. The reef structure extends approximately 530 m distance from the adjacent promontory (Figure 9).

Features: The presence of a reef at this location has long been recognised but the site has not previously been biologically surveyed.

New data: New bathymetric data collected by NIWA (2020) enabled more accurate mapping of the reef's extent (Figure 9).

Video and drop camera images from the present study confirmed the site has a main bedrock ridge interspersed by boulder, cobble and soft substrata at periodically along its length (Plates 22 and 23). The reef extends approximately 530 m north from the southern entrance to Ketu Bay. (Figure 9). The base of the reef is surrounded by coarse soft substratum.

Encrusting biogenic current swept communities in Ketu Reef had moderate to high levels of diversity and abundance. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians (*Cnemidocarpa bicornuta*), anemones (*Anthothoe albocincta*) and sponge (*Ecionemia alata).* Overall, filter-feeding species ranged from occasional to abundant.

Ecological relevance: Ketu Reef is one of several current-swept reef habitats located along Waitata Reach. These reef structures support a high diversity of species, often in high abundance. The biogenic structures that form on these reefs provide habitat for many smaller organisms that in turn, become food for larger species such as fish.

Anthropogenic issues: Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows (Table 8). Most fishers drift fish at this site, but some anchoring may occur. Species, habitats or communities present are intolerant of physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops.

The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment was most apparent at a depth where currents are lower compared to shallow parts of the reef (Table 10).

Table 8. Assessment of anthropogenic impacts for Site 3.33 (Ketu Bay reef).

Original area of significant site (ha)	
Previous area of significant site (ha)	
Recommended area of site (ha)	8.97
Change (ha)	8.97
Percentage change from original (%)	NA
Sensitivity	Very sensitive (A) Supports species, habitats or communities that are not tolerant of anthropogenic seabed disturbance. Not tolerant of dredging, trawling or anchoring.
Threat	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sedimentation at this site is not known.
Impact observed	Some fine sediment at depth.
Suggested buffer	200 m

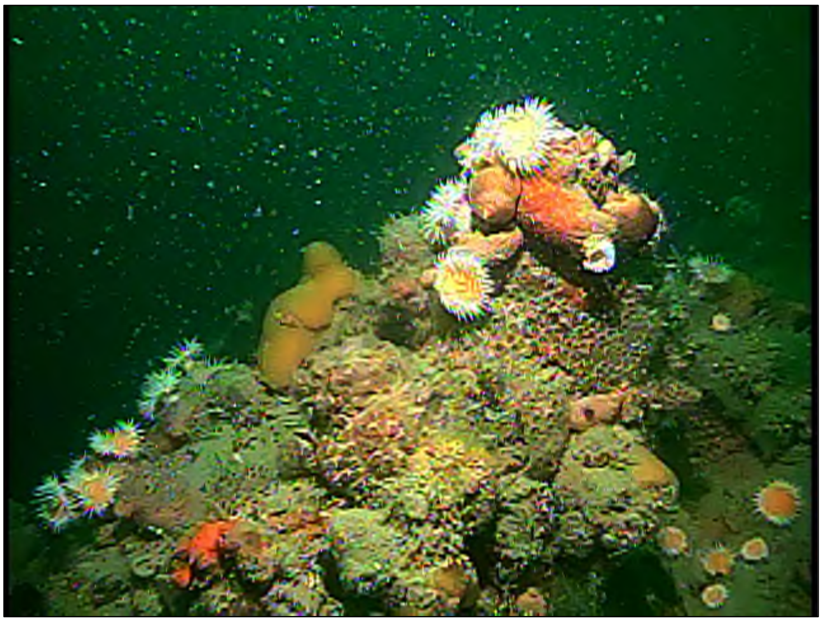


Plate 22. Bedrock outcrops with encrusting biota (Photo 18 at 25.7 m depth. Note the presence of solitary and compound ascidians and anemones.

Plate 23. Boulder and cobbles flanks of the reef (photo 2 at 17.1 m depth. Note the presence of sponge (*Ecionemia alata*) compound ascidians and sponges.

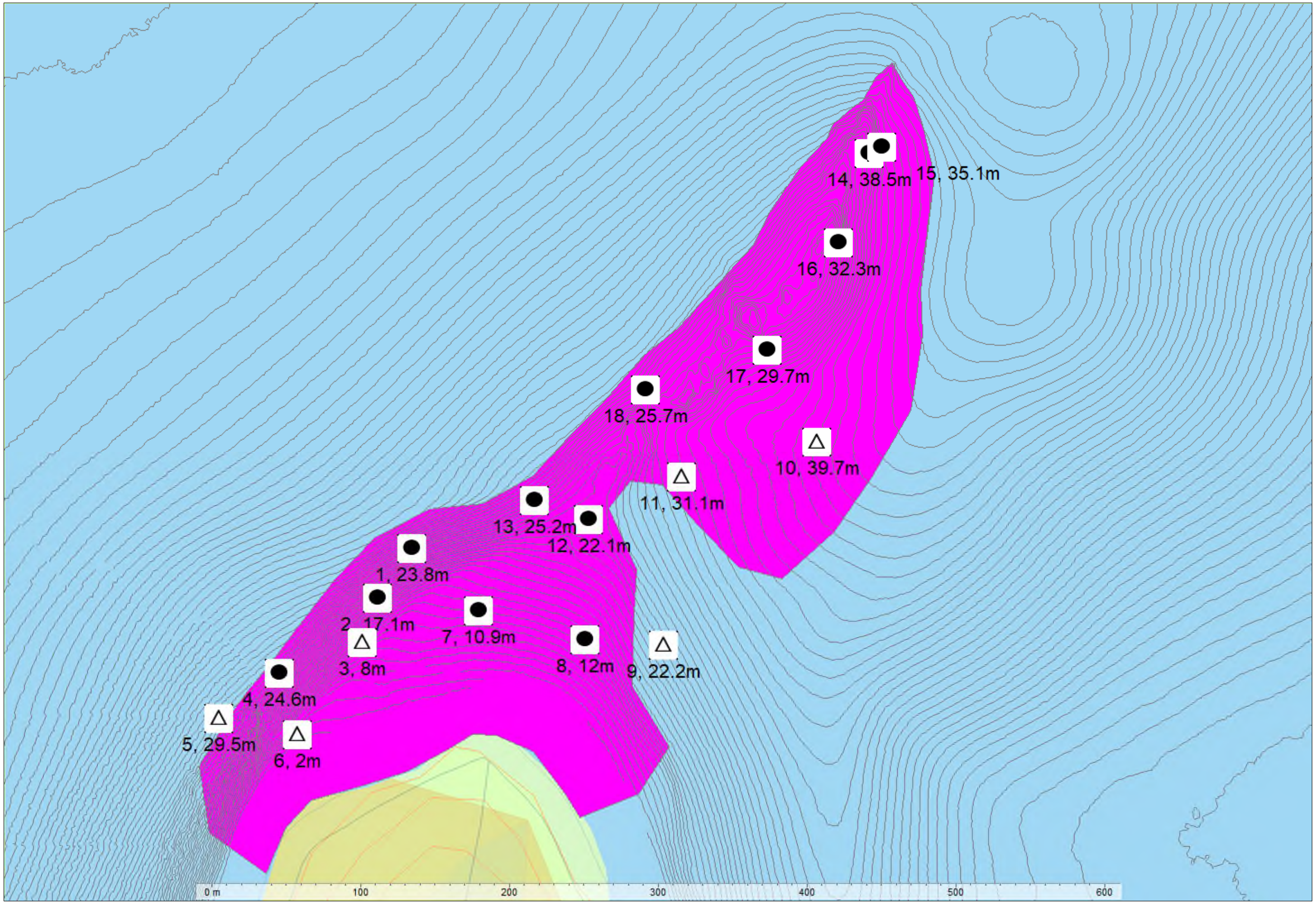


Figure 9. Ketu Bay reef with depth contours. Suggested significant site 3.33 ranging in depth to approximately 50 m depth (pink polygon). Open symbols = soft substrata, closed symbols = rocky substrata.

Site 3.34 Kaitira (East Entry Point) (current swept community)

Location: Area of seabed located on and adjacent to a reef that extends northwards from Kaitira (East Entry Point) at the southern entrance to Pelorus Sound. The Reef extends approximately 150 m from the adjacent promontory (Figure 10).

Features: The reef at this location has been known for many years from local knowledge and photographs (Danny Bolton, pers. comm.), but the site had not previously been biologically surveyed.

New data: New bathymetric data collected by NIWA (2020) enabled more accurate mapping of the reef extent (Figure 10).

Video and drop camera images collected during the present study confirmed the site has a main bedrock structure interspersed by areas of boulders, cobbles and soft substrata (Plates 24 and 25). The reef also has areas of coarse current swept soft sediment. The reef extends approximately 150 m north from the promontory at the eastern entrance to Pelorus Sound (Figure 10). The offshore base of the reef is surrounded by coarse soft substratum.

Encrusting biogenic current swept communities on Kaitira Reef has high levels of diversity and abundance. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians (*Cnemidocarpa bicornuta*), anemones (*Anthothoe albocincta*) and sponge (*Ecionemia alata*). In shallow areas along its eastern edge, large healthy mounds of the tubeworm *(Galeolaria hystrix)* were discovered. An occasional burrowing anemone (*Cerianthus* sp.) was also observed on soft sediment near the reef. Overall, filter-feeding species were common to abundant.

Ecological relevance: The Reef is one of several current-swept reef habitats located along Waitata Reach. The Kaitira Reef is distinct as it also supports the largest known bed of calcareous tubeworms in Pelorus Sound. The reef structures support a high diversity of other species, often in high abundance. The biogenic structures on these sites provide habitat for many smaller organisms that in turn, become food for larger species such as fish.

Anthropogenic issues: Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. Most fishers drift fish at this site, but some anchoring may occur (Table 9). Species, habitats or communities present are intolerant of physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops.

The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment was most apparent at a depth where currents are lower compared to shallow parts of the reef (Table 11).

Table 9. Assessment of anthropogenic impacts for Site 3.34 (Kaitira current swept community).

Original area of significant site (ha)	
Previous area of significant site (ha)	
Recommended area of site (ha)	1.92
Change (ha)	1.92
Percentage change from original (%)	NA
Sensitivity	Very sensitive (A) Supports species, habitats or communities that are not tolerant of anthropogenic seabed disturbance. Not tolerant of dredging, trawling or anchoring.
Threat	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sediment at this site is not known.
Impact observed	Some fine sediment at depth.
Suggested buffer	200 m

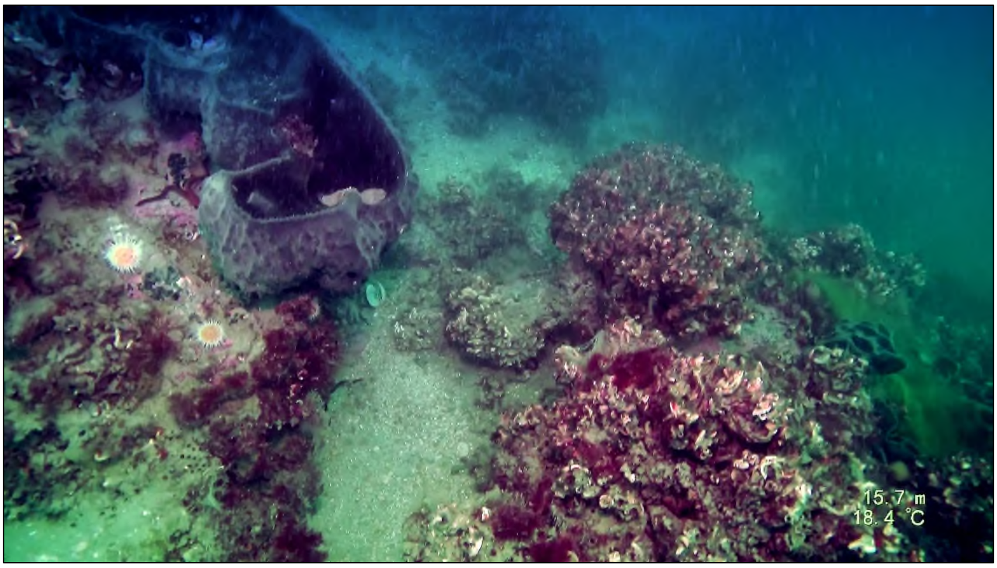


Plate 24. Bedrock outcrops with encrusting biota including large *Galeolaria* mounds (approximately 15 m depth). Note the presence of large *Ecionemia alata* sponges

Plate 25. Bedrock outcrops with encrusting biota including large *Galeolaria* mounds (approximately 15 m depth). Note the presence of large *Ecionemia alata* sponges

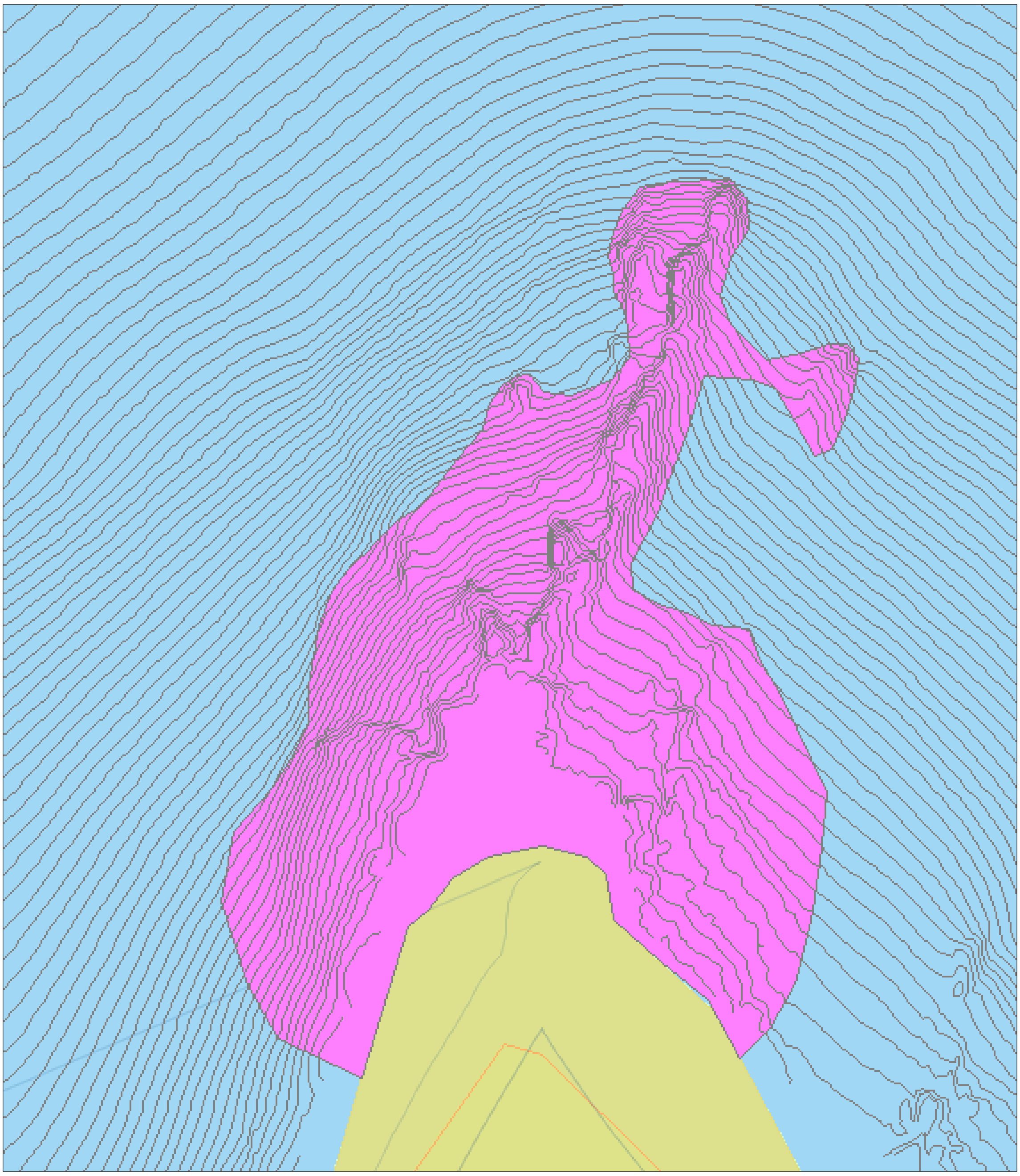


Figure 10. Kaitira Reef with depth contours. Suggested significant site 3.34 extends down to approximately 50 m depth (pink polygon).

Site 3.35 Maud Island eastern reef (current swept community)

Location: Area of seabed located on and adjacent to a reef extending north-east from the eastern-most tip of Maud Island at the southern end of Waitata Reach. The reef extends approximately 480 m distance from the adjacent promontory (Figure 11).

Features: The site had not previously been biologically surveyed. It is located in an area swept by tidal moderate to strong currents flowing along Waitata Reach.

New data: New bathymetric data collected by NIWA (2020) enabled accurate mapping of the reef extent (Figure 11).

Video and drop camera images from the present study confirmed the site has a main bedrock ridge interspersed by a boulder, cobble and soft substrata periodically along its length (Plate 26). The reef also has areas of coarse current swept soft sediment (Plate 27).

The reef had a high cover of encrusting biogenic current swept communities. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians (*Cnemidocarpa bicornuta*), anemones (*Anthothoe albocincta*) and sponge (*Ecionemia alata).* Overall, filter-feeding species were common to abundant.

Ecological relevance: The Reef is one of several current-swept reef habitats located along Waitata Reach. These reef structures support a high diversity of species, often in high abundance. The biogenic structures that form on these sites provide habitat for many smaller organisms that in turn, become food for larger species such as fish. At this site, blue cod are very abundant, likely due to the MPI protected status.

Anthropogenic issues: Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. This area is part of an MPI "no-take finfish zone" established on 1st July 2015 (see insert in Figure 11). Anchoring is now unlikely to occur (Table 10). Species, habitats or communities present are intolerant of physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops.

The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment was most apparent at depths where currents are lower compared to shallow parts of the reef (Table 12).

Table 10. Assessment of anthropogenic impacts for Site 3.35 (Maud Island east reef current swept community).

Original area of significant site (ha)	
Previous area of significant site (ha)	
Recommended area of site (ha)	2.2
Change (ha)	2.2
Percentage change from original (%)	NA
Sensitivity	Very sensitive (A) Supports species, habitats or communities that are not tolerant of anthropogenic seabed disturbance. Not tolerant of dredging, trawling or anchoring.
Threat	Site is a reef and unlikely to be commercially trawled or dredged. Recreational anchoring unlikely due to MPI no-take finfish zone. The impact of sedimentation at this site is not known.
Impact observed	Some fine sediment at depth.
Suggested buffer	200 m

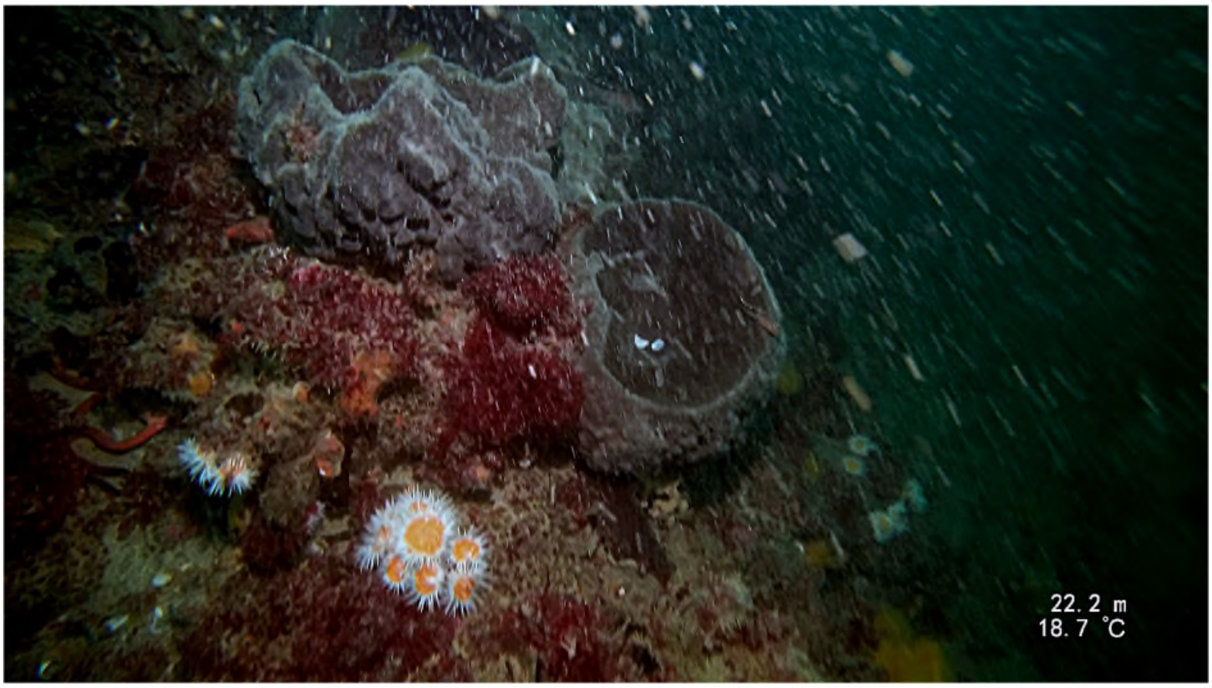


Plate 26. Bedrock outcrops with encrusting biota including large *Ecionemia alata* sponges (approximately 22 m depth).

Plate 27. Shell hash around the reef fringes (approximately 32 m depth). Note the presence of high numbers of blue cod.

Figure 11. Maud Island east reef with depth contours. Suggested significant site 3.35 ranging in depth to approximately 45 m depth (pink polygon). Insert = MPI Maud Island finfish no-take zone with a blue arrow indicating the location of the reef.

Port Underwood tubeworms (*Spiochaetopterus* sp.)

Location: Straw-weed worms (*Spiochaetopterus sp.*) are widespread around Port Underwood and form dense beds around and south of The Tongue (Figure 12).

Features: Dense beds of these tubeworms have been previously recorded during marine farm investigations in Port Underwood (Handley and Alcock, 1999; Davidson *et al.,* 2019). Handley and Alcock (1999) identified them as *Spiochaetopterus* sp., however, they also stated this worm could not be fully identified and could be a new species endemic to New Zealand with a wide distribution (C. Glasby, NIWA, pers. comm.). Anderson *et al*. (2020a) stated straw-weed Chaetopterid tubeworms *(Spiochaetopterus* spp.) have long and thin tubes that grow to about 200-400 mm and appear as tangled straw when collected in beam trawls. The authors stated tubeworms lay almost buried beneath the sediment surface in Queen Charlotte Sound, with the emergent tubes extending only 1-3 cm above the sediment. Anderson *et al.* (2020a) also stated localized densities of *Spiochaetopterus* sp., can be extremely high, and where present can stabilise sediments forming raised mounds that cover small to extensive areas of the seafloor. Although the emergent tubes of this genera do not extend very high above the seafloor, their emergent tubes still provide substrata for other species, particularly epiphytic red algae, and when tubeworm beds are extensive, they are often heavily covered in algal meadow species (Anderson *et al*., 2019).

Anderson *et al.* (2020) stated Spiochaetopterid worms were recorded in 36.6% of all sites (excluding Cook Strait sites), and were found commonly throughout Queen Charlotte Sound in soft-sediment bays within Tory Channel, in depths of 9.6 to 50.2 m. The authors stated their cover ranged from 1-70%, tough mostly < 50%.

Figure 12. Port Underwood and approximate location of dense beds of straw-weed worms.

New data: A drop camera was used to collect information on the presence and percentage cover of straw-weed worms from central Port Underwood (Figure 13). Previous marine farm survey data were also used to assist with mapping the beds. The extent of the straw-weed worms beds was larger than expected (Figure 13) and the survey was terminated pending an assessment by the MDC marine ESMS experts. In central Port Underwood, worms formed beds >50% cover and in many areas >70% cover (Plates 28 & 29). A variety of other species were observed growing on amongst these worm beds including solitary ascidians, sponges, spire shells and red algae.

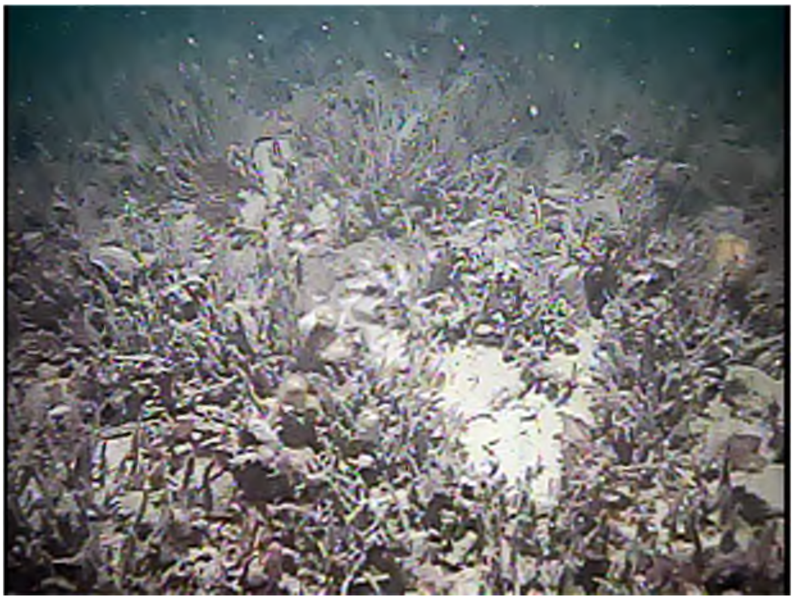


Plate 28. Straw weed worms from Port Underwood (Station 14, 14 m depth).

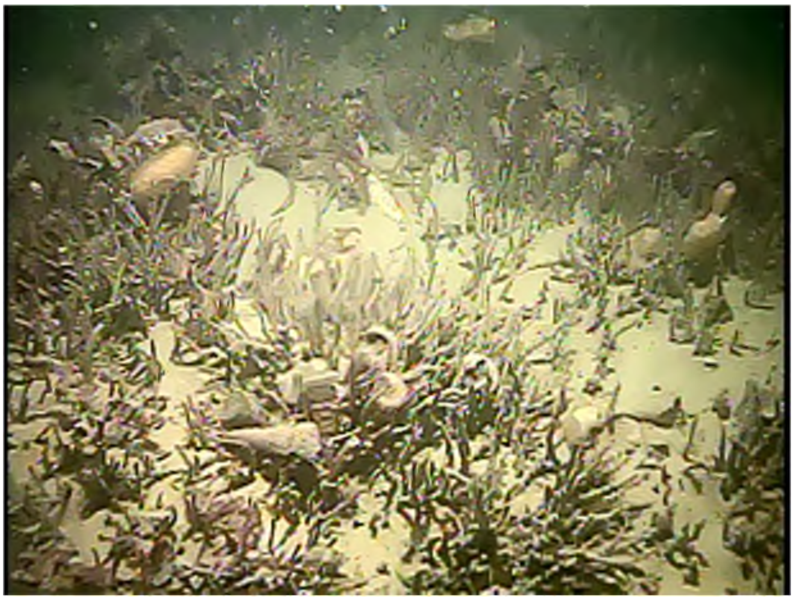


Plate 29. Straw weed worms and associated species (Station 25, 16.5 m depth).

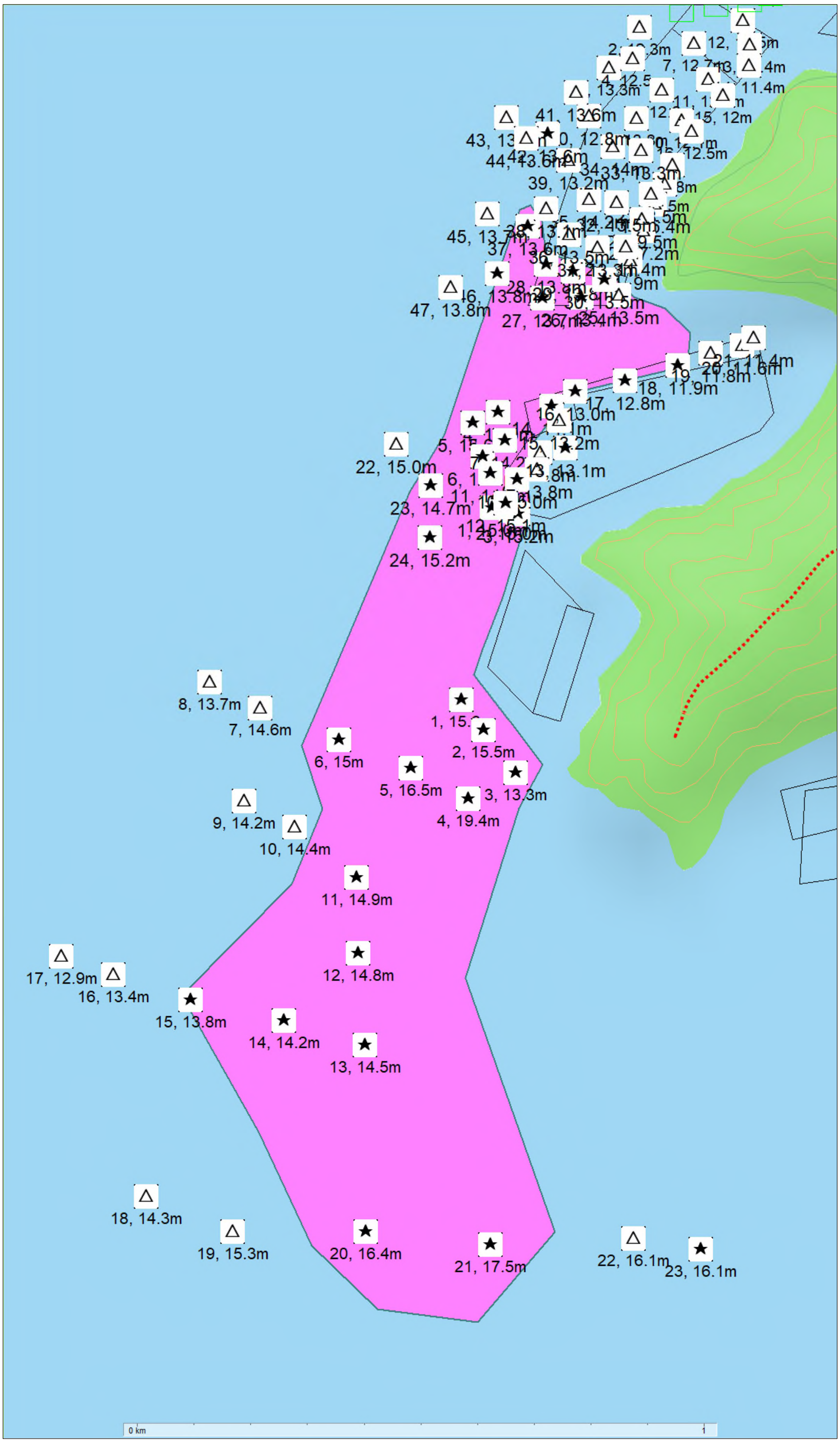


Figure 13. Location of known dense beds of straw-weed worms in central Port Underwood (stars = presence of straw-weed worms >40% cover, open triangles <40% tubeworm cover).

Ecological relevance: This area supports straw weed tubeworms at very high densities compared to other areas in the Marlborough Sounds. In Port Underwood, this area supports the largest area with high-density tubeworms. The full extent of the bed remains unknown.

Anthropogenic issues: Dense beds of straw-weed tubeworms were absent from central areas of western Port Underwood and under central areas of marine farms. They were, however, abundant around and for a short distance into mussel farms. It is likely regular trawling in the main reach of Port Underwood has resulted in a reduction in the extent of beds. Areas close to mussel farms do support dense beds of tubeworms, however, they decline with increasing distance into mussel farms. Farms may provide protection from physical disturbance (Table 11).

Table 11. Assessment of anthropogenic impacts for Site 6.3 (Port Underwood macroalgae).

Original area of significant site (ha)	
Previous area of significant site (ha)	
Recommended area of site (ha)	64.09
Change (ha)	64.09
Percentage change from original (%)	100%
Sensitivity	Sensitive (B) Site supports species, habitats or communities that can tolerate low-level anthropogenic seabed disturbance (i.e. tolerant of occasional recreational anchoring and are likely to recover quickly). Not tolerant of dredging and trawling. Marine farms appear to have positive and negative impacts on this species.
Threat	Core areas of marine farms do not have dense beds of this species. Physical damage likely occurs from trawling. This species appears tolerant of high turbidity.
Impact observed	Worms are absent from central areas of marine farms and also areas regularly trawled.
Suggested buffer	200 m

CHAPTER 2: Expert Panel Assessment (2020-2021)

4.0 Evaluation methodology

4.1 Data collation

All survey data were made available to the ESMS expert panel for the present review. Information collected during the 2020-2021 fieldwork season included: high definition and low-resolution drop camera photographs, handheld still photography, handheld video, remote video, sonar images, diver collected data and observations (note: all raw data are held by MDC).

Compiled data from a variety of other sources including previous reports, significant site surveys or other sampling programmes (e.g. marine reserve monitoring; marine farm monitoring; NIWA's multibeam bathymetric survey) were also made available to the experts. These data were integrated with other historical data and with data collected during annual significant site surveys. For example, multibeam depth contour data were used to delineate boundaries for existing sites where drop camera, diver, HD camera or other data had been previously collected. This approach was used for the first time by Davidson *et al*. (2020) to plot new boundaries for previously described sites.

4.2 Expert Panel

For the present review, most of the Expert Panel involved in the Davidson *et al*., (2011) report and 2015, 2016, 2017, 2018, 2019 and 2020 reviews were reconvened, apart from Sam duFresne (marine mammals), Peter Gaze (birds) and Shannel Courtney (plants). Sean Handley (NIWA) replaced existing member Bruno Brosnan in 2017. Sam du Fresne, Peter Gaze and Shannel Courtney were not involved in the present reassessment as no new or resurveyed marine mammal, bird or plant sites were under scrutiny.

4.3 The assessment criteria

During previous Expert Panel reviews, panel members recognized a need to clarify some of the original assessment criteria used by Davidson *et al.* (2011) to avoid any misinterpretation. Further minor revisions to the criteria were also proposed and adopted during the 2017 review.

The present assessment made no alterations to the 2017 criteria (see Appendix 1 for the revised current criteria). During this process, the Expert Panel took care not to create inconsistencies between the sites assessed in Davidson *et al*. (2011) and subsequent reassessments.

The ESMS criteria may change in the new Marlborough Environment Plan (MEP). Once this plan is finalised, the intention of the panel to start using the revised criteria. Up until that point, the panel will continue to use the existing 2017 criteria to ensure consistency.

4.4 Sensitivity, threats and buffer zone calculations

An assessment of species, community or habitat sensitivity and perceived threats was first conducted by the panel of experts and reported in Davidson *et al*. (2016). The present report presents an update of this assessment.

The revised method requires a site to be assessed for its expected sensitivity: (A) very sensitive, (B) sensitive, or (C) robust/not known. Each category of sensitivity is then given a score (Table 12a). The second stage of the assessment involves the level of protection: (A) offshore and/or are accessible to activities such as dredging and trawling, or likely impacted by threats due to proximity to human activities/impacts; or (B) having a level of protection from threats due to location or remoteness (Table 12b). These factors were used to calculate appropriate buffer zones that aim to reduce the likelihood of damage from anthropogenic activities (e.g. dredging, trawling, anchoring, sedimentation, pollution).

Sources of data/information for this assessment included: impact assessments, published reports and papers, Government websites (MPI, MDC, DOC, MfE), personal experience of the authors and anecdotal reports.

Table 12a. Sensitivity assessment criteria for species, community or habitat to perceived threats.

Sensitivity to anthropogenic factors.

Category	Disturbance description	Examples	Score
A	**Very sensitive:** Site supports species, habitats or communities that cannot tolerate anthropogenic impacts (e.g. nutrient enrichment, sedimentation, pollution, colonisation by invasive species, anchoring, all forms of trawling and dredging).	Bryozoans mounds/field, sponges garden, tubeworm mounds, eelgrass bed, rhodolith bed, soft tubeworm bed.	100
B	**Sensitive:** Site supports species, habitats or communities that can tolerate low level of elevated turbidity, enrichment, invasive species or pollution. Can tolerate low-level anthropogenic seabed disturbance due to the nature of the substrata, community, species and/or hydrodynamic regimes (i.e. tolerant of occasional recreational anchoring). Not tolerant of dredging and trawling.	Benthic algae bed, elephantfish egg laying, hydroid field, burrowing anemones, horse mussel bed, shellfish bed, shrimp burrows, brachiopod bed, algal forest, rocky reef.	50
C	**Robust and/or not known:** Site supports species, habitats or communities that can tolerate high turbidity, enrichment, pollution or invasive species; and/or site not known to support sensitive or very sensitive attributes. Can be tolerant of anchoring, dredging and trawling.	Shell or coarse substrata, high energy shore, short-lived species/communities, drift macroalgae.	0

Table 12b. Buffer zone distance calculator using sensitivity score and the assessed likelihood of an effect occurring from a perceived threat.

Threat multiplier (chance of threats occuring)

Threat level	Location type	Description	Multiplier
A	Effects are likely	Physical disturbance: offshore, and/or sites accessible to dredging and/or trawling. Other: sites exposed or near threats (i.e. source of sediment, near human development, regularly human activity).	2
B	Effects are unlikely	Physical disturbance: sites close to shore and/or protected by physical barriers or legislation (e.g. reef structure, marine reserve). Other: sites well removed from threats or located at remote locations.	1

Buffer zone calculation (for each site type multiply the scores from each table above)

Sensitivity category	Threat level	Scores	Buffer (m)
A	A	100 x 2	200
A	B	100 X 1	100
B	A	50 x 2	100
B	B	50 x 1	50
C	A	0 x 2	0
C	B	0 x 1	0

5.0 Expert assessment results

The Expert Panel assessed all 11 of the 2020-2021 surveyed sites (Table 13 and Appendix 1) and recommended to:

- Accept four new sites in Pelorus Sound.
- Accept the boundary adjustments for two existing significant sites.
- Accept the new data for two existing significant sites.
- Monitor one site to determine if it recovers.

The Expert panel deferred a decision on two sites and recommended the following.

- Collect more data from an existing site at Tawero Point.
- Collect more data from a potential new soft benthos tubeworm site in Port Underwood.

Significant site boundary adjustments and new sites resulted in an overall increase of 32.8ha to the total area of ecologically significant marine sites (Table 13).

Table 13. Summary of ESMS Expert Panel recommendations for 2020-2021 sites.

Sites	Change type	Original sites (2011)	Original area (ha)	Recent surveys	Previous area (ha)	Recommended area (ha)	Recent change	Change %	Benthos type	Reason for change	Notes
Site 3.31 Tawero Point (current swept community)	More data needed	2011	31.26		31.26	31.26	0.00	0.0	Rocky and soft	New data	Complete survey of northern area
Site 4.16 Perano Shoal (tubeworm mounds)	Edit boundary	2011	3.78	2015	5.46	5.60	0.14	2.5	Rocky and soft	New data	NIWA data used to refine boundary
Site 4.22 Puriri Bay (macroalgae bed)	Monitor for recovery	2011	14.30	2015	14.30	14.30	0.00	0.0	Rocky and soft	New data	Repeat drop camera in future. Investigate other algae sites
Site 4.23 Matiere Point (lampshell and burrowing anemone)	Update database	2011	20.25	2020	12.41	12.41	0.00	0.0	Rocky and soft	New data	New video data 2021
Site 4.25 East Bay north (lampshell and burrowing anemone)	Update database	2011	120.47	2020	167.07	167.07	0.00	0.0	Rocky and soft	New data	Decline in lampshells
Site 6.1 The Knobbys (tubeworm mounds and reef)	Edit boundary	2011	2.42		2.42	3.41	1.00	41.2	Rocky and soft	New data	Decline in abundance, distribution and health of T.worms
New Site 3.32 The Reef, Richmond Bay (current swept community)	New site					20.80	20.80	100.0	Rocky and soft	New data	
New Site 3.33 Ketu Bay reef (current swept community)	New site					6.75	8.97	100.0	Rocky and soft	New data	
New site 3.34 Kaitira (East Entry Point) (current swept community)	New site					1.92	1.92	100.0	Rocky and soft	New data	
New site 3.35 Maud Island east reef (current swept community)	New site					2.20	2.20	100.0	Rocky and soft	New data	
New site Port Underwood tubeworms (*Spiochaetopterus* sp.)	More data needed							100.0	Soft	New data	Area likely to be larger, complete survey & re-access
Total			**192.47**		**232.92**	**265.73**					
Most recent change to total area of significant sites							**32.80**				

CHAPTER 3: Discussion and comments

5.1 Changes to significant sites

5.1.1 Reasons for change

Davidson and Richards (2015) noted significant marine sites and subsites can change due to:

(1) Discovery
A new site 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.

In the present study, two existing sites were sampled and new data collected; however, no change to their boundaries or significance ranking occurred based on these new data. Nevertheless, the information supporting the assessment has improved/changed. The following new category is suggested to cover the collection of new data to support an existing site.

(6) Consolidation
A site is investigated, and new data is collected but no change to the site occurs.

5.1.2 Confidence to make change

A change to the size or biological ranking of a significant site is data driven. However, because most significant sites are subtidal, temporal knowledge of biological values are usually poorly understood which has contributed to uncertainty regarding the level of change over time. This issue is compounded by a lack of baseline data before the start of human activities in

New Zealand. This uncertainty is exacerbated due to difficulties of sampling in the marine environment, especially in deep or current swept locations.

For significant sites that have increased or decreased solely because of data quality, there is no need for "before" quantitative or qualitative data. The issue of change becomes more complex when a decline in size or site status occurs wholly, or in part, due to anthropogenic activities (e.g. sediment smothering, physical disturbance, or other loss of attributes). Historically, scientists have collected little data on habitat extent and condition in New Zealand. When available, these historical data sets are often poor quality or lack good spatial resolution/positioning. Despite these issues, historical data can still indicate the past presence of biological features of medium or high quality. These data are usually unsuitable to provide a scale or intensity of change; however, they may be sufficient to confirm a change from a previous state to a new state (e.g. a 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 marine expert review panel, (3) a comparison of before and after data, and/or improved multibeam bathymetric 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, 1990a; Davidson *et al*., 2011). While no data exist to show an incremental loss over the intervening years, based on the literature, the most likely cause for the decline is physical damage from scallop dredging. Dredging has occurred regularly in outer Queen Charlotte Sound, however, detailed data on fishing effort is not publicly available. The literature shows long-lived species like horse mussels can be significantly degraded by such activities (Thrush *et al*., 2001; Wood *et al*. 2012, Morrison et al. 2014; Sciberras *et al*., 2018; Anderson *et al*. 2019; Anderson *et al*., 2020a). Anderson *et al*. (2020a) stated: "there is some evidence, based both on historic catches and anecdotes from past fishers, that horse mussels and bryozoan patch reefs may once have been more extensive across the mid and inner sections of the Duck Pond, outer QCS".

5.3 Information issues (plan updates, data management)

5.3.1 Planning and Resource Consenting

The present assessment is the seventh since the original report outlining significant sites was produced (Davidson *et al.,* 2011). Like the previous studies conducted by Davidson and Richards (2015, 2016) and Davidson *et al.* (2017, 2018, 2019, 2020), many existing sites changed in size and shape compared to the original sites described by Davidson *et al.* (2011).

Further, the level of information known for each site almost always improves as new data are collected.

Significant sites will potentially change each time a new survey or assessment is undertaken. It is therefore important that changes be regularly incorporated into the operative Marlborough Environment Plan. Ideally, this process should occur annually to ensure the most up-to-date information is available for use. The Marlborough Environment Plan (MEP) should also recognise that once sites have been reviewed by the marine experts, approved sites should have a recognised status even if they have not been integrated into the Plan.

5.3.2 Data management and raw data

Survey data from the present 2020-2021 survey are summarised in the present report. Detailed data (i.e. maps, photos, video, sonar) are either produced or listed in separate Excel spreadsheets. All media, raw data and spreadsheets have been stored in an MDC database. The present document should be treated as a summary with further additional detail provided by the excel spreadsheets and raw data files.

5.4 Anthropogenic impacts

Some of the greatest sources of anthropogenic impacts in New Zealand's marine environment come from external sources with climate change, ocean acidification and catchment inputs considered the largest threats (MacDiarmid *et al*., 2012; MFE, 2016; 2019). 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. These authors also rated trawling (3rd equal with sedimentation) and dredging high on the list of anthropogenic impacts in the marine environment.

In the present study, direct evidence of human-related impacts on existing or suggested significant sites was observed. Perano Shoal continues to be impacted by recreational anchoring. The Knobbys tubeworm mounds have dramatically reduced in their extent and size since 1993 and continue to be impacted by recreational anchoring.

The present report also documented a large decline to brachiopod and scallop numbers in northern East Bay and the disappearance of a red algae bed in Pururi Bay. The reason or reasons for these losses are unknown but are likely related to anthropogenic impacts.

In Spring 2018, Ribó *et al*. (2021) documented the presence of giant lampshells from East Bay including the northern East Bay coastline as well as two sites located in inner Queen Charlotte

Sound, but recorded scallops from only one of these sites (e.g. Plate 30). The loss of these shellfish is of considerable concern and warrants further investigation. It is strongly recommended that monitoring of areas that continue to support brachiopods be initiated. The reference transects established by Davidson and Richards (2014) could be incorporated into such a monitoring programme.

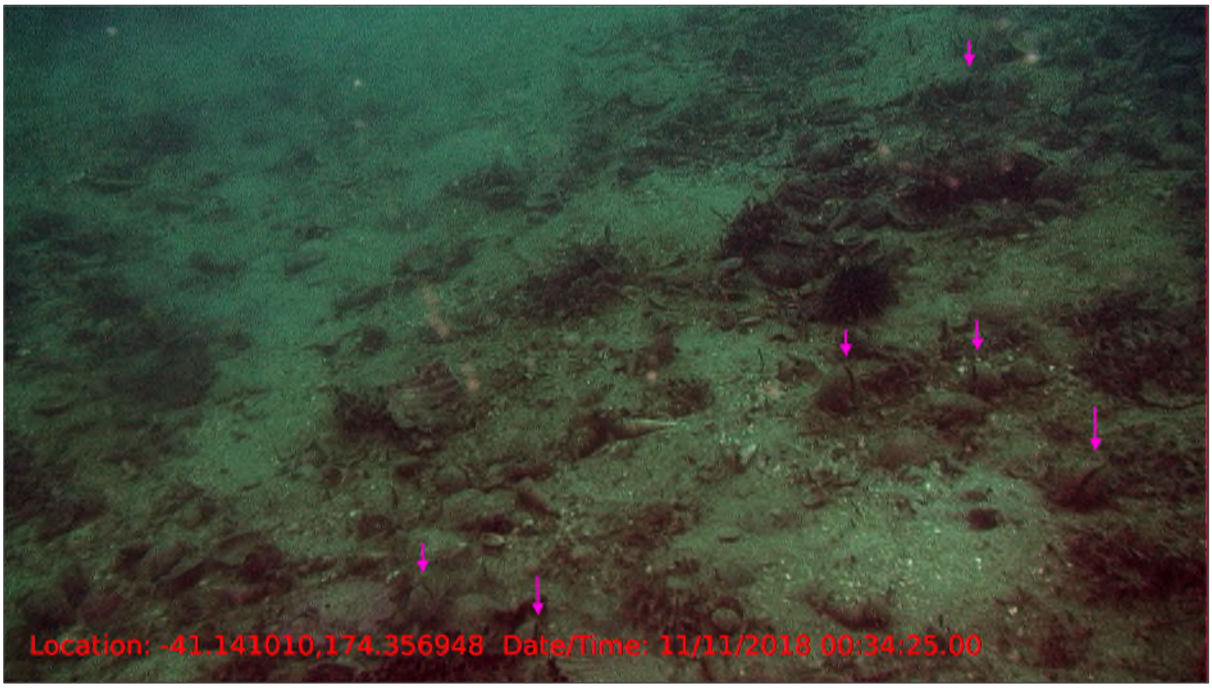


Plate 30. Photo grab from video footage collected in 2018 and reported in Ribó *et al*. (2021). Pink arrows live brachiopods.

A decline in the extent of red algae (*Adamsiella augustifolia*) in Puriri Bay was first reported by Davidson and Richards (2015) and then by Anderson et al. (2020a). The latter authors commented on the poor health of the algae and suggested this was due to sediment smothering the foliage.

The 14.3 ha algae bed in Puriri Bay was first surveyed using a drop camera in 2008. These data were used to map its boundaries for the Davidson et al. (2011) report. At the time it was regarded as the largest foliose red algae bed in Queen Charlotte Sound (Davidson and Richards*,* 2015). The red algae often covered 100% of the seabed in association with a variety of other important species including scallops, giant lampshell and horse mussels (Davidson and Richards, 2015).

Additional photos collected in January 2015 showed a reduction in the area occupied by red algae (Davidson and Richards, 2015). In contrast, historical percentage cover estimates showed a mean percent cover increased from 10 to 15% in 2002 to 40 to 45% by 2015. These data suggest that the bed was annually variable.

A transect located in the red algae bed was sampled regularly by Davidson and Richards (2014) from 2002 to 2013 and the authors reported that it consistently supported red algae. In the section of the transect where red algae were present (i.e. 100 and 150 m along the transect), the percentage cover ranged from 30 to 80 % cover. Although algae percentage cover estimates were only collected twice in 2002 and again in 2015, diver observations made throughout the period confirmed the red algae were present for the entire period.

The reason or reasons for the recent and dramatic loss of red algae in Puriri Bay are likely related to increased sedimentation. It is suggested that other sites that support red algae in Queen Charlotte Sound be resampled to determine if this phenomenon is more widespread. It is noted that Anderson *et al*. (2020a) found the Houhou bed (inner Queen Charlotte Sound) to be healthy and intact, suggesting the situation in Puriri Bay may be localised.

Dense beds of *Chaetopterus* sp. were present in East Bay during the 2021 survey. Davidson *et al*. (2020) recorded similar beds in Long Island-Kokomohua Marine Reserve for the first time during 28 years of reserve monitoring. It remains unclear if this tubeworm is a New Zealand native or an introduced species (Geoff Read NIWA, pers. comm.). This species was first noted in the Marlborough Sounds in the early 1990's (Duffy *et al.*, unpublished data) but has been present in New Zealand since 1966 (Geoff Read, pers. comm.). In a recent dredge survey to assess scallop biomass, *Chaetopterus* sp. was found in 25 survey stations from Queen Charlotte Sound to Pelorus Sound (Williams *et al*., 2019). The reasons for its recent apparent population explosion in Queen Charlotte Sound and the impact on other communities remains unknown. During the present 2021 survey, *Chaetopterus* was very abundant in East Bay and the 2020 survey (Davidson *et al*., 2020) confirmed its high abundance at Long Island. Sites surveyed in Pelorus Sound, Port Underwood and inner Queen Charlotte Sound showed no high-density beds of this soft tubeworm. In general, this tubeworm population boom and its ability to smother existing habitats and communities suggests it is introduced.

5.5 Significant site sensitivity and anthropogenic disturbance

In New Zealand and the world, important or significant biological features have usually been identified as those that provide important ecosystem services (e.g. provide food or habitat, or sequester carbon), have become threatened or rare due to anthropogenic activities (e.g. from physical disturbance, sedimentation) or are naturally rare. Important or significant marine species, habitats or communities include features such as beds or zones of tubeworms (calcareous and non-calcareous), bryozoans, sponges, ascidians, hydroids, shellfish, algae, seagrass, saltmarsh, mangroves, rhodoliths, stony corals, sea pens and xenophyophores). These features are often very vulnerable to anthropogenic impacts as they are usually fragile and slow growing (Airoldi and Beck, 2007; MacDiarmid *et al.,* 2012; 2013a; Anderson *et al*., 2019c).

Numerous studies have highlighted the importance of marine biogenic structures. Kuti *et al*. (2014) reported that complex habitats like coral reefs attracted many times the abundance of reef fish compared to simpler habitats. De Smet *et al*. (2015) reported that biogenic reefs composed of the tube-building polychaete *Lanice conchilega* 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; Thrush *et al*., 2002; Carbines and Cole, 2009; Wood *et al*., 2012; Morrison *et al*., 2014; Anderson *et al*., 2020a). Morrison *et al*. (2014) stated 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; (3) the provision of surfaces for reproductive purposes (e.g. the laying of elasmobranch egg cases); and (4) indirectly through primary production.

5.5.1 Anthropogenic impacts

Ranking of significant sites in Davidson *et al*. (2011) revealed the biological assemblages they supported were often uncommon with many representing one of few or the last of their kind in each biogeographic area. The existence of significant sites or their persistence was often attributed to environmental factors such as topography or substratum providing some level of natural protection from anthropogenic impacts.

Many of Marlborough's significant marine sites are thought to be remnants of habitats and communities historically more widespread (Davidson *et al*., 2011; Davidson and Richards 2015; 2016; Handley 2015, 2016; Davidson *et al*., 2017; 2018). This situation reflects a global trend of declining biogenic habitat area and quality with consequential effects on wider ecological values (Thrush *et al.,* 2006a, 2006b; Gray *et al.,* 2006; Lotz *et al*., 2006; Airoldi *et al.,* 2008; McCauley *et al.,* 2015; Anderson *et al*., 2019; Urlich and Handley, 2020). Aside from climate change effects, key threats to biogenic habitats include bottom trawling, shellfish dredging, sedimentation, invasive species, coastal infrastructure, water quality and port-related dredging (MacDiarmind *et al*., 2012).

Anderson *et al*. (2019) stated: "biogenic habitats growing along the New Zealand coast (e.g. eelgrass meadows, mangrove forests and kelp forests) especially those close to urban areas, face a range of threats and stresses associated with increased sedimentation, benthic disturbance through coastal development (infrastructure) and coastal maintenance (e.g. channel dredging), along with declines in water quality (e.g. increased suspended sediments, nutrification and pollution) associated with these activities". The authors also stated: "although some biogenic habitats occur within Marine Reserves, and they are afforded protection against direct physical disturbance (e.g. benthic fishing activities), they do not safeguard them against key threats from land-based issues such as sediment and nutrient run-off."

A decline in biogenic habitats in New Zealand has been linked to declining juvenile fish habitat and identified as a contributor to declines in fish abundance and biomass (see Morrison *et al*., 2014 for review). Hurst *et al*. (2000) stated: "The Environmental Principles of the 1996 Fisheries Act require that habitat of particular significance for fisheries management should be protected". Because the Fisheries Act 1996 has not prevented the continued fragmentation and loss of habitats (e.g. Davidson & Richards, 2015; Urlich, 2017), Urlich *et al*. (2018) contended that the definition of "maintained" (see: CBD, NZBS, Fisheries Act 1996) has not prevented the frequency and extent of fishing disturbance from outstripping the recovery potential of resident organisms, highlighting the need for management of cumulative impacts on the seafloor. Urlich *et al*. (2018) proposed that anthropogenic disturbance should be managed to "safeguard" ecological functioning of biogenic habitats as fundamental coastal processes underpinning biodiversity and its contingent ecological complexes. Urlich and Handley (2020) suggested a need for improved catchment management, along with more effective integration of marine management responsibilities and marine spatial planning (i.e. ecosystem-based management).

Importantly, significant sites that support biogenic habitats have often been described as important to juvenile fish (Diaz, *et al*., 2003; Dahlgren *et al.*, 2006; McCain *et al*., 2016). Wilson *et al*. (2010) for example reported habitat degradation compounded effects of fishing on coral reefs as increased fishing reduces large-bodied target species, while habitat loss resulted in fewer small-bodied juveniles and prey that replenish stocks and provide dietary resources for predators. Loss and degradation of marine biological values around New Zealand and internationally has usually been linked to anthropogenic activities (Lauder 1987, Stead 1991, Cranfield *et al.* 1999, Cranfield *et al.* 2003, Morrison *et al.,* 2009; Davidson *et al.,* 2011; Paul

2012; Morrison *et al.,* 2014, 2014a; Handley 2015, 2016). Direct physical disturbance by trawling and dredging for example, has been assessed as one of the main causes of damage to marine benthic biological values (MacDiarmid *et al.*, 2012; MfE, 2016). It is likely that without protection or strong management, Marlborough's less resilient significant marine sites will continue to be lost or degraded with consequential impacts on fish abundance.

Handley et al. (2014) reported macrofauna inside and outside Separation Pt protected area showed "Disturbed sites were dominated by fine mud, with little or no shell-gravel, reduced number of species, and loss of large bodied animals, with concomitant reductions in biomass and productivity. At protected sites, large, rarer molluscs were more abundant and contributed the most to size-based estimates of productivity and biomass. Functional changes in fished assemblages were consistent with previously reported relative increases in scavengers, predators and deposit feeders at the expense of filter feeders and a grazer.

Davidson and Richards (2015) highlighted the decline of biological attributes at several significant sites originally identified by Davidson *et al.* (2011), including sites becoming smaller and some being functionally lost. In contrast, Davidson and Richards (2016) did not document loss that could be directly attributed to human activities; rather site boundaries were adjusted based on improved information. Davidson *et al*. (2017a) reported that some sites were adversely affected by anthropogenic activities. In the most recent studies, Davidson *et al*. (2018; 2019; 2020) reported many sites were altered in size due to improvements in survey detail, while others had their attributes degraded by physical disturbance, exotic species and/or increased sedimentation.

Some biogenic habitats once damaged and lost may not recover, but instead may shift to an alternate ecosystem state (Airoldi and Beck, 2007). Large scale historical losses of biogenic habitats have been documented in New Zealand's history (e.g. the loss of ~500 km^2 of green-lipped mussel beds within the Firth of Thames has coincided with large declines in water quality, increased sedimentation and resuspension of sediments (described in Morrison *et al*., 2014a). Large-scale losses of green-lipped mussels within Kenepuru Sounds and horse mussel beds from across the outer Marlborough Sounds are also described by long-time fishers and residents (Handley, 2015, 2016; Davidson and Richards, 2015).

5.5.2 Threat assessment process

Anthropogenic threats for each significant site were compiled in Table 15. An assessment of species, community or habitat sensitivity and perceived threats for significant sites was first attempted Davidson *et al*. (2016). The present assessment adopted an updated version of the original assessment (see Davidson *et al*. 2020). The revised method required a site to be assessed for its expected sensitivity:

(A) very sensitive,
(B) sensitive, or
(C) robust/not known.

Each category of sensitivity is given a score (Table 2a). The second stage of the assessment involves the level of perceived threats:

(A) offshore and/or are accessible to activities such as dredging and trawling, or likely to be impacted by threats due to proximity to human activities/impacts.
(B) having a level of protection from threats due to location or remoteness (Table 2b).

These factors were used to calculate appropriate buffer zones that aim to reduce the likelihood of damage from anthropogenic activities (e.g. dredging, trawling, anchoring, sedimentation, pollution). The expert panel reviewed these buffer zone distances based on the panel's collective knowledge of the biophysical characteristics of each significant site (e.g. personal knowledge) and/or from the literature (including bathymetry charts), as well as information on the distribution and intensity of marine pressures such as bottom trawling and dredging.

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 respond to potential "stressors".

Definitions for the threat categories used in the present assessment of significant sites were:

Anthropogenic disturbance: 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 those from the adjacent catchments.

Sensitivity: Assessment of the sensitivity of habitats, species and/or communities present at a site. Scores ranged from extremely sensitive biological features such as lace corals and brittle tubeworm mounds (high vulnerability score) to robust species or habitats such as coarse substrate/mobile shores and high energy kelp forests (low vulnerability score).

5.5.3 Marine threats

Sensitivity to anthropogenic disturbance is likely to be an important consideration for the management of significant sites. Sites that support sensitive and very sensitive species, communities and/or habitats are vulnerable to human activities and management action is usually appropriate to ensure the continuation of natural values at the site (Table 2a).

Threats to the marine environment and significant sites in the Marlborough Sounds are real. For example, Watson *et al.* (2020) used NIWA multibeam bathymetric data to calculate the extend and cover of anthropogenic benthic impacts in Queen Charlotte Sound, Tory Channel and adjacent areas of Cook Strait. The authors recorded a variety of benthic impacts including anchor drag marks, aquaculture, moorings and port structures. The authors stated these impacts were most pronounced in inner Queen Charlotte Sound, however, they cautioned that the true spatial extent of physical disturbance related to anthropogenic activities was likely to be even more extensive than estimated in their study as the physical anthropogenic footprint measured using the multibeam bathymetric data only captured seabed features observable in the 2 m resolution data. Further, the authors stated the inner Queen Charlotte Sound has a relatively low influence from tidal currents with only very minor evidence of scouring, suggesting that human-induced seafloor disturbance may be better preserved in this part of the sounds compared to other higher energy environments (e.g., outer Queen Charlotte Sound). Watson *et al.* (2020) concluded that the dramatic increases in global marine traffic since the 1990s with trends of growth predicted in the coming decades may mean that seafloor disruption by anchor dragging becomes a major concern for marine habitats and therefore ecosystem health for shallow marine regions like Queen Charlotte Sound and Tory Channel.

5.5.4 ESMS sensitivity and threats summary

Sites in the present report were assessed for their sensitivity and threats using the criteria outlined in Tables 12a and 12b. Sites supported either “very sensitive” or “sensitive” species, habitats or communities (Table 14). Threat assessments for the sites included physical disturbance from trawling, dredging, anchoring, sedimentation/turbidity, and smothering from *Chaetopterus* worms.

The expert panel was particularly concerned or interested about:

1. Recreational anchoring at Perano Shoal in Queen Charlotte Sound.
2. Recreational anchoring at The Knobbys, Port Underwood.
3. Reasons for the loss of red algae at Pururi Bay.
4. Reasons for the loss of brachiopods from northern East Bay.
5. Smothering of *Galeolaria* tubeworm mounds by *Chaetopterus* worms.

Both Perano Shoal and The Knobbys are targeted by recreational fishers and anchoring often results in damage to the very sensitive calcareous tubeworm mounds. It is in fisher's best interest to ensure habitats that support fish, and their juveniles are protected from anchor damage.

The reasons for the loss of red algae at Puriri Bay are unknown but the expert panel considered the recent logging event at the head of the bay may have had an impact on the bed. The panel suggested ongoing monitoring to determine if the bed will recover. The panel also suggested other beds in Queen Charlotte Sound should be surveyed to determine if the loss is more widespread.

The reasons for the loss of brachiopods from northern East Bay is unknown but the panel thought it may be linked to the same drivers behind the decline in other shellfish species in the top of the South Island (e.g. scallops). The panel suggested this site be monitored and any research into the loss of shellfish species be supported.

Lastly, the panel were concerned about the smothering effect of *Chaetopterus* sp. on *Galeolaria* mounds. The panel suggested a study to investigate whether *Chaetopterus* is a native species having a population explosion or an introduced species, should be supported.

Table 14. Summary of anthropogenic disturbance and vulnerability for assessed 2021 significant sites.

Sites	Sensitivity (species, habitat)	Anthropogenic threats	Buffer (m)	Main issues	Impacts observed	Comments
Site 4.16 Perano Shoal (tubeworms)	Very sensitive	Effects likely	200	Recreational anchoring, smothering by *Chaetopterus* may occur.	Yes	Site is located close to a natural reef thereby reducing the chance of dredging or trawling. Anchoring occurs and has resulted in damage.
Site 4.22 Puriri Bay (macroalgae bed)	Sensitive	Effects likely	100	Physical damage from dredging and sedimentation/turbidity	Yes	The area has supported scallops and is dredged. The impact of sediment is not known but the site may be susceptible to sediment smothering due to the sheltered and semi-enclosed bay. The bed was not present in 2021.
Site 4.23 Matiere Point (lampshell and burrowing anemone)	Sensitive	Effects unlikely	50	Sedimentation/turbidity	No	Site is located along and close to a rubble bank thereby reducing the chance of dredging or trawling. Anchoring is possible. Logging of pine plantation in Puriri Bay has likely increased turbidity in the local area. The impact of sediment at this site is not known.
Site 4.25 East Bay north (lampshell and burrowing anemone)	Sensitive	Effects unlikely	50	Recreational anchoring, sedimentation/turbidity	Yes	Site is located along and close to the reef edges thereby reducing the chance of dredging or trawling. Anchoring occurs. The impact of sediment at this site is not known. Lampshell abundance has declined.
Site 6.1 The Knobbys (tubeworm mounds and reef)	Very sensitive	Effects likely	200	Recreational anchoring, sedimentation/turbidity	Yes	Recreational fishers anchor and damage was observed. Sediment levels are likely elevated due to recent forest logging.
New Site 3.32 The Reef, Richmond Bay (current swept community)	Very sensitive	Effects likely	200	Recreational anchoring, sedimentation/turbidity	No	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sediment at this site is not known.
New Site 3.33 Ketu Bay reef (current swept community)	Very sensitive	Effects likely	200	Recreational anchoring, sedimentation/turbidity	No	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sediment at this site is not known.
New site 3.34 Kaitira (East Entry Point) (current swept community)	Very sensitive	Effects likely	200	Recreational anchoring, sedimentation/turbidity	No	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sediment at this site is not known.
New site 3.35 Maud Island east reef (current swept community)	Very sensitive	Effects likely	200	Recreational anchoring, sedimentation/turbidity	No	Site is a reef and unlikely to be commercially trawled or dredged. Occasional recreational anchoring may occur. The impact of sediment at this site is not known.

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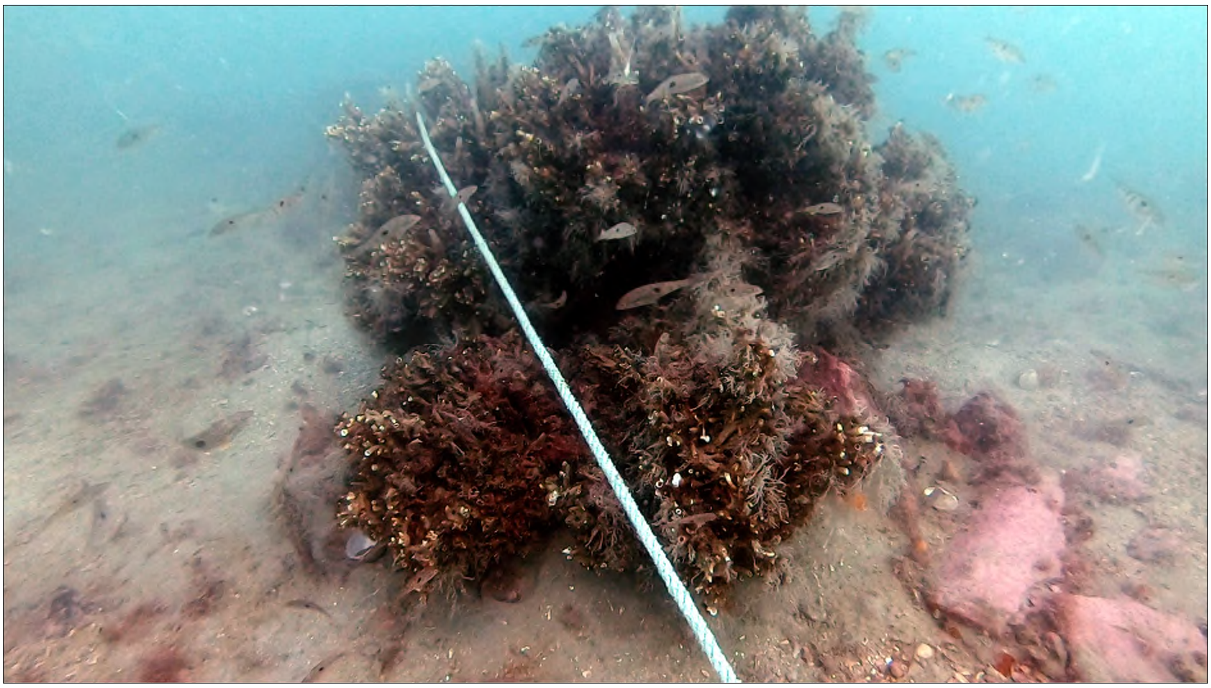

Plate 31. Large numbers of *Chaetopterus* worms appearing to smother a *Galeolaria* mound in Onapua Bay, Tory Channel (photo Tom Scott-Simmonds).

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Appendix 1. Site assessment summaries

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	4.23	
Site name	Matiere Point (subtidal)	
Site description	Matiere Point coast is located in East Bay, outer Queen Charlotte Sound.	
Ecological description of attributes	Southern parts of this site were monitored regularly for 11 years as part of a marine farm recovery study (Davidson and Richards, 2014). Giant lampshells were consistently recorded from the southern sample sites. Davidson and Richards (2015) sampled a new transect installed on the northern side of Matiere Point. The authors reported giant lampshells were present but were recorded in lower numbers compared to the southern transects sampled by Davidson and Richards (2014). Davidson and Richards (2015) reported the burrowing anemone (Cerianthus sp.) was regularly observed between 22m and 28m depth along the northern transect. The authors stated the site represented the best-known example of where these species co-exist along the southern coastline of East Bay, with the best site being Site 4.24. Davidson et al., (2020) updated the site polygon based on detailed bathymetric and multibeam sonar data were collected from this area by Neil et al. (2018a, 2018b). The new depth contour data were used to improve the accuracy of the depth range where burrowing anemones at this site and other sites in the Sounds (approximately 10m and 28m depth) and giant lampshells in East Bay (approximately 20m to 34m depth) had been previously determined by Davidson and Richards (2014; 2015).	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment	1/04/2011	
Previously reported in or identified by	Davidson et al., (2020)	
Field work (present)		
Date	22 April 2021	
Lead organisation	Davidson Environmental	
Personnel	Rob Davidson, Laura Richards , Courtney Rayes. Tom Scott-Simmonds, Oliver Wade	
Important species (revised site)		
Are important species present?	Yes	
Important species 1	Lampshells	
Species status	Conservation/scientific importance	
Biogenic type (if applicable)		
Important species 2	Burrowing enemone	
Species status	Conservation/scientific importance	
Biogenic type (if applicable)		
Important species 3		
Species status		
Biogenic type (if applicable)		
Significant site summary	**Existing and present survey information**	
Original area of significant site (ha)	10.95	
Previous area (ha)	12.41	
Recommended area of significant site (ha)	12.41	
Change to original site	No change	
Change (ha)	0.0	
Percentage change from original area (%)	0%	
Marine zone	Sublittoral (low tide to continental shelf)	
Depth range (m)	0-40	
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)	
Human Impacts	**Comments**	**Expert panel assessment**
Damage and or impacts noted	None observed	
Proportion of significant site effected		
Level of impact	Most of the site is located relatively close to shore and there exists a reef extending south-west from the point. The area is seldom fished, however, an occasional recreation dredger has been observed in the area. Some anchoring may occur but this has not been observed. The species, habitats or communities present are likely tolerant of occasional anchoring but not dredging or trawling, however, this is limited due to the topography and presence of the central reef/ridge. The impact of catchment derived sediment at this site is not known. The southern half of the site is likely more vulnerable to sediment settlement due to its more sheltered aspect compared to the area north-east of Matiere Point.	
Type of damage or activity observed		
Type of damage or activity observed		
Type of damage or activity observed		
Type of damage or activity observed		
Sensitivity & buffer calculation	**Existing and present survey information**	**Expert panel assessment**
Anthropogenic disturbance description	B: Sensitive = 50	
Threat multiplier	B: Effect unlikely = 1	
Suggested buffer (m)	50 m	
Assessment criteria scores	**Assessment criteria scores (most recent)**	**Assessment criteria scores (present review)**
1. Representativeness	M (medium)	M (medium)
2. Rarity	M (medium)	M (medium)
3. Diversity	M (medium)	M (medium)
4. Distinctiveness	H (high)	H (high)
5. Size and shape	L (low)	L (low)
6. Connectivity	M (medium)	M (medium)
7. Sustainability		
8. Catchment	M (medium)	M (medium)
Comments		No change to previous assessment in 2020.
Recommendations		

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	4.16	
Site name	Perono Shoal (tubeworms -calcified)	
Site description	Perano Shoal is an offshore rise located in the entrance to Blackwood Bay and adjacent to the smaller Tauranga Bay, 10.7km north-east of Picton.	
Ecological description of attributes	The presence of tubeworm mounds was first documented during a dive survey in the early 1990's (Duffy et al., unpublished data). The Shoal was included as a significant site because of the high density of tubeworm mounds (Davidson et al., 2011). The site was surveyed in more detail by Davidson and Richards (2015) and a percentage cover of damage was also established. The authors stated "the top of the shoal is between 5m and 7m depth and is predominantly exposed bedrock with few or sparse mounds. Below and surrounding the bedrock outcrop are areas of shell and fine sand, swept by low-moderate tidal currents (Hadfield et al., 2014)". Davidson and Richards (2015) stated Perano Shoal supported a high-density bed of tubeworms dominated by Galeolaria hystrix, Spirobranchus latiscapus and an unidentified Serpula sp. The authors stated mean percentage coverage recorded from diver collected quadrats was 76.67%. Perano Shoal is the only known locality for a living example of Protulophila, a colonial hydroid previously known only from Europe and the Middle East, Jurassic to Pliocene (Dennis Gordon, http://www.niwa.co.nz/news/northern-hemisphere-fossil-discovered-living-in-new-zealand; https://niwa.co.nz/blog/critteroftheweek/124).	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment	1/09/2011	
Previously reported in or identified by	Davidson et al., 2015	
Field work (present)		
Date	20 May 2020	
Lead organisation	Davidson Environmental	
Personnel	Rob Davidson, Laura Richards, Courtney Rayes	
Methods		
Method of assessment	Drop camera (cable remote) HD photographs (remote underwater) HD video (remote underwater)	
Important species (revised site)		
Are important species present?	Yes	
Important species 1	Tubeworm mounds	
Species status	Biogenic habitat forming	
Biogenic type (if applicable)	Tubeworm mounds (e.g. G. hystrix)	
Important species 2	Spirobranchus latiscapus	
Species status	Biogenic habitat forming	
Biogenic type (if applicable)	Tubeworm mounds (e.g. G. hystrix)	
Important species 3	*Protulophila* sp.	
Species status	Conservation/scientific importance	
Biogenic type (if applicable)		
Important species 4	*Cerianthus sp.*	
Species status	Conservation/scientific importance	
Biogenic type (if applicable)		
Significant site summary	**Existing and present survey information**	
Original area of significant site (ha)	3.8	
Revised area (2015)	5.5	
Recommended area of significant site (ha)	5.6	
Change to original site	Increase	
Change (ha)	0.1	
Percentage change from original area (%)	2%	
Marine zone	Sublittoral (low tide to continental shelf)	
Depth range (m)	0-40	
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)	
Human Impacts	**Comments**	**Expert panel assessment**
Damage and or impacts noted	Anchor damage	
Proportion of significant site effected	10-25%	
Level of impact	Most of the site is located on a base of bedrock. Dredging and trawling is unlikely. Some anchoring by recreational fishers occurs. Species, habitats or communities present are intolerant physical seabed disturbance (i.e. very fragile biogenic structures). Davidson et al., (2015) recorded 13.7% damage rate based on diver collected quadrats.	
Type of damage or activity observed	Elevated turbidity	
Type of damage or activity observed	Sedimentation	
Sensitivity & buffer calculation	**Existing and present survey information**	**Expert panel assessment**
Anthropogenic disturbance description	A: Very sensitive = 100	
Threat multiplier	A: Effects are likely = 2	
Suggested buffer (m)	200 m	
Assessment criteria scores	**Assessment criteria scores (2015)**	**Assessment criteria scores**
1. Representativeness	H (high)	H (high)
2. Rarity	L (low)	H (high)
3. Diversity	M (medium)	H (high)
4. Distinctiveness	H (high)	H (high)
5. Size and shape	L (low)	H (high)
6. Connectivity	L (low)	M (medium)
7. Sustainability		
8. Catchment	L (low)	H (high)
Comments	Perano Shoal supports a high density bed of tubeworms (76% cover) dominated by *Galeolaria hystrix, Spirobranchus latiscapus* and an unidentified Serpula sp. The mean percentage coverage recorded from quadrats was 76.67 %. Anchor drag marks were observed running off the high point of the Shoal into deeper waters. From diver collected quadrats 13.6 % of the substratum sampled was damaged by anchoring activities. Perano Shoal is the only known locality for a living example of Protulophila a putative hydroid previously known only from Europe and the Middle East, Jurassic to Pliocene (Dennis Gordon pers.comm.).	
Recommendations	Adopt as a new significant site boundaries. Monitor impact levels and general health of mounds.	

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	4.25	
Site name	East Bay north (lampshell and burrowing anemone)	
Site description	The East Bay north site is a long site that stretches some 7.3 km along the coastline from Onario Point in the west to Paerata Point in the east.	
Ecological description of attributes	The site was first described by Davidson et al. (2011). Several unpublished survey dives were conducted along this coast and confirmed the presence of giant lampshells (Neothyrus lenticularis), burrowing anemones (Cerianthus sp.), anemone (Epiactus sp.) and Galeolaria hystrix tubeworm mounds. Unpublished survey data showed giant lampshells were present at an average density of 1.4 per m2 between 24 and 32 m depth, however, more recent studies have shown giant lampshell can be present in as little as 20m depth in East Bay (Davidson and Richards, 2014). Davidson et al., (2020) updated the site polygon based on detailed bathymetric and multibeam sonar data were collected from this area by Neil et al. (2018a, 2018b) (Figure 8). The new depth contour data were used to improve the accuracy of the depth range where brachiopods and burrowing anemones occur at this site and other sites in the Sounds (approximately 10m and 28m depth) and giant lampshells in East Bay (approximately 20m to 34m depth) had been previously determined by Davidson and Richards (2014; 2015). During the present summer survey, five HD video transects were installed. Video footage confirmed the site supports substrata and habitats comparable to those known for other sites in East Bay sampled over an 11 year period by Davidson et al. (2014). The five video transects indicated scallop densities were very low. Davidson and Richards (2014) study, scallops were uncommon near the start of their study but densities steadily increased over the following 11-year period. Brachiopods (Neothyris and Terebratella) were also rarely seen along the persent video transects. Other notable species present were burrowing anemone (Cerianthus sp.) and Galeolaria mounds, but these were also rarely seen. Blue cod juveniles (<10cm) were regularly	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment	1/04/2011	
Previously reported in or identified by	Davidson, R.J.; Richards, L.A.; Rayes, C.; Scott-Simmonds, T. 2020. Significant marine site survey and monitoring programme (survey 6): Summary report 2019-2020. Prepared by Davidson Environmental Limited for Marlborough District Council. Survey and monitoring report number 1023.	

Field work (present)	
Date	22 April 2021
Lead organisation	Davidson Environmental
Personnel	Rob Davidson, Laura Richards , Courtney Rayes. Tom Scott-Simmonds, Oliver Wade

Methods	
Method of assessment	Drop camera (cable remote) HD photographs (remote underwater) HD video (remote underwater) Photographs (handheld surface)

Important species (revised site)	
Are important species present?	Yes
Important species 1	Lampshells
Species status	Conservation/scientific importance
Biogenic type (if applicable)	
Important species 2	Burrowing enemone
Species status	Conservation/scientific importance
Biogenic type (if applicable)	
Important species 3	Juvenile blue cod
Species status	Iconic
Biogenic type (if applicable)	

Significant site summary	Existing and present survey information
Original area of significant site (ha)	120.47
Previous area (ha)	167.07
Recommended area of significant site (ha)	167.07
Change to original site	No change
Change (ha)	0.0
Percentage change from original area (%)	0%
Marine zone	Sublittoral (low tide to continental shelf)
Depth range (m)	0-42
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)

Human Impacts	Comments	Expert panel assessment
Damage and or impacts noted	No physical damage observed. Lampshells, Galeolaria mounds and burrowing anemones rare.	
Proportion of significant site effected	75-100%	
Level of impact	Most of the site is located relatively close to shore and there exists numerous reefs and cobble banks extending from shore. The area is regularly recreationally fished and anchoring has been observed. Excluding Galeolaria mounds, the species, habitats and communities present are likely tolerant of occasional anchoring but not dredging or trawling. Dredging and trawling are unlikely due to the topography and presence of the rocky substrata. The reasons for the decline in lampshell, scallop and narrowing enemone is unknown. The decline in tubeworm mounds may be related to anchoring.	
Type of damage or activity observed		
Type of damage or activity observed		
Type of damage or activity observed		
Type of damage or activity observed		

Sensitivity & buffer calculation	Existing and present survey information	Expert panel assessment
Anthropogenic disturbance description	B: Sensitive = 50	
Threat multiplier	B: Effect unlikely = 1	
Suggested buffer (m)	50 m	

Assessment criteria scores	Assessment criteria scores (most recent)	Assessment criteria scores
1. Representativeness	H (high)	H (high)
2. Rarity	M (medium)	M (medium)
3. Diversity	M (medium)	M (medium)
4. Distinctiveness	H (high)	H (high)
5. Size and shape	H (high)	H (high)
6. Connectivity	M (medium)	M (medium)
7. Sustainability		
8. Catchment	M (medium)	M (medium)
Comments	Largest site of its kind	No change to the 2020 assessment
Recommendations	Support investigation into the decline of shellfish.	

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	6.1	
Site name	The Knobbys (reef and tubeworms)	
Site description	A large reef located in north-eastern Port Underwood.	
Ecological description of attributes	The submerged ridge, reef and associated tubeworm mounds was first described by Davidson (1993) during a marine farm survey. The author stated "the reef is a shallow ridge dominated by pebbles, coarse sands, broken and dead shell with outcropping rock along its length. Most outcropping rock was colonised by very large colonies of tubeworms which formed mounds up to 20m x 10 m diameter and up to approximately 3 m in height. These colonies appeared healthy with few areas of dead worms. Extensive shallow beds of red algae (*Adamsiella* spp.) were recorded over soft substrates along much of the reef." The author also noted the presence of the adventive alga *Chnoospora minima* (Nelson and Duffy, 1991) that formed a mat over the benthos south-east of the reef .	
Biogeographic area	Port Underwood	
Level of original information	2. Qualitative internal report	
Date of original assessment	1/09/2011	
Report	Davidson R. J.; Duffy C.A.J.; Gaze P.; Baxter, A.; DuFresne S.; Courtney S.; Hamill P. 2011. Ecologically significant marine sites in Marlborough, New Zealand. Co-ordinated by Davidson environmental limited for Marlborough District Council and Department of Conservation.	

Field work (present)

Date	17 December 2019
Lead organisation	Davidson Environmental
Personnel	Rob Davidson, Laura Richards , Courtney Rayes

Site Characteristics

Original area of significant site (ha)	2.418
Suggested revision of significant site (ha)	3.414
Marine zone	Sublittoral (low tide to continental shelf)
Depth range (m)	0 - 16 m
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)

Methods

Method of assessment	Drop camera (cable remote) Photographs (handheld surface) Sonar Scan

Important species (revised site)

Are important species present?	Yes
Important species 1	Red algae
Species status	Biogenic habitat forming
Biogenic type (if applicable)	Turfing algae
Important species 2	Galeolaria hystrix beds
Species status	Biogenic habitat forming
Biogenic type (if applicable)	Tubeworm mounds (e.g. G. hystrix)
Important species 3	
Species status	
Biogenic type (if applicable)	

Human Impacts

Damage and or impacts noted	Mussel farms are located close by. The adventive brown alga *Chnoospora minima* (Nelson and Duffy, 1991) is common in the sheltered bay south of this site.
Proportion of significant site effected	
Level of impact	The adjacent marine farm does is approximately 30 m south of the foot of the reef and >100m from tubeworms mounds (Davidson *et al*, 2019). Sedimentation levels appear high as indicated by high turbidity and sediment often dusting rocks and plant surfaces. Considerable areas of the Port Underwood catchments have been logged in recent years. It is not known if the adventive alga *Chnoospora minim* a (Nelson and Duffy, 1991) competes with native algae.
Type of damage or activity observed	Introduced or exotic species
Type of damage or activity observed	Sedimentation
Type of damage or activity observed	Aquaculture
Type of damage or activity observed	

SIGNIFICANT SITE SUMMARY	Existing and present survey information	Expert panel assessment
Original area of significant site (ha)	2.418	
Recommended area of significant site (ha)	3.414	
Change to original site	Increase	
Change (ha)	0.996	
Percentage change from original area (%)	41.2%	
Anthropogenic disturbance	Moderate	
Vulnerability assessment	Moderate-high	
Sensitivity	Extremely sensitive	
Assessment criteria scores	Assessment criteria scores (original)	Assessment criteria scores
1. Representativeness	H (high)	M (medium)
2. Rarity	L (low)	M (medium)
3. Diversity	M (medium)	H (high)
4. Distinctiveness	H (high)	M (medium)
5. Size and shape	L (low)	H (high)
6. Connectivity	L (low)	H (high)
7. Sustainability		
8. Catchment	L (low)	L (low)
Comments	Increase in site size due to extended survey coverage and more intense sampling. Site covers tubeworm mounds and the reef.	Largest reef in Port Undewood = H for size.
Recommendations	Adopt new site boundaries.	

Site Registration Detail (original)	**Existing and present survey information**	**Expert panel assessment**
Site number	3.32	
Site name	The Reef, Richmond Bay (current swept community)	
Site description	Area of seabed located on and adjacent to The Reef, southern Richmond Bay, Waitata Reach. Richmond Bay is located along the eastern side of Waitata Reach, Pelorus Sound. The Reef extends almost 1 km from the adjacent promontory located at the southern	
Ecological description of attributes	The Reef is dominated by a bedrock reef that extends northwards from a large promontory along the southern coast of Richmond Bay. Boulder and cobbles were present along the edges of the main reef ridge. At the base of the reef, its edges were surrounded by coarse soft substratum. The Reef had a moderate to high level of encrusting biogenic ccurrent swept communities. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment	1/09/2011	
Previously reported in or identified by		
Field work (present)		
Date	15 January 2021	
Lead organisation	Davidson Environmental	
Personnel	Rob Davidson, Laura Richards , Courtney Rayes	
Methods		
Method of assessment	Drop camera (cable remote) HD photographs (remote underwater) HD video (remote underwater) Photographs (handheld surface)	
Important species (revised site)		
Are important species present?	Yes	
Important species 1	Hydroids, sponges, ascidians	
Species status	Biogenic habitat forming	
Biogenic type (if applicable)	High relief biogenic (variety of species)	
Significant site summary	**Existing and present survey information**	
Original area of significant site (ha)		
Recommended area of significant site (ha)	20.8	
Change to original site	Increase	
Change (ha)	20.8	
Percentage change from original area (%)	0%	
Marine zone	Sublittoral (low tide to continental shelf)	
Depth range (m)	0-40	
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)	
Human Impacts	**Comments**	**Expert panel assessment**
Damage and or impacts noted	Fine sediment apparent on deeper substrate and organisms	
Proportion of significant site effected	25-50 %	
Level of impact	Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. Most fishers drift fish at this site, but some anchoring may occur. Species, habitats or communities present are intolerant physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops. The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment	
Type of damage or activity observed	Elevated turbidity	
Type of damage or activity observed	Sedimentation	
Type of damage or activity observed		
Type of damage or activity observed		
Sensitivity & buffer calculation	**Existing and present survey information**	**Expert panel assessment**
Anthropogenic disturbance description	A: Very sensitive = 100	
Threat multiplier	B: Effect unlikely = 1	
Suggested buffer (m)	100 m	
Assessment criteria scores	**Assessment criteria scores (original)**	**Assessment criteria scores (present review)**
1. Representativeness		M (medium)
2. Rarity		M (medium)
3. Diversity		M (medium)
4. Distinctiveness		M (medium)
5. Size and shape		H (high)
6. Connectivity		H (high)
7. Sustainability		
8. Catchment		L (low)
Comments	One of the longest reef structures in Pelorus. High cover of current swept communities.	Largest supporting current swept biogenic communities.
Recommendations	Adopt as a new significant site.	

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	3.33	
Site name	Ketu Bay reef (current swept community)	
Site description	Area of seabed located on and adjacent to a reef that extends northwards from the southern entrance to Ketu Bay, Waitata Reach. Ketu Bay is located along the eastern side of Waitata Reach, Pelorus Sound. The Reef extends approximately 530 m from the adjacent promontory.	
Ecological description of attributes	The Reef is dominated by a bedrock reef that extends northwards from a large promontory along the southern coast of Richmond Bay. Boulder and cobbles were present along the edges of the main reef ridge. At the base of the reef, its edges were surrounded by coarse soft substratum. The Reef had a moderate to high level of encrusting biogenic ccurrent swept communities. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians (*Cnemidocarpa bicornuta*), anemones (*Anthothoe albocincta*) and sponge (*Ecionemia alata*). Overall filter feeding species ranged from occasional to	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment	1/09/2011	
Previously reported in or identified by		

Field work (present)	
Date	15 January 2021
Lead organisation	Davidson Environmental
Personnel	Rob Davidson, Laura Richards , Courtney Rayes

Methods	
Method of assessment	Drop camera (cable remote) HD photographs (remote underwater) HD video (remote underwater) Photographs (handheld surface)

Important species (revised site)	
Are important species present?	Yes
Important species 1	Hydroids, sponges, ascidians
Species status	Biogenic habitat forming
Biogenic type (if applicable)	High relief biogenic (variety of species)
Important species 2	
Species status	
Biogenic type (if applicable)	
Important species 3	
Species status	
Biogenic type (if applicable)	

Significant site summary	Existing and present survey information
Original area of significant site (ha)	
Recommended area of significant site (ha)	9.0
Change to original site	Increase
Change (ha)	9.0
Percentage change from original area (%)	0%
Marine zone	Sublittoral (low tide to continental shelf)
Depth range (m)	0-40
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)

Human Impacts	Comments	Expert panel assessment
Damage and or impacts noted	Fine sediment apparent on deeper substrate and organisms	
Proportion of significant site effected	25-50 %	
Level of impact	Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. Most fishers drift fish at this site, but some anchoring may occur. Species, habitats or communities present are intolerant physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops. The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment was most apparent at depth where currents are lower compared to shallow parts of the reef.	
Type of damage or activity observed	Elevated turbidity	
Type of damage or activity observed	Sedimentation	
Type of damage or activity observed		
Type of damage or activity observed		

Sensitivity & buffer calculation	Existing and present survey information	Expert panel assessment
Anthropogenic disturbance description	A: Very sensitive = 100	
Threat multiplier	B: Effect unlikely = 1	
Suggested buffer (m)	100 m	

Assessment criteria scores	Assessment criteria scores (original)	Assessment criteria scores
1. Representativeness		M (medium)
2. Rarity		M (medium)
3. Diversity		M (medium)
4. Distinctiveness		M (medium)
5. Size and shape		M (medium)
6. Connectivity		H (high)
7. Sustainability		
8. Catchment		L (low)
Comments	One of the longest reef structures in Pelorus. High cover of current swept communities.	
Recommendations	Adopt as a new significant site.	

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	3.34 (new site)	
Site name	Kaitira (East Entry Point) (current swept community)	
Site description	Area of seabed located on and adjacent to a reef that extends northwards from Kaitira, Pelorus Sound Entrance, Waitata Reach. Kaitira is located along the southern shore of Waitata Reach. The Reef extends approximately 150 m from the adjacent promontory.	
Ecological description of attributes	Video and drop camera ground truthing during the present study confirmed the site has a main bedrock ridge that is interspersed by boulder, cobble and soft substrata at periodic intervals along its length. The reef also has areas of coarse current swept soft sediment. The reef extends approximately 150 m north from the promontory at the eastern entrance to Pelorus Sound. At the offshore base of the reef, its edges were surrounded by coarse soft substratum. The Reef has a high level of encrusting biogenic current swept communities. Dominant epibenthic species included hydroids (Sertularia sp.), compound ascidians (Aplidium phortax), solitary ascidians (Cnemidocarpa bicornuta), anemones (Anthothoe albocincta) and sponge (Ecionemia alata). In shallow areas along its eastern edge there are large mounds of the tubeworm (Galeolaria hystrix). Overall filter feeding species are common to	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment	1/09/2011	
Previously reported in or identified by		

Field work (present)	
Date	15 January 2021
Lead organisation	Davidson Environmental
Personnel	Rob Davidson, Laura Richards , Courtney Rayes

Methods	
Method of assessment	Drop camera (cable remote) HD photographs (remote underwater) HD video (remote underwater) Photographs (handheld surface)

Important species (revised site)	
Are important species present?	Yes
Important species 1	Hydroids, sponges, ascidians
Species status	Biogenic habitat forming
Biogenic type (if applicable)	High relief biogenic (variety of species)
Important species 2	*Galeolaria hystrix* mounds
Species status	Biogenic habitat forming
Biogenic type (if applicable)	Tubeworm mounds (e.g. G. hystrix)
Important species 3	
Species status	
Biogenic type (if applicable)	

Significant site summary	Existing and present survey information
Original area of significant site (ha)	
Recommended area of significant site (ha)	1.9
Change to original site	Increase
Change (ha)	1.9
Percentage change from original area (%)	0%
Marine zone	Sublittoral (low tide to continental shelf)
Depth range (m)	0-50
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)

Human Impacts	Comments	Expert panel assessment
Damage and or impacts noted	Fine sediment apparent on deeper substrate and organisms	
Proportion of significant site effected	25-50 %	
Level of impact	Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. Most fishers drift fish at this site, but some anchoring may occur. Species, habitats or communities present are intolerant physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops. The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment was most apparent at depth where currents are lower compared to shallow parts of the reef.	
Type of damage or activity observed	Elevated turbidity	
Type of damage or activity observed	Sedimentation	
Type of damage or activity observed		
Type of damage or activity observed		

Sensitivity & buffer calculation	Existing and present survey information	Expert panel assessment
Anthropogenic disturbance description	A: Very sensitive = 100	
Threat multiplier	B: Effect unlikely = 1	
Suggested buffer (m)	100 m	

Assessment criteria scores	Assessment criteria scores (original)	Assessment criteria scores
1. Representativeness		H (high)
2. Rarity		M (medium)
3. Diversity		H (high)
4. Distinctiveness		H (high)
5. Size and shape		L (low)
6. Connectivity		H (high)
7. Sustainability		
8. Catchment		L (low)
Comments	High cover of current swept communities. Best known *Galeolaria* mounds in Pelorus Sound.	
Recommendations	Adopt as a new significant site.	

Site Registration Detail (original)	Existing and present survey information	Expert panel assessment
Site number	3.35 (new site)	
Site name	Maude Island eastern reef (current swept community)	
Site description	Area of seabed located on and adjacent to a reef that extends north-east from the eastern-most tip of Maud Island, Waitata Reach. The site is located in southern Waitata Reach. The Reef extends approximately 480 m distance from the adjacent promontory. The site has not previously been biologically surveyed but is located in an area swept by tidal current flowing along Waitata	
Ecological description of attributes	Video and drop camera ground-truthing during the present study confirmed the site has a main bedrock ridge that is interspersed by a boulder, cobble and soft substrata at periodic intervals along its length. The reef also has areas of coarse current swept soft sediment. The reef extends approximately 480 m north-east from the promontory. The Reef has a high level of encrusting biogenic current swept communities. Dominant epibenthic species included hydroids (*Sertularia* sp.), compound ascidians (*Aplidium phortax*), solitary ascidians (*Cnemidocarpa bicornuta*), anemones (*Anthothoe albocincta*) and sponge (*Ecionemia alata*). Overall filter-feeding species are common to abundant. The Reef is one of several current-swept reef habitats located along Waitata Reach. These reef structures support a high diversity of species, often in high abundance. The biogenic structures that form on these sites provide habitat for many smaller organisms that in turn, become food for larger species such as fish. At this site, blue cod are very abundant, likely due to the MPI protected status.	
Biogeographic area	Pelorus Sound	
Level of original information	3. Quantitative internal report	
Date of original assessment		
Previously reported in or identified by		

Field work (present)	
Date	15 January 2021
Lead organisation	Davidson Environmental
Personnel	Rob Davidson, Laura Richards , Courtney Rayes

Methods	
Method of assessment	Drop camera (cable remote) HD photographs (remote underwater) HD video (remote underwater) Photographs (handheld surface)

Important species (revised site)	
Are important species present?	Yes
Important species 1	Hydroids, sponges, ascidians
Species status	Biogenic habitat forming
Biogenic type (if applicable)	High relief biogenic (variety of species)
Important species 2	
Species status	
Biogenic type (if applicable)	
Important species 3	
Species status	
Biogenic type (if applicable)	

Significant site summary	Existing and present survey information
Original area of significant site (ha)	
Recommended area of significant site (ha)	2.2
Change to original site	Increase
Change (ha)	2.2
Percentage change from original area (%)	0%
Marine zone	Subtittoral (low tide to continental shelf)
Depth range (m)	0-50
Wave Climate	Sheltered coast (enclosed or semi-enclosed water body)

Human Impacts	Comments	Expert panel assessment
Damage and or impacts noted	Fine sediment apparent on deeper substrate and organisms	
Proportion of significant site effected	25-50 %	
Level of impact	Most of the site is located on or immediately adjacent to a bedrock reef structure swept by regular moderate to strong tidal flows. This area is part of an MPI "no-take finfish zone" established on 1st July 2015 (see insert in Figure 11). Anchoring is now unlikely to occur. Species, habitats or communities present are intolerant of physical seabed disturbance (i.e. fragile biogenic structures). These features are also not tolerant of dredging or trawling, however, this is unlikely due to the topography and presence of bedrock outcrops. The impact of catchment derived sediment at this site is not known but it is likely minimized due to regular tidal currents that sweep the site. In general, fine sediment was most apparent at depths where currents are lower compared to shallow parts of the reef.	
Type of damage or activity observed	Elevated turbidity	
Type of damage or activity observed	Sedimentation	
Type of damage or activity observed		
Type of damage or activity observed		

Sensitivity & buffer calculation	Existing and present survey information	Expert panel assessment
Anthropogenic disturbance description	A: Very sensitive = 100	
Threat multiplier	B: Effect unlikely = 1	
Suggested buffer (m)	100 m	

Assessment criteria scores	Assessment criteria scores (original)	Assessment criteria scores (present review)
1. Representativeness		H (high)
2. Rarity		M (medium)
3. Diversity		H (high)
4. Distinctiveness		M (medium)
5. Size and shape		M (medium)
6. Connectivity		H (high)
7. Sustainability		
8. Catchment		L (low)
Comments	Very good example of a habitat with current swept communities. Part of a MPI protected area.	High for represenativeness due to it being protected for fishing and therfore supports the most natural fish populations in Pelorus.
Recommendations	Adopt as a new significant site.	

Appendix 2. History of annual field surveys

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 by 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 expert 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 subsites outlined in Davidson and Richards (2015). The review report presents the findings of that reassessment. It also comments on issues associated with the 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 assessment criteria originally used to determine significant sites as developed by Davidson *et al*. (2011).

The Panel's overall findings recommended that:

(1) three sites are 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 following 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

Before the 2015-2016 fieldwork season, a report outlining potential or candidate sites for a 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 of 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 subsites 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 suggested 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) led to both increases and decreases to the size of individual significant sites and an overall decline of 262.6ha 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 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. Previously used in 2016. 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 human associated impacts. Catchment 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/to catchment effects high due to modification or poor management.
Vulnerability	
Resilient (low or unlikely)	Algae forest, coarse substrata, moderate or high energy reef, high energy shore, short-lived species.
Sensistive (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.

1.3 Field survey 3 and expert peer review

A total of 10 sites were described during the study of 2016-2017. One site (Titi Island) was split into 3 sub-sites while one site (Rangitoto Islands) was split into four subsites. Subsites were defined as having comparable habitats and communities, but each sub-site was physically separate. One new subsite was added to an existing set of three subsites at Hunia (Port Gore). In total, 15 sites and subsites were investigated.

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). Increases were due to an improvement in the level of survey 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.

The Expert Panel accepted the boundary modifications proposed by Davidson *et al*. (2017a) and Tory Channel sites suggested by Davidson *et al*. (2017b). Two other new sites and one new sub-site were also accepted by the review group. The Expert Panel recommended that one site (Titi Island rock) proposed by Davidson *et al*. (2017a) be reassessed in the future once more information was available.

1.4 Field survey 4 and expert peer review

A total of 14 sites were described during the study of 2017-2018. Six potential new significant sites (Woodlands west rhodoliths, Ouokaha Island coast, Tuhitarata Bay reef, Matai Bay tubeworms, Penzance Bay elephantfish egg-laying, Treble Tree coastline) were described. Matai Bay tubeworms and Penzance Bay elephantfish egg-laying sites were located within the larger Tennyson Inlet site.

Three existing significant sites increased in size by a total of 146.2 ha: site 3.9 = 143.12 ha, site 3.12 = 1.175 ha and site 3.15 = 1.9 ha. Those increases were due to either an improvement in the level of detail or redefining of the boundaries. Four sites declined in size by a total of 112.68 ha (Sites 3.7, 3.8, 3.11 and 3.25). Declines were mostly due to the improved level of information, however, small areas of site 3.8 (Fitzroy elephantfish egg-laying habitat) were impacted by marine farms and therefore removed. Parts of this significant site (i.e. Garne and Savill Bays) appeared impacted by the exotic alga *Asperococcus bullosus* (Nelson and Knight, 1995). This brown alga was abundant and often covered much of the benthos. Further, these bays appeared siltier compared to historic observations conducted in the 1990's. It is unknown if one or both factors explain the decline in elephantfish egg cases recorded during the present study. Another exotic species was also widespread at site 3.8. A tubeworm in the Family Chaetopteridea was abundant at many locations between 4 to 12 m depth. It was considered possible that these tubeworm beds may also influence egg-laying elephantfish.

Human impact was observed at three of the potential new significant sites (site 3.23 Woodlands west, site 3.26 Ouokaha Island, site 3.29 Treble Tree coast). At site 3.26, *Galeolaria hystrix* tubeworm mounds had been overturned, probably from anchors or anchor chains used by recreational fishers. At site 3.23, farm anchor blocks had been dragged through the rhodolith bed. At site 3.29, evidence of commercial dredging was observed. No existing significant sites were recommended for removal.

The Expert Panel (Davidson *et al*., 2018a) accepted all the boundary modifications proposed by Davidson *et al*. (2018). Five new sites were also accepted by the Panel, while one site (Treble Tree coast) proposed by Davidson *et al*. (2018) was declined until more data is made available.

1.5 Field survey 5 and expert peer review

Davidson *et al*. (2019a) presented data for a total of 11 sites. At four existing significant sites, additional data were collected and presented (Tennyson Inlet, Penzance Bay, Ouokaha Island and Deep Bay). Of these, it was suggested that two sites be increased in size. Four potential new significant sites (Hitaua Bay Head, Rat Point Reef, Nikau Bay outer coast, and Gold Reef Bay (west) were described. Of these, Hitaua Bay had been a significant site previously. Three sites were investigated that did not support biological values likely to be sufficient to warrant ranking as a significant site.

For the existing significant sites, proposed increases were: Tennyson Inlet 740.2 ha and Deep Bay 0.07 ha. These increases were due to either an improvement in the level of detail or redefining of the boundaries. No existing significant sites declined in size. Parts of the Tennyson Inlet significant site were impacted by the exotic tubeworm in the Family Chaetopteridea. This worm was abundant at many locations between 4 to 12 m depth. The authors stated, “it is unknown if these tubeworm beds influence site selection by egg-laying elephantfish”.

Direct human impact was observed at Ouokaha Island where approximately 11% of tubeworm mounds had been likely impacted by anchoring. The indirect human impact from sedimentation was observed at the proposed new site along the coast north and south of Nikau Bay. Inorganic rubbish was observed under a moored boat in Penzance Bay.

The expert panel accepted recommendations proposed in the summer fieldwork report produced by Davidson *et al*. (2019a). Three new sites were accepted by the Panel (Rat Point (reef), Gold Reef Bay west (biogenic community) and Nikau Bay outer coast (current swept biogenic community)). Three sites that were surveyed were rejected as they did not support features that were considered significant (see Davidson *et al*., 2019b). existing sites were accepted (Penzance Bay (elephantfish spawning), Ouokaha Island (tubeworm mounds)). Adjustments to the boundaries of two existing sites were approved (Tennyson Inlet (stable protected catchment), Deep Bay (subtidal cockle bed)). One site located at the head of Hitaua Bay (subtidal cockle bed), previously removed as a significant site was reinstated.

The Panel also assessed site sensitivity/impacts from a range of anthropogenic threats including physical disturbance. One site was recommended for urgent management action (Ouokaha Island), and other sites were recommended for future management action (e.g. at the time of forest harvest). Other recommended management actions included the selection of mooring types in Penzance Bay and widespread actions to minimise sediment originating from the Pelorus catchment.

1.6 Field survey 6 and expert peer review

In the Davidson *et al.* (2020) study only a small amount of fieldwork was possible due to the Covid19 event. It was, however, possible to update many sites using data collected in recent years during other surveys undertaken for the Marlborough District Council. All sites were from the Queen Charlotte Sound, Tory Channel and Port Underwood.

A total of 17 sites were discussed. Two of those significant sites had associated subsites: Site 5.4 Tory Channel west (18 subsites) and Site 5.8 Tory Channel east (12 subsites). Of the 17 sites, one was rejected, three sites are new and the remaining 13 are either enlarged or reduced in size due to an improved level of information. The total area of significant sites discussed in the report showed an overall increase of 425.34 ha.

In the Davidson *et al.* (2020a) The marine experts assessed site sensitivity/impacts from a range of anthropogenic threats including physical disturbance outlined in the field report. The Expert Panel accepted three new sites (Long Island horse mussels, Kokomohua Island tubeworms and Tory Channel (north) subtidal seagrass). One existing significant site was rejected based on new data collected by Anderson *et al*. (2020). Adjustments to the boundaries of 13 sites comprising many sub-sites in Cook Strait, Tory Channel and Queen Charlotte Sound were accepted. The Panel also assessed site sensitivity/impacts from a range of anthropogenic threats including physical disturbance.