Photo 7 Silt, mussel shell, microalgal mat

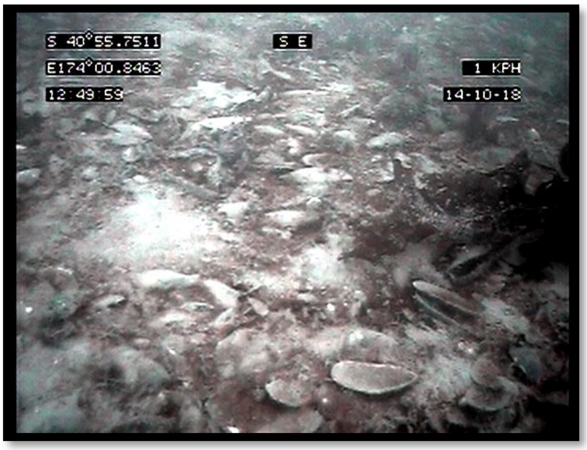


Photo 8 Silt, microalgal mat

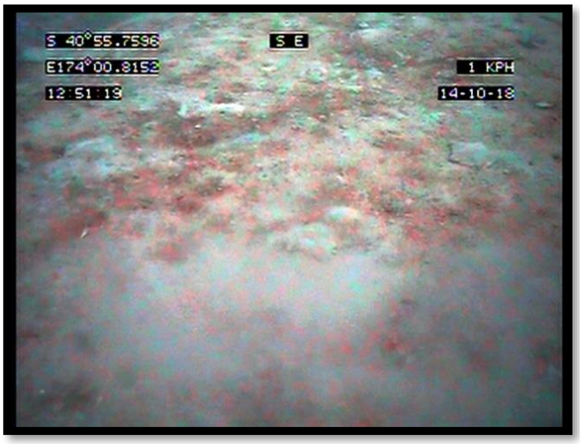


Photo 9 Silt, shell

Photo 10 Silt, shell

Photo 11 Silt, shell

Photo 12 Silt, microalgal mat

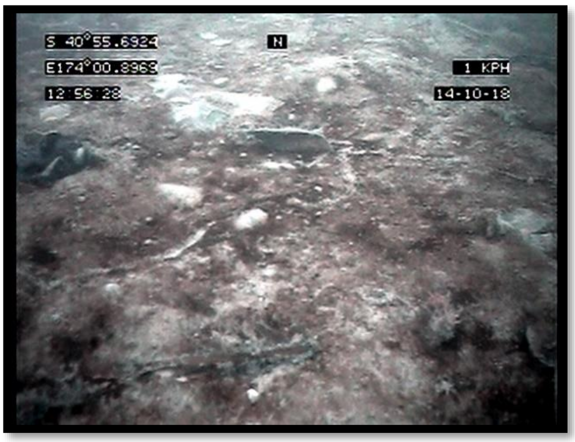


Photo 13 Silt

Photo 14 Silt, shell

Photo 15 Silt, shell

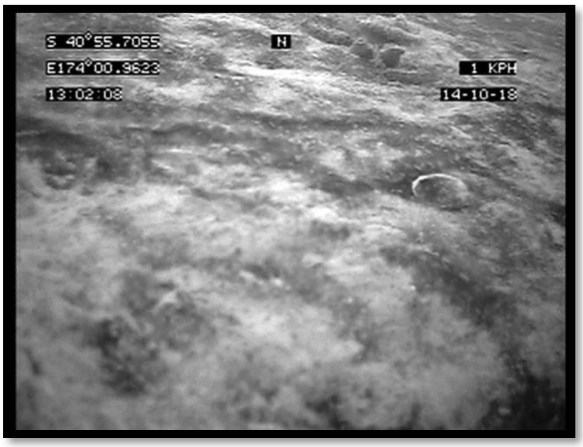


Photo 16 Silt, microalgal mat, shell, mussel shell

Photo 17 Silt, microalgal mat, shell, mussel shell

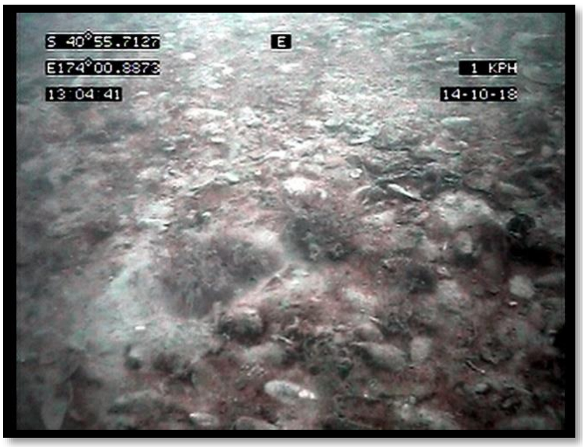


Photo 18 Silt, mussel shell

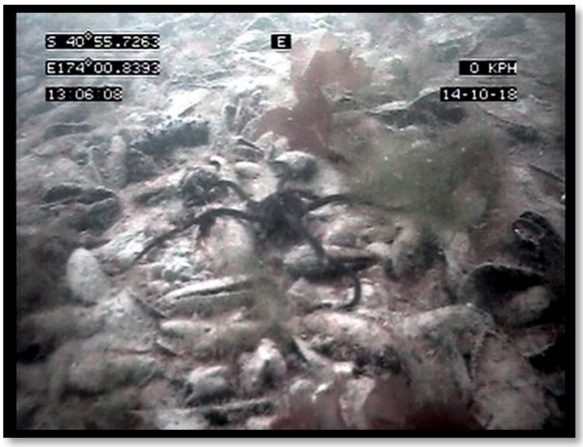
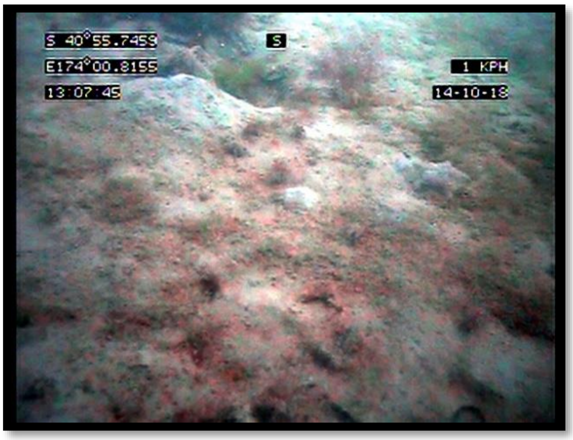


Photo 19 Silt, microalgal mat

Photo 20 Silt, mussel shell, microalgal mat



4

APPENDIX 4

Davidson Environmental Report for marine farm site 8060

Davidson Environmental Limited

Biological report for the reconsenting of marine farm 8060 at Blowhole Point, Waitata Reach, Pelorus Sound

Research, survey and monitoring report number 914

A report prepared for:
Sanford Ltd
Havelock

October 2018

Bibliographic reference:

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October 2018

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1.0 Preface

The present report provides biological information for a proposed reconsent of an existing marine farm at Blowhole Point in outer Waitata Reach, Pelorus Sound. The farm is owned by Sanford Ltd.

2.0 Background information

2.1 Waitata Reach

Waitata Reach is 15 km long and extends from Maud Island in the south to Paparoa Point (east of Long Beach) in the north (Figure 1). The Reach is relatively deep channel (50-60 m) with steep sloping edges. The Reach is swept by regular and often strong tidal currents on both incoming and outgoing tides. Offshore areas are relatively flat, deep and dominated by mud and shell substratum.

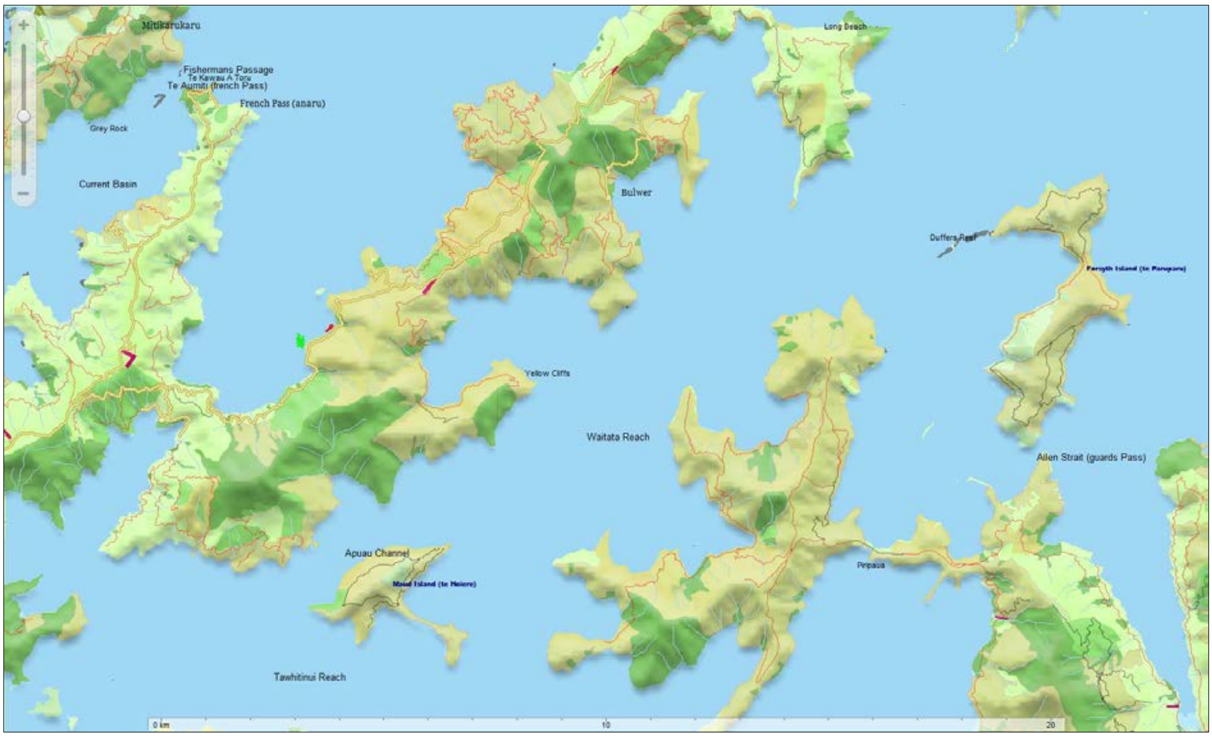


Figure 1. Location of Waitata Reach, outer Pelorus Sound.

2.2 Marine farming

There are 7 shellfish farms and two salmon farms in Waitata Reach (Figure 2). Numerous farms are in the bays located adjacent to the Reach. Shellfish marine farm consents are predominantly used for farming mussels.

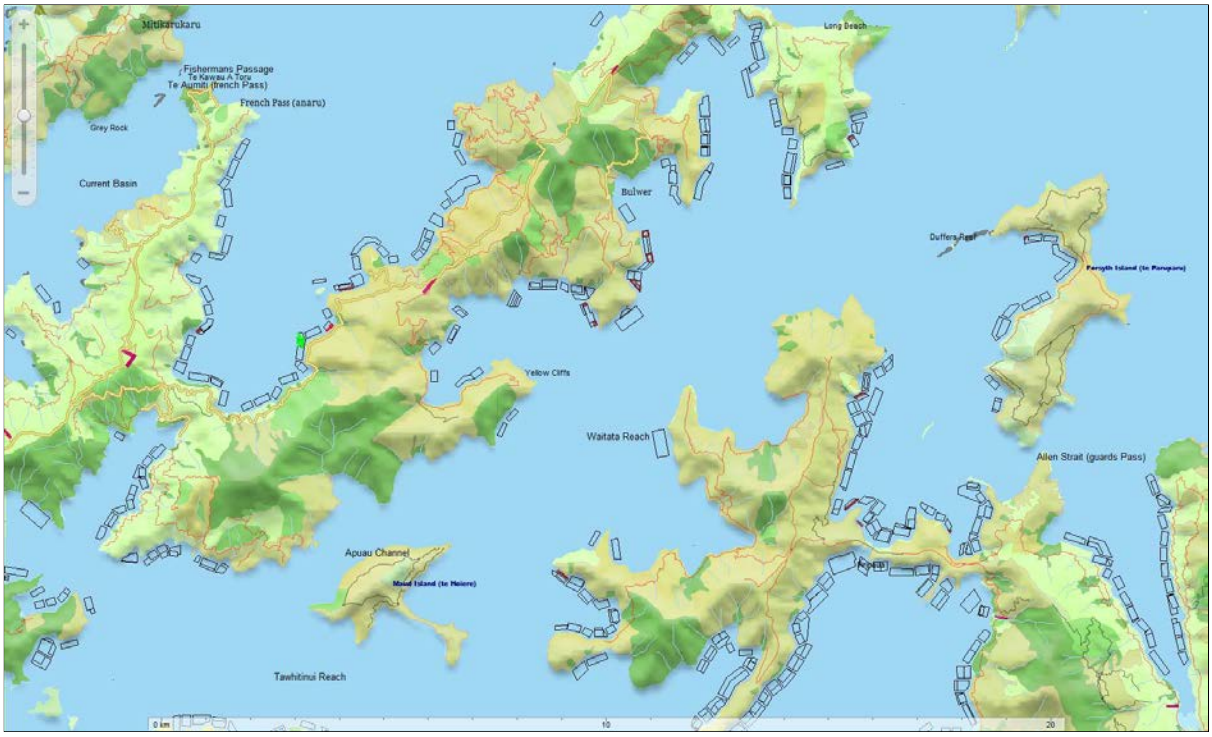


Figure 2. Marine farms located along Waitata Reach and the adjacent bays.

2.3 Catchments

The adjacent land and catchments are mostly regenerating native vegetation with isolated areas of pasture. One large reserve (Deep Bay Scenic Reserve) is located west of Maud Island and is managed by DOC, the remainder of land is in private ownership. A small forestry block is located north and south of Blowhole Point.

2.4 Fishing

Commercial fishing catch for the Waitata Reach is at the lower end of the range for New Zealand (Figure 3). Trawling and during the scallop season (dredging) regularly occurs throughout much of the Reach. No data is available on recreational fishing, however, based on observations it is a regular occurrence.

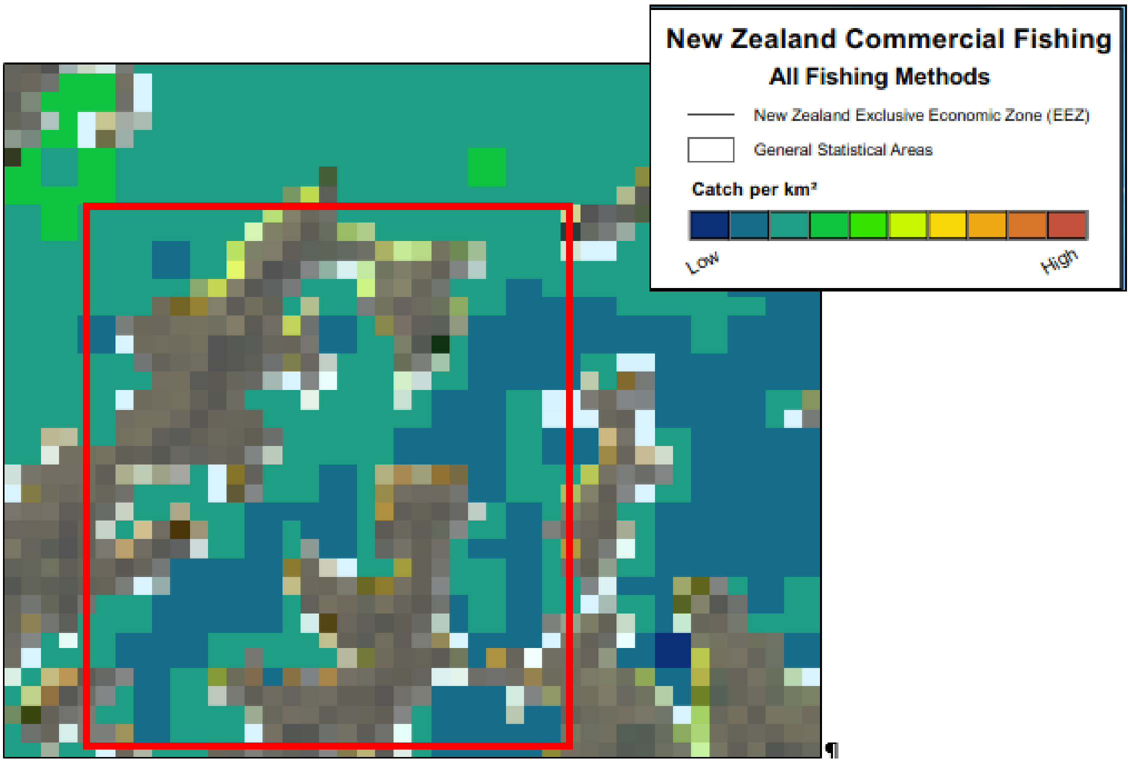
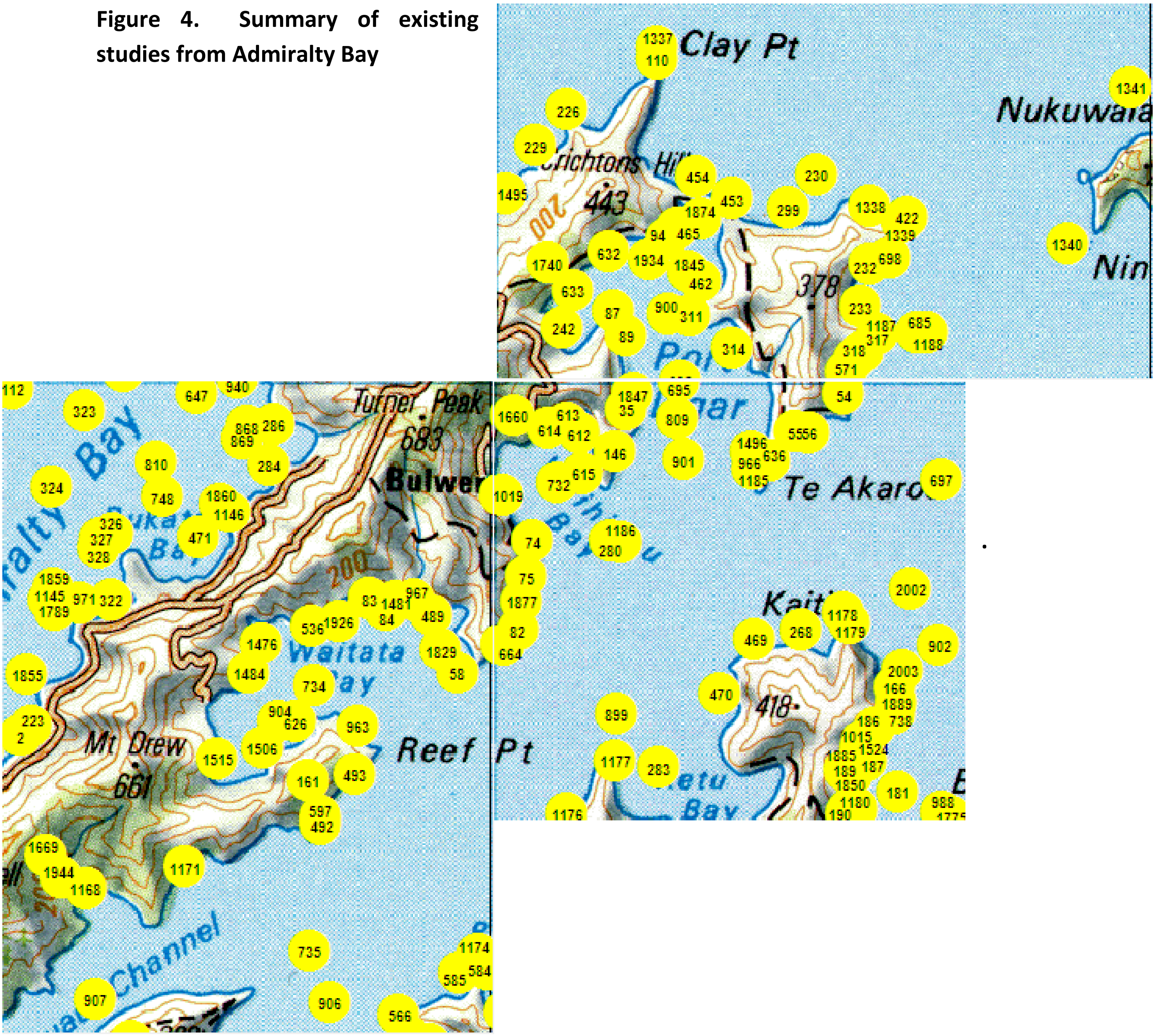


Figure 3. The distribution of total commercial catch shown here is estimated from most fishing events reported in statutory catch and effort returns for the period 1 October 2007 to 30 September 2013. A small number of shellfisheries have not yet been mapped by MPI and are not included in this map. The location of fishing events is reported by either coordinates or by statistical areas and for the latter, MPI estimates the part of the statistical area used for each type of fishery. Catch by some methods is attributed to the whole statistical area where no better information is available. The data is aggregated into grid squares of between 1 and 2500km^2 as required to give 6-year annual average of data from at least three permit holders. Red box = Waitata Reach.

2.5 Existing biological studies and data

Many studies and investigations have occurred in Waitata Reach and the adjacent bays (Figure 4). Most data points have been commissioned by the marine farm industry, particularly in relation to new farms and extension applications. There are also a small number of species, habitat or community-based studies. Despite the large number of data points in the area, there are only a small number of recognized significant biological sites.

Figure 4. Summary of existing studies from Admiralty Bay



2.6 Significant sites

There are four known significant sites located in northern Waitata Reach (Figure 5). All sites are localized and relatively small.

Significant site 2.17 (Paparoa current swept habitat)

Paparoa is a rocky headland defining the western entrance to Pelorus Sound. This area is swept by regular and relatively strong tidal currents, particularly on the outgoing tide. Davidson and Brown (1994) reported rock outcrops close to shore covered in biogenic habitat-forming species such as ascidians, hydroids, sponges, anemones and bryozoans. Davidson *et al*. (2011) reported Paparoa reef was one of a limited number of reef sites swept by regular and strong tidal currents in this biogeographic area. The authors also stated the regular tidal currents allow habitat forming species such as bryozoans, sponges and hydroids to establish on the rocky and soft coarse substrata. The site was resurveyed by Davidson and Richards (2016) confirming the site supported current swept communities.

Significant site 3.1 (Harris Bay red algae)

Harris Bay is on the western side of the entrance to Pelorus Sound, immediately south of Paparoa and 54 km by sea from Havelock. Harris Bay has 1.7 km of coastline and a sea area of 37.5 ha (Plate 18). The northern side is relatively shallow and supports a bed of red algae located in the 5-22 m depth range (Davidson *et al*., 2011). The site was resurveyed in 2017 where a decline in the cover and distribution of algae was reported (Davidson *et al*., 2017).

Significant site 3.2 (Oke Rock)

Oke Rock is located 0.7 km east of Mataka Point on the western side of the Pelorus Sound entrance. A small part of this pinnacle breaks the surface at low water and is easily located by the beacon. Subtidally the rock is steep sided and continuous with sand/shell banks that extend west. other rock outcrops occur west of Oke Rock but do not break the surface. Oke Rock is notable for having the highest known abundance of the burrowing anemone in the Marlborough Sounds (Davidson *et al*., 2011). This anemone lives on sand/broken shell banks at 12-28m depth. Oke Rock is also colonised by a good diversity of encrusting species including green-lipped mussels, sponges, bryozoans, hydroids and ascidians. Strong tidal currents bring plenty of food to these filter-feeders. Oke Rock is the only site in the Pelorus biogeographic area where the Marlborough Sounds endemic chiton *Notolax latalamina* has been recorded.

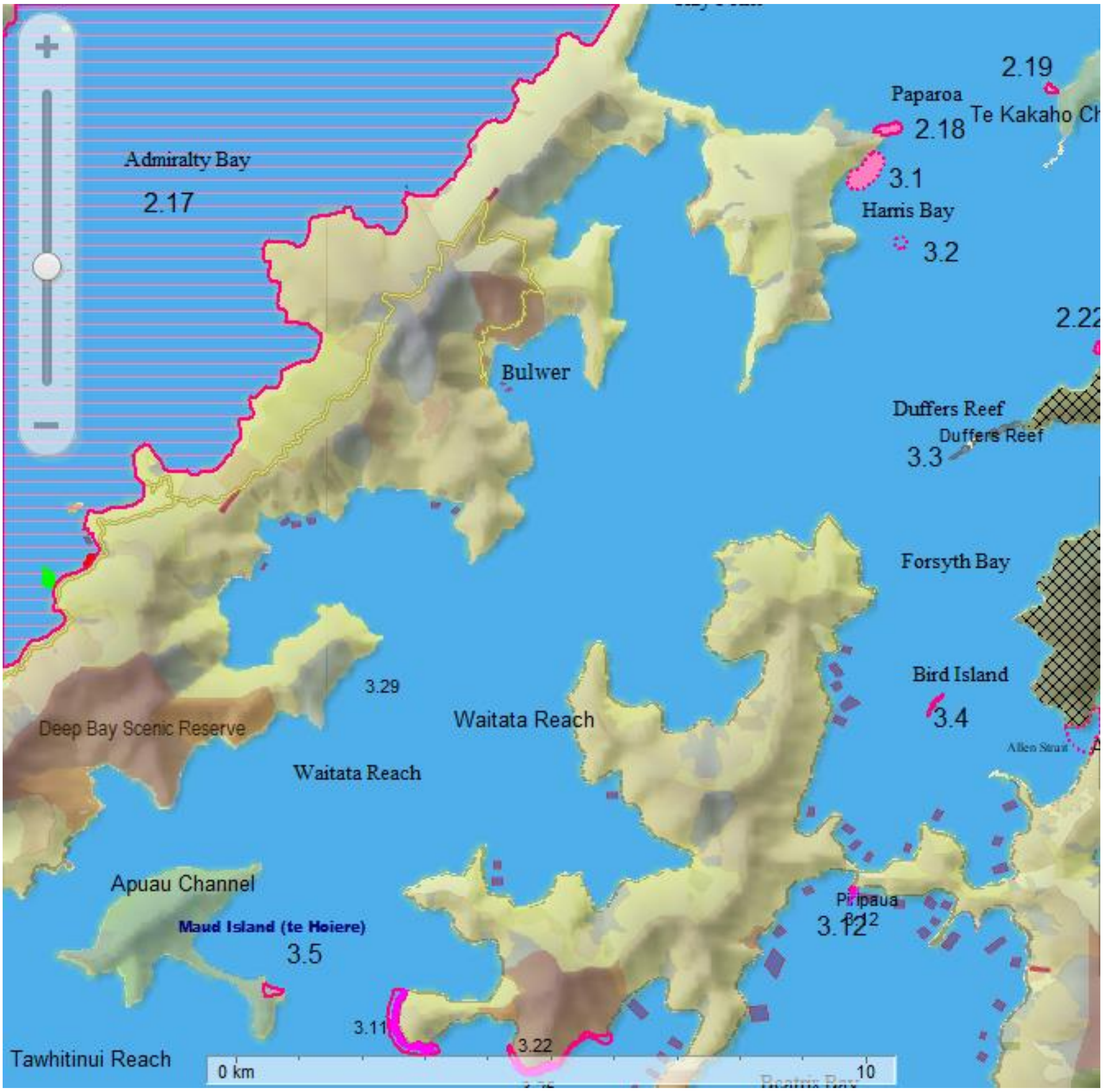


Figure 5. Known significant sites in Waitata Reach (red polygons).

2.7 Marine mammals

At least five marine mammal species regularly and/or seasonally transit through western regions of the Sounds (see Slooten *et al*. 2002, Markowitz *et al.* 2004, Merrimen *et al*. 2009, Clement and Halliday 2014), and several of these species concentrate seasonally in the Admiralty Bay region, west of the Pelorus Entrance area. These species include the New Zealand fur seal (*Arctocephalus forsteri*), bottlenose dolphin (*Tursiops truncatus*), dusky dolphin (*Lagenorhynchus obscurus*), common dolphin (*Delphinus delphis/capensis*) and orca (killer whales - *Orcinus orca*).

Several studies have occurred in the greater Admiralty Bay area aimed at investigating marine mammal use of the area and interactions with aquaculture (Markowitz *et al*., 2004; Vaughn *et al.,* 2007; Pearson *et al.,* 2012), Department of Conservation (e.g. B. Lloyd unpubl. data; Merriman, 2007) and aquaculture-funded research (Clement and Halliday, 2014).

New Zealand fur seals (status = not threatened) can be observed year-round within Admiralty Bay waters, suggesting that this may be the only species considered a true resident of the bay (Clement and Halliday, 2014). It is likely, given Admiralty Bay's proximity to several of the breeding colonies, young animals use this bay as a stepping stone as they slowly begin to explore and eventually move away from breeding colonies (D Clement, pers. comm.). Further, high numbers in May (see Clement & Halliday, 2014) might indicate that fur seals are taking advantage of plentiful prey resources or the cooperative feeding tactics of dusky dolphins, as these two species are observed feeding together cooperatively (Markowitz *et al.,* 2004, Vaughn *et al.,* 2007). Young fur seals have also been observed resting and swimming at mussel farms in Catherine Cove (Davidson and Richards, 2017).

Of all the cetacean species studied, bottlenose dolphins (status = Nationally endangered: Baker *et al*., 2010) is the species most consistently observed within Admiralty Bay waters (D. Clement, pers. comm.). A semi-residential population of animals is known to associate with the Marlborough Sounds region for most of the year, regularly and systematically moving from one end of the Sounds to another (Merriman *et al*., 2009). Clement and Halliday (2014) stated that re-sighting rates indicate that the majority of individual bottlenose dolphins show high and regular use of Admiralty Bay.

Bottlenose dolphins within the Sounds represent one of three isolated subpopulations around New Zealand's coastline; the others are found along the northeast coast of the North Island and within Fiordland in the south-west of the South Island. This species nationally endangered status is due to their restricted ranges and the fact that the other two sub-populations have reported general population declines over the last decade. Such factors make this species potentially more vulnerable to disturbance or changes within their distribution range (D. Clement, pers. comm.).

Starting in 1998, Markowitz *et al*. (2004) studied dusky dolphin (status – not threatened) presence within the Marlborough Sounds, and in particular Admiralty Bay. The authors found that the number of dusky dolphins observed in Admiralty Bay increased significantly over the winter months. Estimating across the winters of 1998–2004, the dusky dolphin population within Admiralty Bay included 711 (95% CI: 608–844) individuals, with a mean population of 220 dolphins in the bay on any given week (Markowitz *et al*. 2004, 2010). Known individuals were found to re-visit Admiralty Bay in subsequent winters, as 55% of marked individuals photographed in the bay between 1998 and 2002 were identified during more than one winter (Markowitz *et al*., 2004). Admiralty Bay is now recognised as an important wintering and feeding area for dusky dolphins migrating from Kaikoura and other regions around New Zealand (Davidson *et al.,* 2011). Dusky dolphins are also seen periodically in Pelorus Sound.

While no studies have focused specifically on the presence of common dolphins (status = not threatened) in outer Pelorus, Clement and Halliday (2014) suggest that outer Sounds bays such as Admiralty may serve as important habitat for at least a proportion of the common dolphin population found around New Zealand. Common dolphins appear most abundant in the outer Sounds bays during mid- to late winter and early spring, often coinciding with dusky dolphins while in the region (Clement and Halliday, 2014).

Seasonal trends and the high re-sighting rates of identified individuals within the area over consecutive seasons and years indicates that common dolphins are either seasonally migrating to this region (i.e. like dusky dolphins) or use it as part of a large home range, like bottlenose dolphins (D. Clement, pers. comm.).

2.8 King shag

King shag is one of the world's rarest seabird species. The species is endemic to the Marlborough Sounds, and is seldom observed outside of this region. The species nests at a small number of colonies, usually on rock stacks that are separate from the mainland, however there are two mainland colonies presently used by birds (Hunia and Tawhitinui Bay). Most historical counts have been undertaken by boats, however, most recent surveys have been aerially surveyed and photographed during the breeding seasons of 2016 (2 surveys), 2017 and 2018 (Schuckard *et al*., 2015; 2018; in prep.). The most recent count has shown a 24% decline in the number of adult birds (Schuckard *et al*., in prep.). The total number of nests range from 187 in 2015 to 89 (June 2016), 117 (July 2016) and 153 nests June 2017 (Schuckard *et al*., 2018). No or very few nests have been recorded from the colony in Admiralty Bay at Stewart Island. Schuckard (1994) identified several concentrations of feeding activity in Waitata Reach (Figure 6).

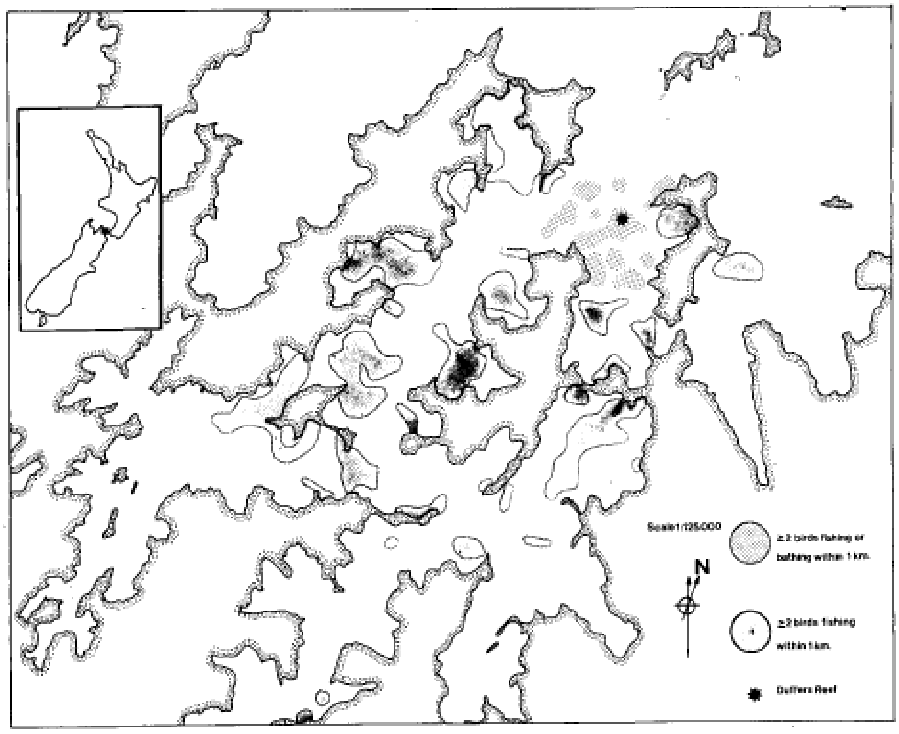


Figure 6. Concentrations of feeding activity by king shags in outer Pelorus Sound. Figure from Schuckard (1994).

Diet studies have shown that king shags feed on a variety of fish. Lalas and Brown (1998) recorded 683 prey items of which flatfish accounted for 90% of items.

2.9 Benthic

Most benthic studies that have occurred in Waitata Reach have been in relation to marine farms, however, there have been several other scientific studies.

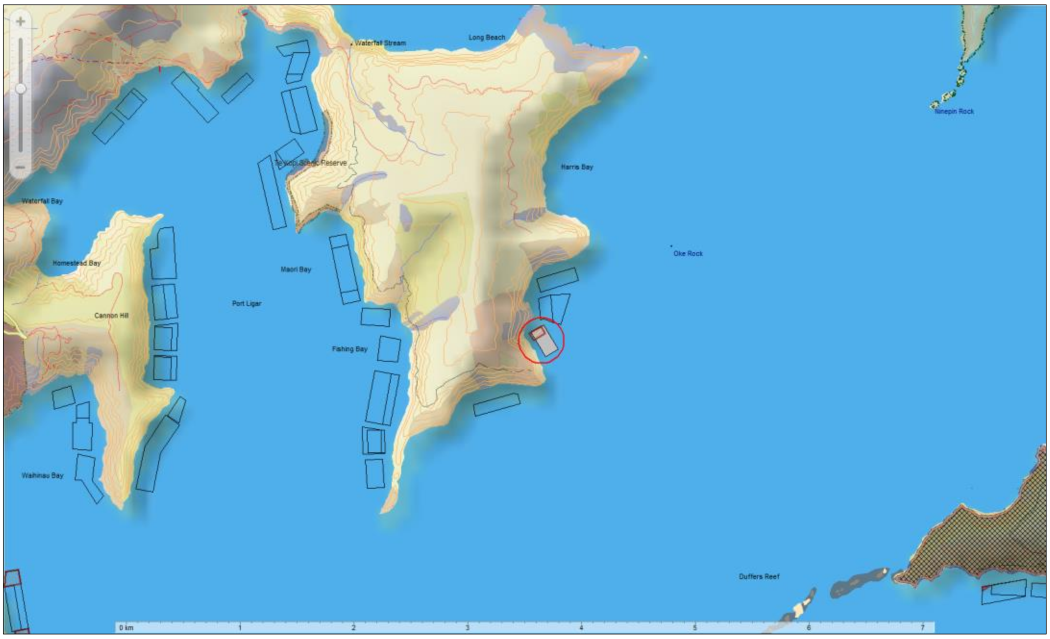
Duffy *et al.* (in prep) qualitatively described the biota from 360 sites around the Marlborough Sounds including Waitata Reach. The edges of the Reach are swept by regular currents and often support filter feeding species such as hydroids, sponges, ascidians and in places bryozoans. Offshore soft bottom areas are often coarse due to the presence of currents. Mud and shell are widespread. Macroalgae is restricted to a narrow band around low tide.

Duffy *et al.* (in prep) found rocky reef sample sites were grouped with their Site Group 1. This was the largest group with 11 sub-groups including Queen Charlotte Sound (34 sites) Pelorus (31 sites), Port Hardy (2), Admiralty Bay (8), Cherry Bay at D'Urville Island (1), Squally Cove in Croisilles (1), Catherine Cove (2), Guards Bay (2), Anakoha Bay (2) and Forsyth Island (5). The most common rocky habitat type was cobble banks. Although the group had few indicator species, it was the most species-rich of the inner sounds site groups (average 31 species per site). Duffy *et al*. (in prep) stated the best indicator species were *Maoricolpus roseus*, *Galeolaria hystrix* and *Forsterygion lapillum*.

3.0 Marine farm 8060

The present report provides biological information in relation to marine farm 8060 located immediately north of Blowhole Point (Figure 7, Plate 1).

Figure 7. Proposed reconsenting marine farm site in outer Pelorus Sound (red circle) and all other marine farms in the bay.



3.1 Summary

Marine farm number:	8060
Owner:	Sanford Limited
Location:	Blowhole Point, Pelorus Sound
MPI exclusion area present:	Yes
Consented size:	3.252 ha
Proposed size:	3.252 ha
Changes proposed:	Adjust MPI exclusion zone boundary and redefine appropriate activities (i.e. limit extent of production crop structures).
Reason for proposed changes:	Rocky substrata present.

Plate 1. Looking south-eastwards through the existing backbone lines of farm 8060 with Blowhole Point in the background. Photo taken from a position north-west of the inshore backbone.

4.0 Historical reports

One historical biological report was found in relation to marine farm 8060.

Roberts and Forrest (1995) produced a report for the initial farm application. Subsequently a Ministry of Fisheries structure exclusion zone was established at the northern inshore end of the farm to avoid rocky substrata.

The authors stated:

"The site covers a depth range of 5-39 m. The shore slopes gently (4-10 m) at the north end, and steeply (8-39 m) at the south end. A boulder/cobble habitat subtidally to 4 m contains a dense forest of brown algae (*Carpophyllum flexuosum* and *C. mascholocarpum*) and low densities of kina (< 0.1/m^2). A sand/mud/shell substrate occurs at the base of this cobble zone grading through to muddy sand to soft mud by 8 m depth. Associated with this shelly habitat down to about 6 m are isolated areas of bedrock where kina occurred at densities of 0.5/m2. At the north end, the main surface biota were snakestars, brachiopods and patches of a filmy red alga.

Horse mussels and kina were occasionally seen (< 0.1/m^2) on the nearshore muddy sand. Isolated "reefs" were seen. Most of these reefs were mounds (up to 0.5 m diameter and at densities of 0.2/m^2) formed entirely by Sabellid polychaetes (a type of fan worm). We believe that these reefs are formed by the worm tubes protruding from the seabed and collecting a mound of sediment around them. Low densities of other fauna (such as snake stars, kina and cushion stars) were often seen associated with the mounds.

A second type of reef was observed below 20 m depth. This type consisted of small clusters of solitary ascidians (*Cnemidocarpa bicornuata*) which formed a structure for other encrusting fauna such as tubeworms. This reef was seen at a relatively low density (0.05-0.1/m^2) and was no more than 0.4 m diameter. Horse mussels or horse mussels shell may provide the initial surface from which the structures develop. Horse mussels were uncommon (< 0.1/m^2). The two reef types described above are an unusual ecological feature which we believe are not widespread in the Sounds. Scallops were not seen."

5.0 Methods (present survey)

The area was investigated on 14th October 2018. Prior to fieldwork, the consent corners were plotted onto mapping software (TUMONZ Professional). The laptop running the mapping software was linked to a Lowrance HDS-12 Gen2 with an external Lowrance Point 1 high sensitivity GPS, allowing real-time plotting of the corners of marine farm surface structures and to pinpoint drop camera stations in the field. This GPS system has a maximum error of +/- 5 m.

The corners of the existing marine farm surface structures were surveyed by positioning the survey vessel immediately adjacent to the corner floats and the position plotted. It is noted that surface structures can move due to environmental variables such as tidal current and wind. The plot of surface structures is variable from day to day and over the duration of tidal cycles. These data should not therefore be regarded as a precise measurement of the position of surface structures, but rather an approximate position.

5.1 Sonar imaging

Sonar investigations of the area were conducted using a Lowrance HDS-12 Gen 2 and HDS-8 Gen2 linked with a Lowrance StructureScan™ Sonar Imaging LSS-1 Module. These units provide right and left side imaging as well as DownScan Imaging™. The unit also allows real time plotting of StructureMap™ overlays onto the installed Platinum underwater chart. A Lowrance HDS 10 Gen 1 unit fitted with a high definition 1kw Airmar transducer was used to collect traditional sonar data from the site.

Prior to the collection of underwater photographs, the boundaries of both the consent area and the marine farm surface structure area were investigated using the sonar. Any bottom abnormalities such as reefs, hard substrata or abrupt changes in depth were noted for inspection using the drop camera (see section 5.2).

5.2 Drop camera stations, mussel debris and low tide

A total of 25 drop camera photographs were collected from the farm (including alongside droppers and warps) and adjacent areas inside and offshore of the consent. At each drop camera station, a Sea Viewer underwater splash camera fixed to an aluminium frame was lowered to the benthos and an oblique still photograph was collected where the frame landed.

The cover of benthic mussel shell from drop camera photographs were ranked as: None = no mussel shell, Low = 1-30%, Moderate = 31-50%, Moderate to High = 51-75%, and High = 76-100% cover. Percentage cover of mussel shell was also estimated by a trained observer viewing drop camera photographs.

The location of photograph stations was selected to obtain a representative range of habitats and depths within the consent. Additional photographs were taken when any features of interest (e.g. mussel shell, reef structures, cobbles) were observed on the remote monitor on-board the survey vessel. All photographs collected during the survey have been included in Appendix 1.

Low tide was determined at strategic locations inshore of the consent. The survey vessel was positioned over the low water mark and the position plotted using the mapping software. Low tide was visually determined using the transition between intertidal and subtidal species. This process was also guided by the known state of the tide at the time of the inspection.

6.0 Results

On the day of the survey, the tide was high at 12.50 pm (2.6 m) and low at 6.13 am (0.7 m). During fieldwork, the tide was incoming. In general, mean water currents at this site are low and approximately 0.1 m/sec (Broekhuizen *et al.,* 2015). The tidal current at this marine farm increases towards the offshore side of the farm where it is closer to the main channel. This site is relatively exposed and subjected to considerable wind driven waves especially during southerly, easterly and northerly weather events. The marine farm site is located directly adjacent to the main Reach. It is therefore likely that the site has very short water residence times.

During the present study no tidal flow was observed, however, a relatively large surface chop from the south was experienced.

6.1 Consent corners and surface structures

The inshore corner depths of the consent area ranged from 4 m to 8 m. Offshore boundaries of the consent area ranged from 9.4 m to 37.3 m depth (Table 1, Figure 9). Existing surface structures consisted of one block of backbones covering a total area of approximately 1.1 ha.

Surface structures were located inside the consent. The northern end of three backbones and anchors and warps were located inside the MPI exclusion zone.

The distance between low tide and the consent boundary was measured at three positions along the adjacent shoreline. The distance to the inshore boundary at the position of low tide 1 was 70 m, at low tide 2 was 66 m, and at low tide 3 was 54 m (Plate 2, Figure 9).

6.2 Sonar imaging

Sonar runs collected from the benthos under and adjacent to the consent revealed rocky substrata inshore and within the northern inshore corner of the consent (Figure 9). No growing structures were present in the consent area that supported rocky substrata. The remainder of the scanned consent was characterised by low feature terrain (i.e. soft substrata). Areas inshore of the consent supported a bedrock and cobbles zone.

Table 1. Depths at the consent corners and existing surface structures. Depths adjusted to datum. Coordinates = NZTM (Northing/Easting).

Type	No. & Depth (m)	Coordinates
Consent corner	1, 8m	1685369.4,5467981.7
Consent corner	2, 4m	1685241.6,5468196.5
Consent corner	3, 9.4m	1685353.3,5468263.0
Consent corner	4, 37.3m	1685481.2,5468048.0
Structure corner	A, 9.2m	1685367.1,5468230.1
Structure corner	B, 14.2m	1685424.5,5468119.1
Structure corner	C, 7.7m	1685371.0,5468032.3
Structure corner	D, 5.7m	1685312.9,5468138.7
Low tide	Low tide 1	1685183.8,5468214.7
Low tide	Low tide 2	1685228.7,5468098.6
Low tide	Low tide 3	1685283.7,5468027.1

Plate 2. Aerial view of three low tide GPS locations relative to the inshore farm boundary (red polygon).

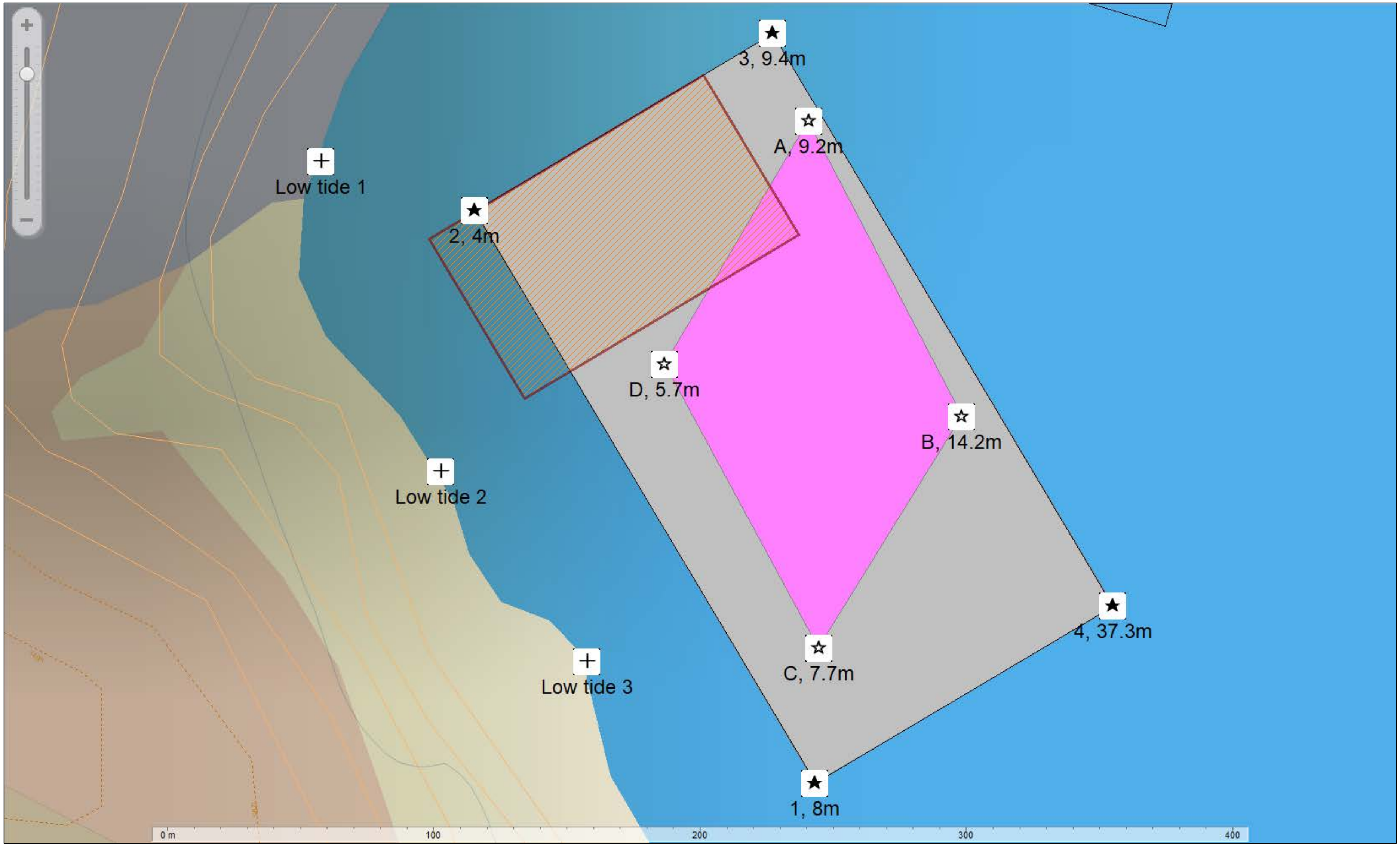


Figure 8. Depths of the proposed reconsent area (grey), existing marine farm surface structures (pink) and existing MPI exclusion zone (hatched). Three low tide locations are also plotted (crosses).

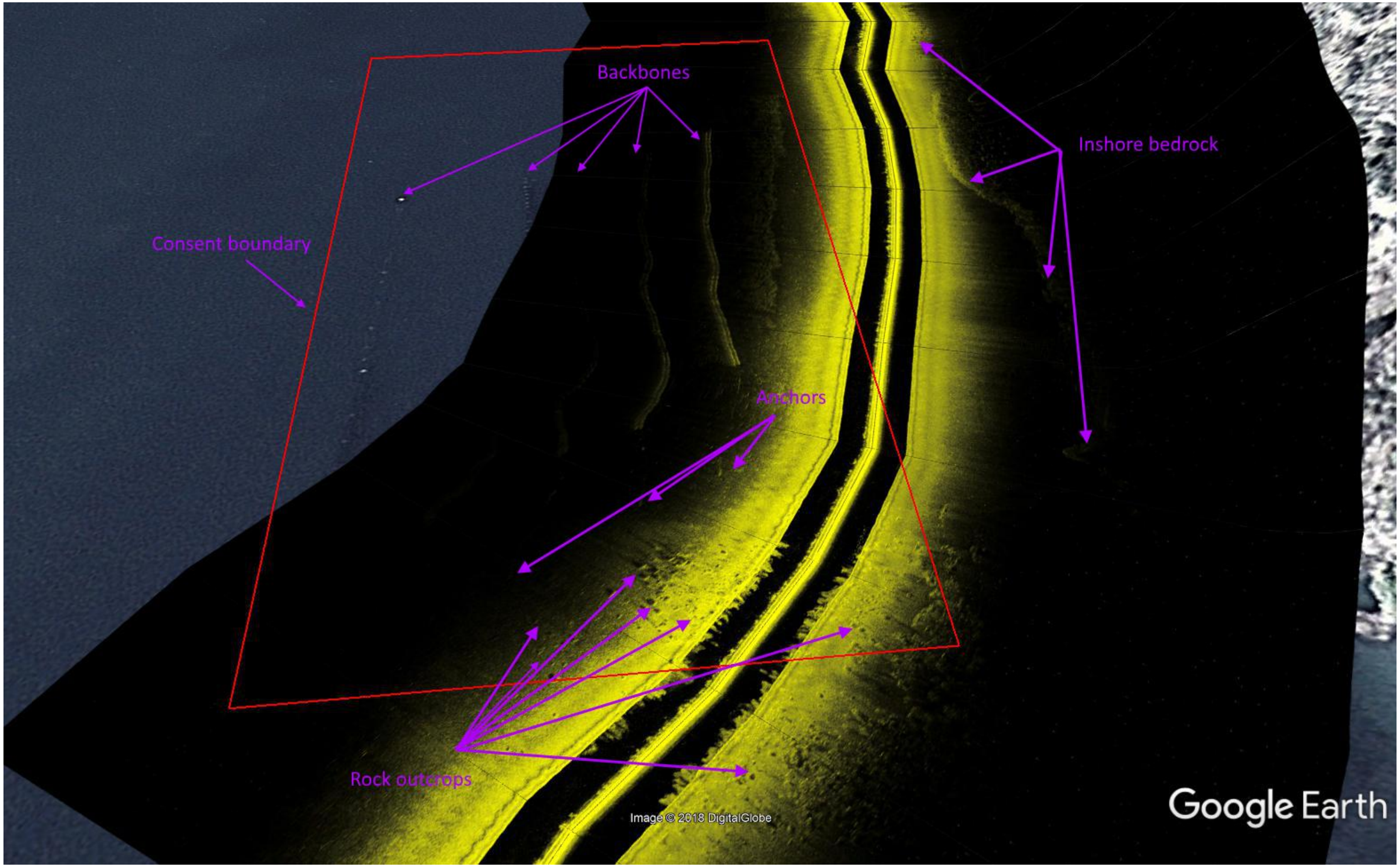


Figure 9. Sonar run at farm site 8060. Red polygon = consent boundary, yellow line = sonar track.

6.3 Drop camera images

Drop camera photographs were taken throughout the existing consent and offshore of the consent (Table 2, Figure 10, Appendix 1). Photographs were used to describe the benthic substratum, mussel shell debris cover and presence of biological characteristics.

Within the consent

Most of the benthos within the consent was characterised by soft substratum. In offshore areas the benthos was characterised by silt (mud) with a component of natural shell (Plate 3). Mussel shell was present in areas occupied by farm structures (Plate 4).

Coarse soft substratum was observed along the inshore areas of the consent. This substratum consisted of silt, fine sand and natural shell (Plate 4). Inshore areas of the consent were characterised by fine sand, silt and natural shell (Plate 5). Outcropping rock was recorded at the northern inshore end of the consent; however, no farm structures were in this area (Plate 6, Table 2, Figure 11). Rock was located completely within the MPI structure exclusion zone.

Plate 3. Silt and clay representative of deep offshore parts of the consent (photo 14, 10 m depth).

Plate 4. Silt and mussel shell from under backbones in the consent (photo 20, 9.1 m depth)

Plate 5. Fine sand, silt, and broken shell inside the consent (photo 4, 5.4 m depth).

Plate 6. Bedrock outcrops and macroalgae inside the consent with no production structures present (photo 5, 5 m depth).

Mussel shell

Mussel shell debris was observed from 5 of the 22 consent photos. In the consent, mussel shell debris ranged from 5 to 95% cover under the backbones but when present, was usually <50% (Plates 7) (Table 2, Figure 11). Mussel shell debris was not recorded under warp structures or most of the MPI exclusion area (Figure 11).

Plate 7. Silt with a moderate level of mussel shell debris under backbones located in the consent (photo 21, 8.9 m depth).

Offshore of the consent

The benthos offshore of the consent area was characterised by silt and clay. Mussel shell was recorded in two offshore photos from areas around and offshore of backbones (Plate 8, Figure 11, Table 2).

Plate 8. Silt and clay with mussel shell offshore of the consent (photo 23, 17.8 m depth).

Table 2. Coordinates of drop camera stations showing location relative to the marine farm consent area (NZTM). Colours are: grey = within consent, pink = under backbones, blue = outside consent. Depth, substratum, level of mussel shell debris are listed.

No. & Depth (m)	Coordinates	Location	Substratum	Shell debris	% mussel shell
1, 7.7m	1685361.3,5467998.7	In consent, no structures	Fine sand, silt, shell	None	0
2, 6.8m	1685338.0,5468045.9	In consent, no structures	Fine sand, silt	None	0
3, 6.2m	1685314.2,5468098.7	In consent, no structures	Fine sand, silt, shell	None	0
4, 5.4m	1685286.9,5468148.7	In consent, no structures	Fine sand, silt, shell	None	0
5, 5m	1685260.5,5468190.7	In consent, no structures	Bedrock, macroalgae	None	0
6, 5.1m	1685269.3,5468167.5	In consent, no structures	Fine sand, silt, shell, microalgal mat	None	0
7, 5.8m	1685280.5,5468207.3	In consent, no structures	Bedrock, macroalgae, sand, shell	None	0
8, 10.3m	1685387.8,5468034.1	In consent, under warps	Fine sand, silt, shell, microalgal mat, red algae	None	0
9, 8.2m	1685359.0,5468078.2	In consent, under backbones	Fine sand, silt, shell	None	0
10, 7.6m	1685336.8,5468120.6	In consent, under backbones	Fine sand, silt, shell, microalgal mat	None	0
11, 6.8m	1685312.0,5468165.0	In consent, under warps	Fine sand, silt, shell, microalgal mat	None	0
12, 6.6m	1685293.4,5468195.7	In consent, no structures	Bedrock, macroalgae, sand, shell	None	0
13, 6.8m	1685301.6,5468187.1	In consent, no structures	Silt, fine sand, shell, microalgal mat	None	0
14, 10m	1685394.9,5468055.2	In consent, under warps	Silt	None	0
15, 9.3m	1685370.8,5468105.5	In consent, under backbones	Silt, mussel shell	Moderate	50
16, 9m	1685340.0,5468161.8	In consent, under backbones	Silt, mussel shell	Low	5
17, 7.8m	1685317.6,5468195.9	In consent, no structures	Silt, fine sand, shell, red algae	None	0
18, 7m	1685301.3,5468223.4	In consent, no structures	Fine sand, silt, shell	None	0
19, 11.7m	1685415.6,5468093.9	In consent, under warps	Silt, microalgal mat	None	0
20, 9.1m	1685393.4,5468137.3	In consent, under backbones	Silt, mussel shell	High	95
21, 8.9m	1685361.7,5468189.5	In consent, under backbones	Silt, mussel shell	Moderate-high	70
22, 8.8m	1685335.1,5468240.3	In consent, no structures	Silt	None	0
23, 17.8m	1685442.1,5468127.1	Offshore of consent, no structures	Silt, mussel shell	Low-moderate	25
24, 9.9m	1685405.4,5468190.0	Offshore of consent, no structures	Silt, mussel shell, red algae	Low	10
25, 9.7m	1685375.7,5468247.7	Offshore of consent, no structures	Silt, microalgal mat	None	0

Figure 10. Drop camera stations of the reconsent area (open triangles = soft substrata, dark circles = rocky substrata), consent renewal area (teal) and surface structures (pink). Numbers are the photo number and water depth (m).

Figure 11. Estimated percentage cover of mussel shell from drop camera stations (open triangles = soft substrata, dark circles = rocky), consent renewal area (teal) and surface structures (pink). Numbers are the estimated % cover of mussel shell.

7.0 Conclusions

7.1 Benthic habitats and substratum

Substratum and habitat distribution relative to the reconsent area was based on drop camera stations and sonar imaging of the benthos. Most of the consent area was located over a relatively featureless gently sloping benthos dominated by combinations of fine sand, silt substratum with or without a component of natural shell. At the offshore southern corner, the seafloor dropped steeply towards the main channel. Fine sand substratum was observed from inshore shallow parts of the consent.

Mud (i.e. silt) is the most common subtidal habitat in sheltered areas of the Marlborough Sounds (McKnight and Grange, 1991) and has been traditionally targeted for marine farming activities. This substratum type is considered suitable for consideration for marine farming activities in the Marlborough Sounds.

Unlike mud and silt, rocky substratum is not traditionally considered suitable for marine farming activities as it is likely smothered by shell debris and may no longer functions as a hard substratum habitat. Rocky substrata in the form of outcropping rock was observed at the northern inshore corner of the consent. Hard substrata were not recorded under existing production droppers.

7.2 Species and communities

Species abundance and diversity from most of the consent was moderate compared to high current locations in the Sounds. Benthic observations within soft substratum dominated areas of the consent confirmed the area supported species typical of fine sand and silt substratum in the outer Pelorus Sound (e.g. snake star, microalgal mat, red algae, cushion sea star, wandering anemone, sea cucumber). No fish were observed from drop camera photos.

No scallops and horse mussels were observed during the present survey (Appendix 1). No species, habitats or communities regarded as ecologically significant (see Davidson *et al*., 2011) were observed during the present study.

7.3 Sea birds

Based on the few studies that have investigated the interactions between mussel farms and birds, mussel aquaculture can potentially affect seabirds by altering their food resources, cause physical disturbances (e.g. noise) and/or introduce possible entanglement risks. The structures associated with aquaculture may also provide benefits including additional perching and feeding opportunities

Overall, New Zealand (Butler, 2003) and overseas studies (Ross *et al*., 2001; Roycroft *et al*., 2004; Kirk *et al*., 2007) suggest that the general attraction of particular seabirds to mussel farms is likely due to increased foraging success on fish and biofouling, and even on the cultured stock itself. The consequences of this attraction will likely depend on the species' dietary preferences and response to both direct and indirect ecosystem changes induced by mussel cultivation.

Birds are potentially at risk from operational by-products of farms, including ties and plastics. Butler (2003) found young and adult Australian gannets (*Sula serrator*) in the Marlborough Sounds entangled in discarded rope ties from mussel farms that had been incorporated into nests by parents. The closest gannet colony is 17 km at Waimaru Peninsula in Beatrix Bay and well within their flight range. A variety of shag species are also present in the area and may potentially use ties as nesting material. It is therefore important that marine farmers minimize the introduction of ties into the marine environment.

The mussel industries Environmental Management System (EMS), formally known as the Environmental Code of Practice seeks to minimise such risks, and they are likely to be minimal on well-maintained farms (Keeley *et al*., (2009).

7.4 King shag

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

Butler (2003) undertook the first review of the possible effects of marine farms on king shag. He described the potential effects in three categories: physical effects (structures of farms, lights, debris from farms, and shell waste); effects of activities (disturbance, noise and water pollution); and effects on marine ecology (hydrography, sediment and water column changes, creation of new habitat, exclusion of trawlers, unwanted organisms).

Butler (2003) considered that most king shag feeding occurred in deeper water, and that potential impacts resulting from mussel farms excluding king shag foraging may become apparent if deeper-water mussel farms were developed. Lloyd (2003) reviewed the effects of aquaculture on seabirds and cetaceans. He also appeared to believe the existing pattern of inshore mussel farms was less likely to affect king shag foraging compared to proposals for extensive mid-bay mussel farms in Admiralty Bay. Fisher and Boren (2012), undertook a rigorous study of king shag foraging distribution in Admiralty Bay; see Section 2.4) and concluded that deep water marine farms posed a greater threat compared to inshore sites.

The most recent general review of the ecological effects of aquaculture (Sagar, 2013) only specifically mentioned king shag in relation to disturbance but discussed the main effects of 'filter feeder species' farms on seabirds in general, and their significance. The authors stated the eight key effects were: entanglement with farm structures, habitat exclusion, smothering of benthos, changed abundance of prey, provision of roosts, disturbance by farm activities, ingestion and entanglement with farm debris, and attraction to lights. Sagar (2013) considered that the potential effects of habitat exclusion and smothering of benthos were, in general, insignificant to seabirds given the small area occupied by filter feeder farms. However, he qualified this, noting that the significance of effects "will depend on the spatial scale of the aquaculture facility in relation to the distribution and abundance of prey species", and concluded that effective management could be achieved by avoiding locating farms in key foraging areas of species with restricted habitat requirements (see Sagar, 2013). The review listed "home ranges or location of important feeding and breeding habitats for most populations of seabird species "as being a key information gap for every one of the eight key potential effects."

Of all the threats, most attention had been given to the potential effects of mussel farms on king shags, and the possibility that king shags are excluded from the area under and around a mussel farm due to physical structures inhibiting foraging, and/or changing the habitat causing decreases to key prey species (McClellan, pers comm.). Unfortunately, the extensive data that has been collected on the locations of foraging king shags has, however, not been able to answer this key question.

The present marine farm reconsenting site is in a shallow area of outer Pelorus Sound. King shags do not appear to utilize shallow areas of the Sounds preferring to hunt in depth > 20-30m depth. King shags, do however, forage in areas near this farm in the main Reach (Schuckard, 1995, author pers obs.). The applicant proposes that the present farm site size and consented structure number remains unchanged. This means any impact on king shags will also remain unchanged if the site is reconsented.

7.5 Marine mammals

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

For mussel farming, occupied farm areas may be perceived by some marine mammals (particularly those that echolocate) as a physical, visual or acoustic obstruction within their habitat. Based on research to date in Admiralty Bay, dusky dolphins appear unable to cooperatively herd schooling fish when adjacent to or within mussel farm structures (see Pearson *et al*., 2012). Clement and Halliday (2014) also noted the reluctance of common dolphins to enter or feed near farm structures within the Admiralty Bay region. Over the course of five consecutive winters between 1998 and 2002, Markowitz *et al.* (2004) found that dolphins spent significantly less time in areas occupied by mussel farms than other parts of the inner bay. Pearson *et al*. (2012) also reported similar findings from tracking dolphin groups both inside and outside of mussel farms across all of Admiralty Bay during the winters and springs of 2005-2006. To test specifically whether these results were due to the fact that dusky dolphins might not use habitats closer to shore in general, rather than avoiding the farm areas themselves, Markowitz's study looked at the amount of time groups spent near farms (<200 m) and Pearson's study looked at time spent within the nearshore zone (<400 m of the shoreline) around inner and all of Admiralty Bay, respectively. Both studies found dolphins frequented areas occupied by mussel farms significantly less often than similar areas near farms or within the general nearshore zone.

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

Displacement

For dusky and common dolphins, the existing farm represents an area lost as foraging habitat. It is unknown if this loss is important to these species. The present proposal, however, is applying for no additional water space, therefore the present level of impact on these species will remains unchanged.

Based on migratory patterns and behavour it is unlikely these farms represent a threat to echolocating whales.

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

Entanglement

There are two reported incidences of dolphin entanglement and death at a salmon farm in New Zealand, both from the Marlborough Sounds (M. Aviss, MDC). In one, an unidentified dolphin species became trapped while a predator net was being replaced, and in the other case, a Hector's dolphin became trapped under a predator net. Internationally, fatal entanglements of dolphins in predator nets on finfish farms have been reported from Australia (Gibbs and Kemper, 2000; Kemper and Gibbs, 2001; Kemper *et al*., 2003) and Italy (Díaz López and Bernal Shirai, 2007). This may reflect attraction of dolphins to a food source (Kemper and Gibbs, 2001) although such interactions between finfish farms and cetaceans have not been proven (Kemper *et al*., 2003).

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

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

The present marine farm utilizes standard mussel farming structures that are under tension and therefore present a low risk of entanglement to marine mammals.

7.6 Biosecurity issues

The applicant belongs to mussel industries Environmental Management System (EMS). As a member, the applicant and his contractors are bound by good environmental practices. As well as all aspects of farming such as establishment, seeding, and harvesting, the Code includes guidelines on the transfer of mussel seed and the NZ Mussel Industry Seed Transfer Code. All members of the ECOP are also bound by the Biosecurity Act 1983, as well as the Hazardous Substances and New Organisms Act 1996.

7.7 Mussel farming impacts

7.7.1 Benthic impacts

Mussel shell debris was recorded from 5 of the 22 consent area photos. Mussel debris was most abundant under backbones and was usually <50% cover. No mussel shell debris was recorded under warps. Mussel debris was recorded immediately offshore of the consent, near backbones. Some mussel shell was observed in a corner of the MPI exclusion area, but away from rock.

Shell debris impact levels were within the range known for mussel farms in the Marlborough Sounds. This farm impact at this site is at the low-moderate end of the impact range compared to other farms in the Sounds. This is consistent with a study by Harstein and Rowden (2004) who investigated the impact of mussel farming. The authors had one of their study farms located in this area of Pelorus. The authors stated impacts were relatively low compared to farms located in more sheltered areas of the Sounds.

It is probable that the impact of continued shellfish farming at this site will result in the deposition of more shell and fine sediment under and near droppers. Based on the literature and assuming the present level of farming activity remains consistent, it is very unlikely that the surface sediments would become anoxic, however, the redox layer is likely shallower compared to sites away from the farm (Hartstein and Rowden, 2004; Keeley *et al*., 2009;).

Recovery of the benthos takes approximately 5-7 years on deep soft substratum as shell is often smothered thereby reducing recovery times compared to inshore coarser substratum areas (Davidson and Richards, 2014).

7.7.2 Productivity

Mussel farms can influence adjacent farms by slowing water flow to farms located in downstream positions (Ogilvie, 2000). This is particularly pronounced in quiescent areas of the Sounds. However, published work by Zeldis *et al*. (2008, 2013) suggests that the major factors influencing productivity in the Marlborough Sounds relate to cyclical weather patterns in the summer (El Nino and La Nina) and river-derived nutrient inputs in winter. Slow crop cycles in some years are therefore a reflection of a weather cycle and much less about the number of farms.

There has been no data presented to show the ecological carrying capacity of the Sounds has been reached, however, this topic is not well researched. There is considerable evidence showing the major drivers of the Pelorus system, for example, naturally leads to large within and between year variability. Relative to this, the impact of mussel farms appears to be material but relatively small compared to major environmental drivers (Broekhuizen *et al*., 2015).

Tidal flows in Waitata Reach are high (Broekhuizen, 2015). Winds are likely to also be a significant driver of water movement in this area, especially during the north, east and southerly events. The proximity of the farm to the main channel and Cook Strait means water turnover times are likely to be very short compared to bays well distant to main reaches in Pelorus Sound (e.g. Hallam Cove).

Based on these considerations and the existing literature, it is probable the site will likely cause phytoplankton depletion inside its boundaries; however, these are expected to quickly return to background levels as water leaves the consent. The present reconsenting application represent no change to the number of consented lines and therefore represents no change to phytoplankton predation and water flows in the bay.

7.8 Boundary adjustments, line adjustments and monitoring

No biological communities of particular interest were found during the present survey. Further, most of the consent is located over silt and fine sand substratum with or without a component of natural shell. This substratum is the common and widespread habitat type in sheltered shores of the Marlborough Sounds. The impacts associated with mussel farming on muddy habitats characterised by silt are low compared to farm impacts in shallow habitats dominated by rocky or biogenic communities.

Warps are known to have little or no impact on benthic communities (Davidson and Richards, 2014). At this site the benthos under warps appeared relatively natural, with no mussel shell debris present.

Surface structures were located within the consent over a soft bottom. Rocky substrata were recorded in the northern inshore corner of the consent. Rock is presently located within an MPI exclusion zone. The previous survey that identified this substratum occurred in 1995. New sonar technology used in the present study confirmed and mapped the presence of rock outcrops. Based on these new data, a small reduction to the MPI exclusion is suggested (Figure 12). Further it is suggested that the exclusion area be restricted to production lines only. Warps and anchors have little or no impact on the habitats present in this area.

The effect on king shag and marine mammals would remain unchanged if the consent is reconsented.

No other changes to the present consent boundaries are suggested on biological grounds. Habitats and species associated with the site are typical of and outer Sounds Bays and as such no monitoring is suggested.

Figure 13. Consent (grey), surface structures (pink) and suggested production dropper exclusion areas (red hatched). Existing MPI exclusion zone = red line. Drop camera stations with soft substratum are open triangles, while closed circles are rocky substrata.

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Appendix 1. Drop camera photographs

Photo 1 Fine sand, silt, shell

Photo 2 Fine sand, silt

Photo 3 Fine sand, silt, shell

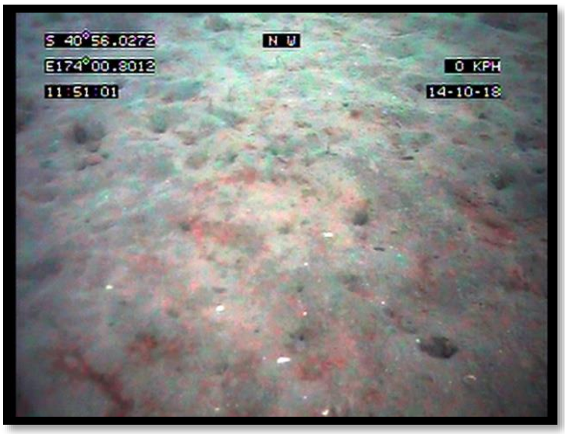

Photo 4 Fine sand, silt, shell

Photo 5 Bedrock, macroalgae

Photo 6 Fine sand, silt, shell, microalgal mat

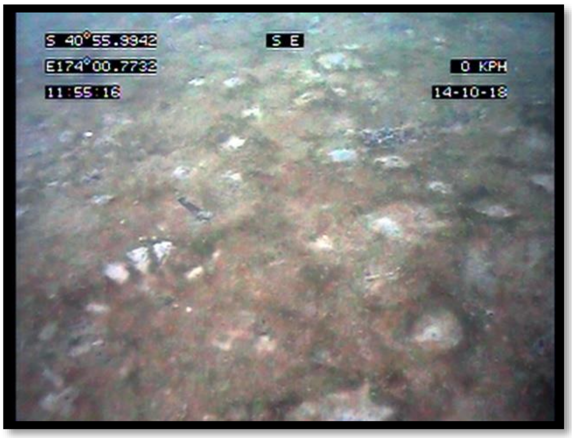

Photo 7 Bedrock, macroalgae, sand, shell

Photo 8 Fine sand, silt, shell, microalgal mat, red algae

Photo 9 Fine sand, silt, shell

Photo 10 Fine sand, silt, shell, microalgal mat

Photo 11 Fine sand, silt, shell, microalgal mat

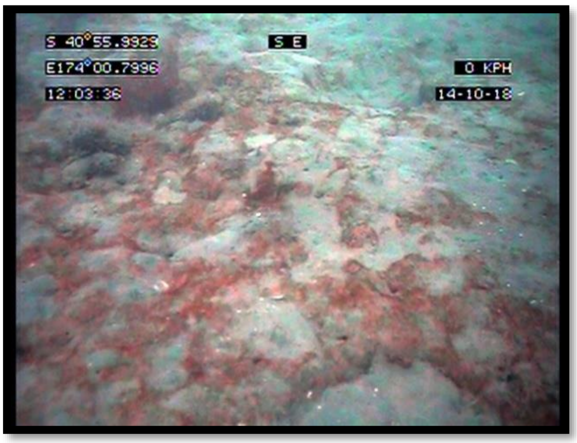

Photo 12 Bedrock, macroalgae, sand, shell

Photo 13 Silt, fine sand, shell, microalgal mat

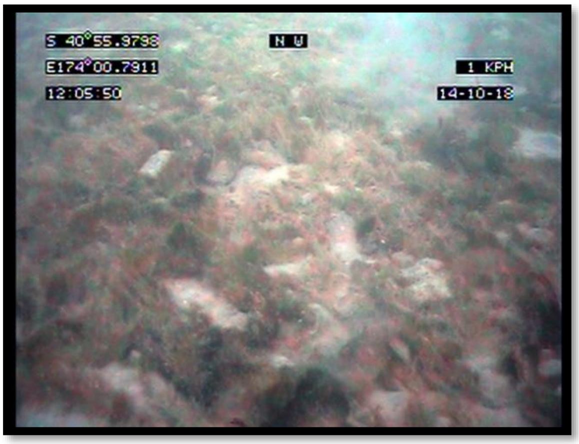

Photo 14 silt

Photo 15 Silt, mussel shell

Photo 16 Silt, mussel shell

Photo 17 Silt, fine sand, shell, red algae

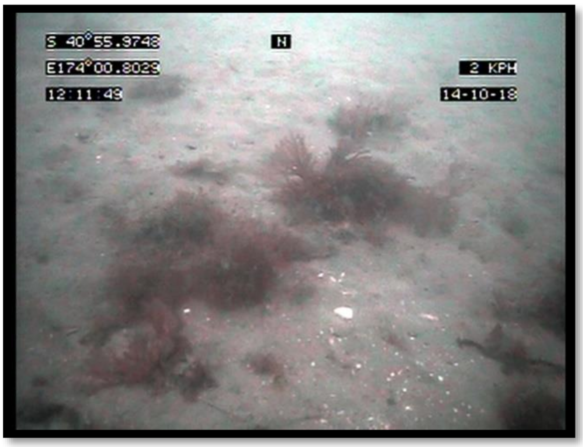

Photo 18 Fine sand, silt, shell

Photo 19 Silt, microalgal mat

Photo 20 Silt, mussel shell

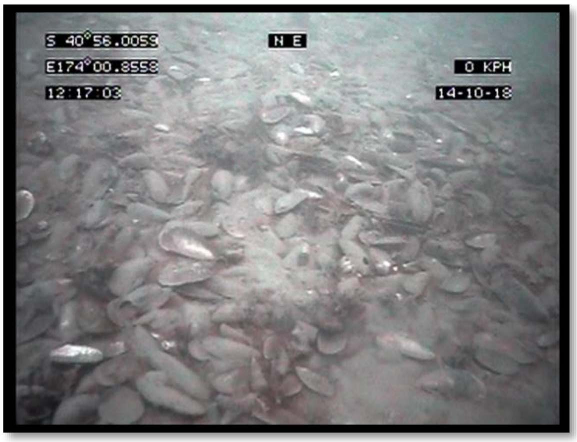

Photo 21 Silt, mussel shell

Photo 22 silt

Photo 23 Silt, mussel shell

Photo 24 Silt, mussel shell, red algae

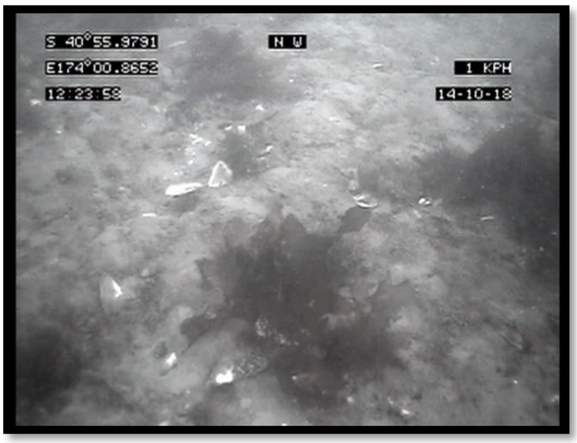

Photo 25 Silt, microalgal mat

From:	Adrian Low <adrian.low@mitchelldaysh.co.nz>
Sent:	Friday, 18 January 2019 11:13 AM
To:	Peter Johnson-5472
Cc:	Alison Undorf-Lay
Subject:	RE: U180922 - marine farm site 8058 Mataka Point
Attachments:	8058 Layout Plan Final.pdf; 4892 King shag advice Mataka and Blowhole Pt farms (004).pdf

Dear Peter

In response to your questions below:

1. I confirm that the application is for the 4.2 hectare area covered by the existing resource consent – in the location shown in Figure 3 on Page 7 of the application.

2. At this farm Sanford uses Anchor Blocks and the warp length to water depth ratio is 3:1.

3. Attached is a revised layout drawing for the site with warp lengths etc. which reflect water depths.

4. Attached is an assessment of the effects of the continued operation of the marine farm on King Shag from an appropriately qualified and experienced avifauna ecologist.

I trust you are now in possession of all the information you require to process this application towards its conclusion.

If there is any further matter which you want to discuss or clarify please let me know.

Many thanks

Adrian

Adrian Low
Associate

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www.mitchelldaysh.co.nz

From: Peter Johnson-5472 <Peter.Johnson@marlborough.govt.nz>
Sent: Monday, 5 November 2018 10:30 AM
To: Adrian Low <adrian.low@mitchelldaysh.co.nz>
Subject: U180922 - marine farm site 8058 Mataka Point

Dear Adrian Low,

Thank you for your application for resource consent (ref: U180922) for the continuation of an existing 4.2 hectare marine farm (site 8058) at Mataka Point for the farming of Greenshell mussel.

I've undertaken an initial assessment of the application and determined that it is complete in terms of section 88 of the RMA.

I've also reviewed the existing consents for the site and pursuant to section 92 of the RMA request the following information from you regarding the current application:

1. The NZMG coordinates listed on page 4 of your application bound an area measuring 5.25 hectares in size. It appears that those coordinates have been copied from the location plan attached as Appendix 1 to your application, which were not updated to reflect the reduction in size of the farm specified in the consent order of 3 May 1999. Please confirm that the application is for the 4.2 hectare area (350m x 120m) in the location shown in your Figure 3 on Page 7 of your application.

2. Please describe the proposed anchoring method(s) for the farm (eg. anchor blocks or screw anchors) and the proposed anchor warp length to water depth ratio (eg. 3:1) for each proposed backbone.

3. The structures and lighting plan provided in your Appendix 1 shows the farm to have one block of seven 170-metre long backbones arranged evenly across a 4.2 hectare area, with anchor warp surface lengths of 85 metres. The submitted biological report identifies that the site has water depths ranging from 4.3 metres at the inshore corner, to 32.6 metres at the most seaward corner. Row b) column 3 of your table on page 10 of your application states that *"…the current layout of longlines within the authorised area may be refined to make most efficient use of the site."* In light of this and your answer to item 2 above, please provide an updated structures layout drawing of the proposed farm.

4. Given the proximity of the site to the Duffers Reef NZ King Shag colony and the water depths at the site, please provide a brief assessment prepared by an appropriately qualified and experienced avifauna ecologist as to the actual and potential effects on the New Zealand king shag from the proposed marine farm. I attach for your information a recent example of such information provided for a marine farm in Forsyth Bay.

Please let me know if you've any questions arising from the above.

Regards,

Peter Johnson
Senior Resource Management Officer

MARLBOROUGH DISTRICT COUNCIL

Only Marlborough

Phone: 03 520 7400

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Blenheim 7240, New Zealand
peter.johnson@marlborough.govt.nz
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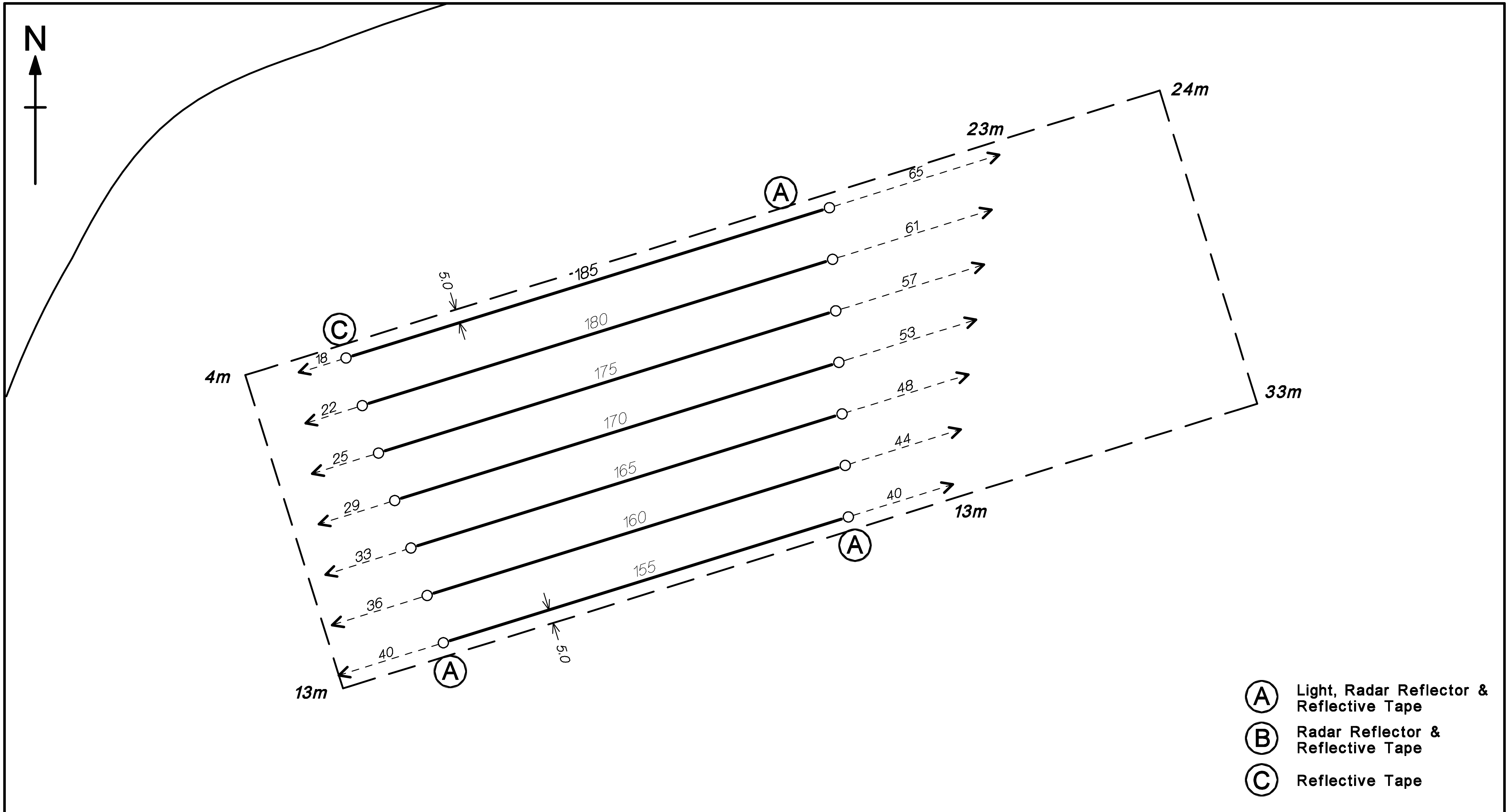

REFERENCE

- o Orange Float
- < Anchors
- - - - - Anchor Warp
- —— Backbone

NOTE

Total Longlines = 7
Backbone Lengths = as shown
Total Backbone Length = 1190m
Longline Spacing = 18.33m
Warp Surface Loss = as shown
Warp Ratio = 3:1 minimum

Layout Details

Marine Farm Site 8058

Blow Hole Point, Pelorus Sound

Ref; MF_2606b
Date; 17 January 2019
Prepared by; DRAUGHTING PLUS LTD

SCALE 1:2000

50 0 50 100m

KING SHAG ADVICE - EFFECTS OF RENEWAL OF MATAKA POINT MARINE FARM 8058 AND BLOWHOLE POINT MARINE FARM 8060

Rachel McClellan
December 2018

INTRODUCTION

Marlborough District Council requires advice on the actual and potential effects of renewal of resource consents for two mussel farms on king shags (*Leucocarbo carunculatus*). The farms are Marine Farm Site 8058 (4.20 hectares) and 8060 (3.25 hectares), situated between Mataka and Blowhole Points, outer Pelorus Sound. The two farms are located with one other farm in a small bay facing east into the Cook Strait. Resource consents for both farms were issued in 1999; the farms have therefore presumably been present for almost 20 years. The reconsenting of the farms will involve no changes to the farms themselves.

King shags (Threatened-Nationally Endangered; Robertson *et al.* 2017) only breed in the Marlborough Sounds in approximately nine colonies distributed from the west of Durville Island to Queen Charlotte Sound. However, recent research has shown that the species was once found along the southern coast of the North Island, and was probably extirpated at the time of Polynesian arrival (Rawlence *et al.* 2017). The Duffers Reef colony is the largest colony known, supporting approximately one third of the total population. The colony is located off Forsyth Island, at the head of Forsyth Bay, just over three kilometres to the southeast of Marine Farm Sites 8058 and 8060.

POTENTIAL THREATS - GENERAL

King shags are potentially affected by a range of threats within the Marlborough Sounds. These include: commercial fishing for finfish (including trawling), commercial dredging for scallops, mussel and fish farming, recreational fishing using nets and pots, impacts of adjacent land use on the marine environment, human disturbance, introduced mammalian predators, native avian predators, storm events, and climate change. These are briefly summarised below. The potential effects of mussel farms are described in more detail in the following section.

The Marlborough Sounds flatfish fishery takes witch (*Arnoglossus scapha*) as bycatch, a key prey species of king shag, based on two dietary studies to date. The fishery also targets two other important species in the king shag diet: lemon sole (*Pelotretis flavilatus*) and common or New Zealand sole (*Peltorhamphus novaezeelandiae*). Bottom trawling for flatfish and dredging for scallops are likely to modify benthic habitats, which may also affect flatfish populations.

Two seabird risk assessments (Ministry of Fisheries, and Department of Conservation) have highlighted the potential direct effects of the flatfish trawl industry, and fish trap, fish potting, and set net fishing methods, on king shag. The studies concluded that there are moderate to extreme levels of risk from direct mortality due to entrapment of king shag (Richard *et al.* 2011; Rowe 2013). However, to date, no king shags have been reported as bycatch.

The advent of farming and plantation forestry have altered the marine environment within the Marlborough Sounds to an unknown extent. Sedimentation from such practices continues, and may affect king shag food sources.

King shags are vulnerable to disturbance at breeding colonies, taking flight if boats approach too closely. Observers have described eggs “tumbling out” of nests as birds take to the air. Unguarded eggs and possibly young chicks can then be taken by native southern black-backed gulls (*Larus dominicanus dominicanus*; Not Threatened) and red-billed gulls (*Larus novaehollandiae scopulinus*; At Risk-Declining).

King shag colonies located on the mainland - such as at Tawhitinui – may be vulnerable to rats (*Rattus* sp.), hedgehogs (*Erinaceus europaeus*), possums (*Trichosurus vulpecula*), cats (*Felis catus*), mustelids (*Mustela* sp.), and pigs (*Sus scrofa*). Rats have been eradicated from the Duffers Reef islets in the past and could reinvade, or invade other island colonies.

Storm events are a natural risk that can directly affect king shag productivity, particularly where nests are relatively close to the water’s edge. However, climate changes may result in an increase the frequency of such storm events, and sea level rise, and has the potential to significantly affect the stability of the king shag population. Climate change may also affect the distribution and abundance of key prey species.

POTENTIAL EFFECTS OF MUSSEL FARMS

Mussel farms are thought to pose several potential threats to king shag. These include entanglement, ingestion of debris, disturbance, habitat avoidance, and habitat changes.

Disturbance can be avoided by ensuring mussel farms are placed sufficient distances from colonies and important roost sites. Likewise, vessels attending mussel farms can ensure routes to and from port avoid roost and colonies by at least 100 metres.

Injury and mortality from entanglement with droplines and other structures has not been reported. The risk is likely to be very low given the structures involved lack nets and provide ample open space between droplines. The level of risk of debris ingestion is unknown, and is very difficult to assess. However, the New Zealand Greenshell™ Mussel Industry has had a detailed Environmental Code of Practice in place since 2004 with a strong emphasis on waste management.

Potential effects that are generally considered to be more important are habitat avoidance due to mussel farm structures, and changes to benthic habitats caused by mussel farms which may alter the availability of key prey species such as flatfish. This is likely to be partly because king shag appear to rarely forage within mussel farms.

To date, at least 14 sightings of king shags foraging in mussel farms have been made, out of approximately 1,000 foraging observations (~1.4% of observations). Most of these observations were collected by two observers surveying king shag habitat use in Forsyth Bay and surrounds. For example, Mr Derek Brown wrote in evidence for Environment Court: *“On eight separate occasions between April 1999 and June 2002 I have observed king shags feeding under mussel lines at long-established marine farms. Photo 2 shows one such king shag, undertaking dives between mussel farm lines in southern Forsyth Bay. On two separate occasions (at Port Ligar on 13-7-00 and Waihinau Bay on 10-6-02) I observed the shag surface with an unidentified flatfish in its beak, while within the confines of a marine farm. On several* *other occasions I have seen king shags successfully catch fish in very close proximity to marine farms"*[1].

Several possibilities, or combinations of possibilities, could explain the low rate of sightings:

1. Farm structures restrict king shags from foraging.
2. Prey species such as flatfish are less likely to be found in the modified environments beneath and around mussel farms.
3. Key prey species, such as witch, are less likely to be found in shallower depths where mussel farms are more common.
4. Mussel farms comprise only a small proportion of the entire area available for foraging by king shag.
5. Mussel buoys can obstruct the observation of king shags resting on the water surface between foraging bouts.

Regarding Point 1 above, king shag are clearly not excluded by mussel farms, as individuals have been reported foraging within them. However, the possibility that there are characteristics of mussel farm structures that cause some shags to forage elsewhere cannot be discounted.

Regarding Point 2, the ways in which fish communities are affected by mussel farms in the Marlborough Sounds are very poorly known. For example, the use of mussel farms by flatfish – the main prey species of king shag – has never been examined. Only one study has examined how mussel farms change fish communities, by assessing pelagic fish populations associated with 10 mussel farms in Pelorus Sound, and comparing them to adjacent areas with no farms (Grange 2002). This study identified no statistically significant differences in pelagic fish communities between farmed and non-farmed areas, although data suggested that farms may support higher diversities and abundances of pelagic fish.

Regarding Point 3, the flatfish witch (*Arnoglossus scapha*) is the most commonly taken prey species by king shag according to two dietary studies. The recent encyclopedic review of New Zealand marine fish species states that witch are found "on coarse sand and muddy substrata at depths of 4-737 metres (commonly 30-300 metres)"; that witch spawn "on the continental shelf to around 100 m"; that larvae may have "a prolonged pelagic stage"; and that pelagic juveniles less than 110 mm standard length (SL) "inhabit mid-water depths of 30-350 m in areas where bottom depths range at 1,700-2,100 m" (Roberts *et al.* 2015). These data suggest that there may be little overlap between witch distribution at any life stage and the generally shallower depths at which mussel farms are usually located.

Regarding Point 4, the Marine Farming Association states that marine farms cover approximately 2% (*c.*30 square kilometres) of the water surface of the Marlborough Sounds (*c.*1,500 square kilometres)[2]. This is a relatively similar percentage to the c.1.4% of foraging records of king shag within mussel farms. In comparison, the foraging range of king shag has been estimated at 1,358 square kilometres (based on a foraging range of 25 kilometres from each colony, where bathymetry is above 50 metres depth; Marlborough Sounds Important Bird Area; Forest and Bird 2014).

1 Brown D.A. 2001: Evidence presented to the Environment Court for an appeal by Maclab (NZ) Limited No. U990690. Forsyth Bay.

2 http://assets.marinefarming.co.nz/MFA%20Brochure.pdf accessed 17 August 2018

Lastly, regarding Point 5, when viewed from a boat, the amount of water surface within a farm that is clearly visible can be highly variable, depending on the viewing angle, the layout of the farm, and the weight of mussels on the droplines. Views of a king shag resting on the water surface may be blocked by mussel buoys.

KING SHAG CENSUS RESULTS

New Zealand King Salmon prepared a King Shag Management Plan as part of conditions of consents for the establishment and operation of two salmon farms in 2014. The management plan sets out the requirements for a census of known king shag colonies every three years. The first of these was carried out in February 2015, and the second in 2018 (Schuckard *et al.* 2015; Schuckard 2018). The 2018 count shows a 24% decline in numbers of birds (Table 1). This is greatly in excess of the management plan's 5% decline threshold, set to trigger a subsequent set of management actions, including instigation of annual monitoring (rather than every three years).

Table 1 provides the results from the 2015 and 2018 censuses (Schuckard 2018). Major changes have occurred throughout the species' distribution, from the west coast of Durville Island through to Queen Charlotte, with major declines, one major increase, abandonments and newly established colonies.

Table 1: King shag aerial census results 2015 and 2018 (from Schuckard 2018).

Colony	General Location	2015	2018	Percent Change
Rahuinui	Durville Island (west)	75	51	-32%
Trio Islands	Admiralty Bay (outer)	173	129	-26%
Stewart Island	Admiralty Bay (inner)	26	16	-37%
Sentinel Rock	Pelorus Sound (outer)	64	0	-100%
Duffers Reef	Pelorus Sound (mid)	297	212	-29%
Tawhitinui	Pelorus Sound (inner)	43	65	+51%
Hunia Rock	Port Gore	53	31	-42%
White Rocks	Queen Charlotte (outer)	103	69	-33%
The Twins	Queen Charlotte (outer)	0	51	+100%
Blumine Island	Queen Charlotte (mid)	-	4	?
Ruakaka-Blackwood	Queen Charlotte (inner)	0	5	+100%
Total		**834**	**634**	**-24%**

The aerial census method cannot distinguish mature individuals from juveniles and subadults. Because of this, it is not known whether the decrease is a result of a decline in the mature population, or changes in the pre-breeding population, or a combination of the two. Population modelling indicates that a possible scenario for the decline is a major reduction in the "per capita fecundity rate" (a combination of some or all of adult breeding frequency, nesting attempts, clutch size, nesting success and fledging success), in the presence of a stable adult mortality rate. It is possible that the fecundity rate will improve in the next few years, increasing the size of the pre-breeding population, and resulting in higher census counts.

However, it is also possible that the decrease is, at least in part, due to a decline in adult survival. Declines in adult survival have immediate impacts on population stability, and if they continue, the species' situation is of significant concern. For this reason, it is imperative that the king shag population is monitored more regularly, ideally with intensive monitoring at some colonies to investigate variation in breeding initiation, and causes and timing of nesting failures.

Also, the accuracy of the census relies on the location of all colonies being known prior to commencement of the survey. Detection of a colony at Blumine Island in 2018 meant that it was not surveyed in 2015, illustrating this issue. Missing an important new colony (for example, the new colony at The Twins) could significantly affect the results, although this is unlikely to explain a reduction of 200 birds.

Census results show that the decline has occurred throughout the species' distribution. This suggests, but does not confirm, that the decline may be due to widespread influences, such as changes in marine conditions affecting food sources rather than particular human activities in a specific area.

It is noted that a third summer census is likely to be undertaken in February 2019 (as part of conditions of New Zealand King Salmon consents). Furthermore, Department of Conservation undertook a fourth consecutive winter breeding survey in 2018, including surveying all colonies in May, June and July to examine monthly variation in breeding frequency. These results, once available, will assist in the interpretation of king shag population trends.

DUFFERS REEF COLONY

Duffers Reef is one of the largest of the king shag colonies, and of all the colonies, is the closest to the Mataka Point-Blowhole Point mussel farms. The colony was first recorded in September 1951, when 150 adults and 29 nests were observed. Since that time, it has remained one of the most important king shag colonies. In 2015 and 2018, it supported approximately one third of the total king shag population. It is also one of two king shag colonies with particularly high levels of mussel farms within a 10 kilometre radius.

MacKenzie (2018) analysed counts at the Duffers Reef colony spanning 20 years (1994-2013). He showed an increasing trend as a result of higher counts in 2011 and 2013.

The aerial census count in 2015 of 297 birds represents a 28% increase from the previous highest count in 1994 of 232 birds. The count in 2018 of 212 birds represented a drop of 29% from the 2015 peak.

Annual variation at Duffers Reef can be high, demonstrated by the only consecutive annual counts at the colony in December 1995-1997, which were 221, 175, and 205 respectively (a 21% decline between 1995 and 1996, and a 17% increase by the following year). Within-year variation is also high: a count at the colony in 31 May 1994 found 195 birds, and approximately six months later, a count recorded 232 birds on 2 November 1994, an increase of 19%.

Nest counts over the last 60-70 years at the four main king shag colonies, including Duffers Reef (Figure 1), show that the numbers of nests recorded in 2015-2017 largely fall within the existing range of counts. The 2017 nest count was the second-highest recorded since the colony was discovered in 1951.

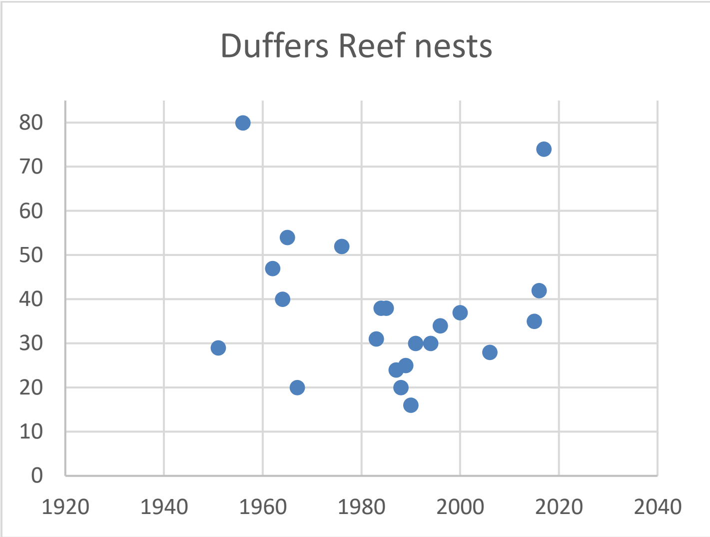

Figure 1: King shag nest counts, Duffers Reef, Marlborough Sounds (from Schuckard *et al.* in prep).

In summary, the Duffers Reef king shag population recorded its highest population peak in 2015 since 1994, and appears to have maintained comparable nesting intensity, including one of the highest recorded nest counts in *c.*70 years, in 2017.

CONCLUSION

In summary, it is not possible to say with certainty how mussel farms affect the king shag population. This will require research on aspects of king shag ecology such as foraging distribution, diet, and interactions with mussel farms, as well as the effects of mussel farms on fish, particularly flatfish populations.

However, despite this, I consider that consent renewal for Marine Farm Sites 8058 and 8060 is unlikely to have an adverse effect on the Duffers Reef king shag population. This is because the farms are existing effects (for approximately 20 years), during which time, the Duffers Reef king shag population has recorded its highest population peak in 2015, and appears to have maintained comparable nesting intensity, including one of the highest recorded nest counts in *c.*70 years in 2017.

Consent conditions specific to king shag management and protection, and relevant to the operation of the two mussel farms, are:

- Minimisation of the loss of debris, such as dropline ties, entering the water. However, I note that this is already part of the industry's environmental code of practice.
- Maintenance of at least 100 m from the Duffers Reef king shag colony at any time of the year for all mussel farm vessels attending the Mataka-Blowhole Points farms.

Any survey or monitoring of king shag use of mussel farms for the purposes of addressing specific research questions needs to be well planned and implemented at a much wider scale. I am aware that a banding study has recently been initiated by the Marine Farming Association and the Department of Conservation. It is likely that GPS loggers will also be attached to adult birds as part of this research programme, which has the potential to illustrate the foraging behaviour and distribution of king shag in fine detail, including interactions with mussel farms.

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To: Marlborough District Council
PO Box 443
Blenheim 7240

MARLBOROUGH DISTRICT COUNCIL

ISO 9001:2008
Document Number:
RAF0010-CI1921

SUBMISSION ON APPLICATION FOR A RESOURCE CONSENT

1. Submitter Details

Name of Submitter(s) in full ....

Electronic Address for Service *(email address)* ....

Postal Address for Service *(or alternative method of service under section 352 of the Act)* ....

....

....

Primary Address for Service *(must tick one)*

Electronic Address *(email, as above)* ☐ or, Postal Address *(as above)* ☐

Telephone *(day)* .... Mobile .... Facsimile ....

Contact Person *(name and designation, if applicable)* ....

....

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2. Application Details

Application Number U ....

Name of Applicant *(state full name)* ....

Application Site Address ....

Description of Proposal ....

....

....

---

3. Submission Details *(please tick one)*

I/we support all or part of the application ☐

I/we oppose all or part of the application ☐

I/we are neutral to all or part of the application ☐

☐ I am a trade competitor for the purposes of section 308B of the Resource Management Act 1991

☐ I am directly affected by an effect of the subject matter of the submission that:
a) adversely affects the environment; and
b) does not to relate to trade competition or the effects of trade competition

☐ I am NOT directly affected by an effect of the subject matter of the submission that:
a) adversely affects the environment; and
b) does not to relate to trade competition or the effects of trade competition

☐ I am NOT a trade competitor for the purposes of section 308B of the Resource Management Act 1991

The specific parts of the application that my/our submission relates to are *(give details, using additional pages if required)*

The reasons for my/our submission are *(use additional pages if required)*

The decision I/we would like the Council to make is *(give details including, if relevant, the parts of the application you wish to have amended and the general nature of any conditions sought. Use additional pages if required)*

---

4. Heard in Support of Submission at the Hearing

I/we wish to speak in support of my/our submission ☐

I/we do not wish to speak in support of my/our submission ☐

OPTIONAL: Pursuant to section 100A of the Resource Management Act 1991 I/we request that the Council delegate its functions, powers, and duties required to hear and decide the application to one or more hearings commissioners who are not members of the Council. *(Please note that if you make such a request you may be liable to meet or contribute to the costs of commissioner(s). Requests can also be made separately in writing no later than 5 working days after the close of submissions.)* ☐

5. Signature

Signature .... Date ....

Signature .... Date ....

6. Important Information

- Council must receive this completed submission before the closing date and time for receiving submissions for this application. The completed submission may be emailed to mdc@marlborough.govt.nz.
- The closing date for serving submissions on the consent authority is the 20th working day after the date on which public or limited notification is given. If the application is subject to limited notification, the consent authority may adopt an earlier closing date for submissions once the consent authority receives responses from all affected persons.
- You must serve a copy of your submission on the applicant as soon as is reasonably practicable after you have served your submission on the consent authority.
- Only those submitters who indicate that they wish to speak at the hearing will be sent a copy of the section 42A hearing report.
- If you are making a submission to the Environmental Protection Authority, you should use form 16B.
- If you are a trade competitor, your right to make a submission may be limited by the trade competition provisions in Part 11A of the Resource Management Act 1991.
- If you make a request under section 100A of the Resource Management Act 1991, you must do so in writing no later than 5 working days after the close of submissions and you may be liable to meet or contribute to the costs of the hearings commissioner or commissioners. You may not make a request under section 100A of the Resource Management Act 1991 in relation to an application for a coastal permit to carry out on activity that a regional coastal plan describes as a restricted coastal activity.
- Please note that your submission (or part of your submission) may be struck out if the authority is satisfied that at least 1 of the following applies to the submission (or part of the submission):
  - it is frivolous or vexatious;
  - it discloses no reasonable or relevant case;
  - it would be an abuse of the hearing process to allow the submission (or the part) to be taken further;
  - it contains offensive language;
  - it is supported only by material that purports to be independent expert evidence, but has been prepared by a person who is not independent or who does not have sufficient specialised knowledge or skill to give expert advice on the matter.

7. Privacy Information

The information you have provided on this form is required so that your submission can be processed under the Resource Management Act 1991. The information will be stored on a public file held by Council. The details may also be available to the public on Council's website. If you wish to request access to, or correction of, your details, please contact Council.