BASELINE: Characterisation of the water and seabed environment of the proposed mussel farm in Jervis Bay.

Margaret Platell, Troy Gaston and Vincent Raoult

University of Newcastle

Final Report to South Coast Mariculture

MARCH 2020

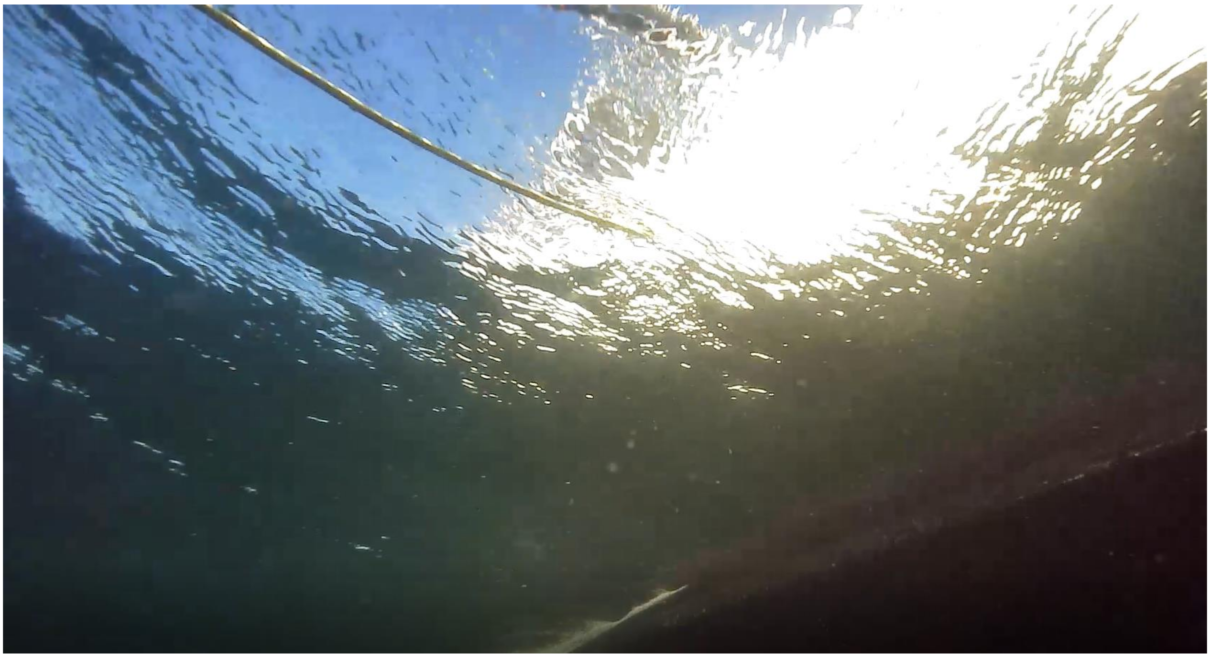


Plate 1 View from beneath the vessel at Callala North Lease site.

Plate 2 The seafloor at Vincentia Lease site.

Executive Summary

Baseline sampling of the water quality and seabed environment at the pre-existing southern (Vincentia, V) and new northern (Callala North and Callala South, CN & CS) lease sites, with two associated controls for each lease was carried out in July 2019 for South Coast Mariculture in Jervis Bay.

The water depth at the nine sites ranged between 8.5 m (Vincentia Lease, V.L) and 14.2 m (Callala North Control 2, CN.C2). Water quality varied little among the nine sites and between bottom and surface waters, except that turbidity was slightly greater at depth (8.2 vs 6.6 NTU). Average salinity was that of seawater (35-36), waters were cool (15°C), pH was 8.4) and waters were well-oxygenated (95 to 100% saturation).

Remote Operated Vehicle (ROV) surveys showed that the seabed at all sites was characterised by pale sand, small attached plants (macrophytes) and drift algae and observations of stingarees, seastars, flathead and seapens. There were branching sponges at one site (CN.C1), extensive drift algae rows, with associated fish and epifaunal molluscs, at three northern sites (CN.C2, CS.C3 & CS.C4), while the southernmost sites (Vincentia) had evident surface burrows and limited drift algae, with some kelp blades.

Mean grain size was similar between the lease and the two control sites at each of the three lease locations and significantly less at the Vincentia location (186-237 µm) vs Callala North and Callala South (291-323 µm). This was reflected by the mean %mud and %Total Organic Carbon (TOC) being greatest at Vincentia and least at Callala North and Callala South. The mean TOC ranged between 0.05% at CS.C3 to 0.18% at V.C6. It is noted that the scope of future sampling will be dictated by any changes in the mean TOC from Baseline, as per the South Coast Mariculture (2015) Benthic Monitoring Plan.

A total of 5127 benthic macroinvertebrates were counted and was dominated by crustaceans (45%), bivalve molluscs (40%) and polychaetes (13%). Heart urchins were relatively large and conspicuous but contributed <1% overall. The number of taxa (richness) was significantly greater at the Vincentia location, while the numbers of animals (abundance) showed no consistent differences among the nine sites. The taxonomic composition of the benthic macroinvertebrate assemblages differed significantly between most sites, except for some in the more northern parts, and these differences were most obvious between Vincentia and the two other lease locations.

Twenty-eight of the 36 Baited Remote Underwater Video Systems (BRUVS) drops were successful with a total of 805 organisms observed. Yellowtail Scad (687) were most dominant, with large schools observed at all sites except CN.C1. Small numbers of flathead and Eastern Fiddler Ray were observed at all sites. Significant differences in the fish assemblages were shown for only CN.C1 vs the other two sites from Callala North and two of the three sites in Vincentia, reflecting mainly the Port Jackson shark being more abundant at CN.C1. It is noted that there was loss of replication due to turbidity issues and cameras falling awkwardly.

The results from this Baseline Study provide a robust background, based on water quality, seabed surveys, sedimentary characteristics (including TOC), benthic macroinvertebrates and fish, against which any potential future changes from mussel aquaculture activities can be assessed. It is suggested that sampling be continued at the same time of year (winter) during the time that the lease is operational.

Contents

1. Introduction

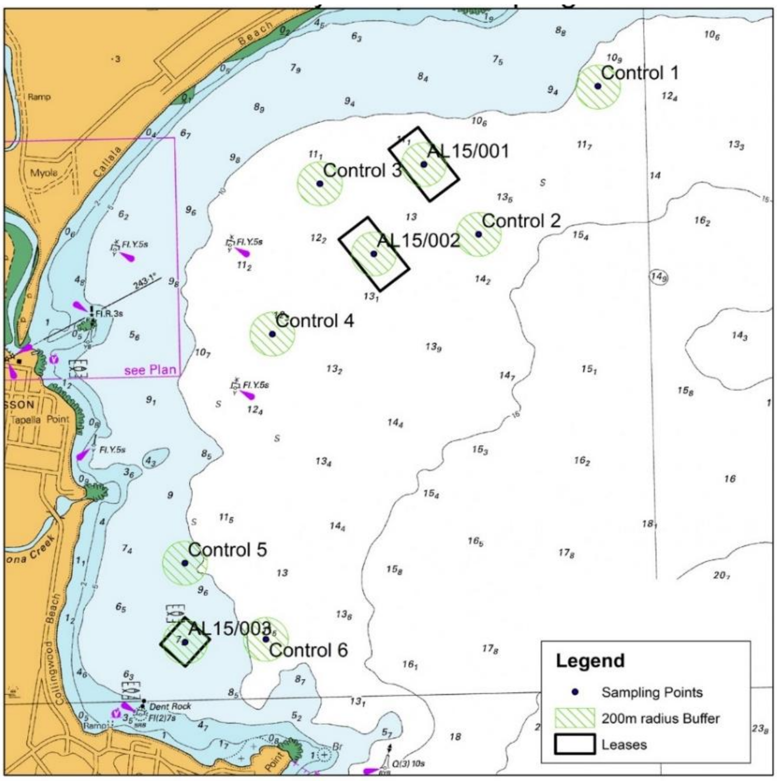
A mussel aquaculture lease expansion by South Coast Mariculture in Jervis Bay is to include a pre-existing lease (Vincentia), which used raft culture and ceased operation in 2008 (Joyce et al., 2010) and two new leases (Callala North and Callala South) to the north (Fig. 1.1). For each of the lease sites there are two control sites which will form the experimental design for the Baseline Survey (nine sites in total). Baseline sampling of the water quality and seabed environment at these nine sites (Fig. 1.1), prior to the deployment of live mussels, was carried out in July 2019, following the guidelines established in the South Coast Mariculture (2015) Benthic Monitoring Plan for Jervis Bay that was submitted to the DPI, and with further sampling included (Appendix A).

For the purposes of this report:

AL 15/001 = Callala North Lease (CN.L) with Control 1 and 2 (CN.C1 & CN.C2)

AL 15/002 = Callala South Lease (CS.L) with Control 3 and 4 (CS.C3 & CS.C4)

AL 15/003 = Vincentia Lease (V.L) with Control 5 and 6 (V.C5 & V.C6)



SITE	LATITUDE	LONGTITUDE
AL15/001	35° 1' 22.967"	150° 42' 41.398" E
AL15/002	35° 1' 49.131"	150° 42' 23.020" E
AL15/003	35° 3' 42.802"	150° 41' 13.188" E
Control 1	35° 1' 0.958" S	150° 43' 43.429" E
Control 2	35° 1' 44.008"	150° 43' 0.162" E
Control 3	35° 1' 27.997"	150° 42' 4.545" E
Control 4	35° 2' 12.196"	150° 41' 46.531" E
Control 5	35° 3' 19.414"	150° 41' 13.744" E
Control 6	35° 3' 42.530"	150° 41' 41.706" E

Source: data from NSW DPI and Australian Hydrographic Service
Datum: GDA94 MGA Zone 56

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Prepared by Aquaculture Management October 2015

NSW GOVERNMENT Department of Primary Industries

Figure 1.1. Map showing location and coordinates of the sampling sites in Jervis Bay (from South Coast Mariculture (2015).

Sampling was carried out on the South Coast Mariculture Runabout, skippered by Hika Rountree, between 9 and 11 July, 2019, with water quality and sediments (and benthic macroinvertebrate) collection carried out on the first day, with Remotely Operated Vehicle (ROV) and Baited Underwater Remote Video System (BRUVS) sampling over the next two days (Table 1.1).

Table 1.1. Details of sample collection at each of the nine sites for the South Coast Mariculture operations in Jervis Bay. MP - Margaret Platell; DH - Dan Hewitt; HS - Harrison Smith; VR - Vincent Raoult.

Date	UoN personnel	Water quality	Sediment collection	ROV Survey	BRUVS
9.7.2019	MP, DH, HS	Completed	Completed		
10.7.2019	VR, DH, HS			Completed	CN & CS (six sites)
11.7.2019	MP, DH, HS				V (three sites)

The method of collection, subsequent laboratory treatment, results and discussion for the different elements of this study are provided in the following sections. Examinations were done for infauna by Ally Suzzi and MP, for ROV footage by MP and BRUVS footage by Hannah-Finlay Jones and MP.

2. Field sampling - Water quality

Water quality was measured using a Horiba u-50 Multiparameter Water Quality Meter, at both the surface and at depth at the approximate centre of each study site. Parameters included temperature (°C), salinity, pH, turbidity (NTU) and dissolved oxygen (mg/L and % saturation).

The depth was recorded at each site, with that for Vincentia Lease (V.L) being shallowest (8.5 m), most sites ranging between 10.2 and 13.4 m and the deepest site (14.2 m) being CN.C2 (Table 2.1).

Table 2.1. Water depth at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

Area name	Site type	Site name	Water depth (m)
Callala North	Control	CN.C1	11.3
Callala North	Control	CN.C2	14.2
Callala North	Lease	CN.L	12.3
Callala South	Control	CS.C3	11.9
Callala South	Control	CS.C4	13.0
Callala South	Lease	CS.L	13.4
Vincentia	Control	V.C5	10.2
Vincentia	Control	V.C6	12.0
Vincentia	Lease	V.L	8.5

Water quality parameters varied little over the study area (Appendix B) and were therefore averaged for surface and bottom waters and the standard errors shown (Table 2.2). These calculations showed that most parameters were similar between the surface and bottom waters, except for turbidity which was slightly greater at depth (6.6 vs 8.2 NTU, respectively). The temperature and salinity are consistent with those for within this region of NSW (CSIRO, 1994) and other parameters consistent with those reviewed by Joyce et al. (2010).

Table 2.2. Means (± SE) for water temperature (°C), salinity, pH, turbidity (NTU) and dissolved oxygen (mg/L and %) measured at the surface and at depth for each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

Water column	Water temperature (°C)	Salinity	pH	Turbidity (NTU)	Dissolved oxygen (mg/L)	Dissolved oxygen (%)
Surface	15.4 (0.2)	35.7 (0.3)	8.4 (0.0)	6.6 (1.2)	7.4 (0.2)	95.7 (2.5)
Bottom	15.7 (0.2)	36.3 (0.0)	8.4 (0.0)	8.2 (1.3)	7.8 (0.3)	100.2 (3.0)

3. Seabed survey

The appearance of the seabed was recorded at each site by undertaking 4 x replicate transects for 2-3 min duration, travelling ~1m above the seabed in a straight line using a BlueRobotics BlueROV2 Remotely Operated Vehicle (ROV) with a Heavy Lift kit modification and 4 LED lights. The ROV was operated through a Panasonic Toughbook and a wireless Logitech controller. Headings were maintained using the stabilize mode function, which holds the heading automatically using the on-board compass and accelerometer. To help ensure that transects were of similar length between sites, speed was controlled by moving at 25% constant forward thrust. The ROV was also used to film the existing underwater infrastructure at Callala North Lease site. The positions of all initial dives were located by GPS. Videos were recorded at 1080p resolution and 30 frames per second.

ROV videos were scored for features of the seabed and any fauna or flora, using timestamps and screenshots. Full details are reported in Appendix C and the main findings, including a "typical" screenshot of the seabed at that site provided in Table 3.1. The digital recordings are stored on a secure University of Newcastle server.

ROV videos showed that the environment at all sites was characterised by pale sand and small attached macrophytes, with stingarees (mainly *Trygonoptera testacea*), *Luidia* seastars, flatheads and sessile seapens being relatively conspicuous on the seabed (Table 3.1). Most notable differences are between the Vincentia sites (most evidence of surface burrowing activities, limited drift algae, including some kelp) and the more northern sites, and between Callala North Control 1 (with most branching sponges) and Callala North Control 2 (extensive drift algae).

For the seabed, shell debris was limited and included *Pecten* scallops (CN.C1) and empty whole gastropods (CS.L) (Table 3.1). Feeding pits, presumably from stingarees, were observed at most sites.

For the observed fauna, branching sponges were most obvious at CN.C1 but occurred at other sites, including those with drift algae (Table 3.1). A range of elasmobranch and fish species observed including stingarees (*Trygonoptera testacea* and *Urolophus cruciatus*), Eastern Fiddler Ray (*Trygonorrhina fasciata*), Port Jackson shark (*Heterodontus portusjacksoni*), flathead (*Platycephalus* spp.), and apogonid, labrid and carangid fishes. Larger invertebrates included the *Luidia* seastar, seapens and a swimming aplysiid (seahare) (Table 3.1)

For the observed flora, there was sparse drift algae present at CN.C1 and CN.L (small fragments) and all Vincentia sites (small fragments and large kelp pieces) (Table 3.1). However, there were extensive and profuse "rows" of drift algae at three sites (CN.C2, CS.C3 and CS.C4). At CN.C2, there was essentially only red algae, with white encrusting organisms evident (containing at least some pteriid bivalves). The drift algae rows at the other two sites (CS.C3 and CS.C4) contained a mixture of algae, and thus contained less of those white encrusting organisms. At the last site (CS.L), the drift algae "rows" were present, but were less developed (Table 3.1).

Table 3.1. Summary of the observations for ROV filming for each of the nine sites, for the South Coast Mariculture operations in Jervis Bay, recorded 10 July 2019. Note that a question mark before the name of an organism indicates that identification is most likely to be accurate, but cannot be confirmed owing to key features not being observed.

Site	Time Film Started (24hr)	Total Duration (min)	Site Type	Comments	Images
CN.C1	08.51.44 to 09.00.14	10:54	Control	**Seabed**: Rippled pale sand, some shell debris, including scallops, occasional feeding pits **Fauna**: Occasional branching sponges, some encrusting sponges, seapens, *Luidia* seastar, stingaree *Urolophus cruciatus*, wormtubes and flathead **Flora**: Sparse drift algae and some small attached macrophytes	
CN.C2	08.15.22 to 08.26.26	12:39	Control	**Seabed**: Rippled pale sand patches between drift algae, one small rock outcrop **Fauna**: School of 100+ pelagic fish, suspected sandy sprat, apogonids over algae, large flathead, suspect *Platycephalus bassensis*, fanbellied leatherjacket *Monacanthus chinensis*, wrasse, school of pelagic carangids, and *Luidia* seastar **Flora**: Dense rows of drift algae, high and profuse in places. Appears entirely red algae with white encrusting organisms (?pteriids)	
CN.L	09.52.50 to 10.02.11	11:03	Lease	**Seabed**: Rippled pale sand, little shell debris, occasional feeding pits **Fauna**: Swimming aplysiid and *Luidia* seastar **Flora**: Small attached macrophytes, sparse drift algae, a few larger accumulations of drift algae	

Site	Time Film Started (24hr)	Total Duration (min)	Site Type	Comments	Images
CN.L	10.02.11 to 10.35.57	5:56	Lease Infra-structure	**Mooring base:** Scorpaenid on top **Mooring line**: Some algal growth, more extensive towards surface **Mooring top**: Two floats clearly seen	 
CS.C3	10.48.06 to 10.57.12	12:06	Control	**Seabed**: Rippled pale sand patches between drift algae **Fauna**: Large branching sponges, small fish, suspect labrids, school of apogonids, ?damselfish and male eastern fiddler ray *Trygonorrhina fasciata* **Flora**: Dense rows of drift algae, appears a mixture of red and green/brown branching algae, some white encrusting organisms (suspect some pteriids), small attached macrophytes, a few pieces of drift kelp	
CS.C4	11.23.20 to 11.35.10	16:38	Control	**Seabed**: Rippled pale sand patches between drift algae, little shell debris **Fauna**: ?Damselfish, stingaree *Trygonoptera testacea*, apogonids, octopus garden, Port Jackson Shark *Heterodontus portusjacksoni*, large school pelagic fish, striped wrasse and flathead **Flora**: Dense rows of drift algae, appears a mixture of red and green/brown algae, very few/some white encrusting organisms, small attached macrophytes, one tall macrophyte	

Site	Time Film Started (24hr)	Total Duration (min)	Site Type	Comments	Images
CS.L	12.18.56 to 12.28.16	11:05	Lease	**Seabed**: Rippled pale sand areas, some medium to larger areas, between drift algae, some shell debris, a few/occasional feeding pits **Fauna**: *Luidia* seastar, stingaree *Trygonoptera testacea* and *Urolophus cruciatus*, flathead and isolated sponge **Flora**: Some rows, some scattered drift algae, appears a mixture of red and green/brown algae, some white encrusting organisms, small attached macrophytes	
V.C5	12.42.29 to 12.52.18	12:17	Control	**Seabed**: Disturbed pale sand areas, frequent feeding pits, one piece of conglomerate, some small dark spots evident **Fauna**: *Luidia* seastar, stingaree *Trygonoptera testacea*, 200+ school of carangids and seapen **Flora**: Small drift and attached macrophytes, larger pieces drift kelp, some with holdfasts)	
V.C6	13.24.35 to 13.34.29	12:56	Control	**Seabed**: Disturbed pale sand areas, frequent feeding pits **Fauna**: Branching sponge, recently vacated feeding pit, large stingaree *Trygonoptera testacea* left another feeding pit, seapen, odd pair of ?pipefish **Flora**: Small drift and attached macrophytes, larger pieces drift kelp, some rows of drift macrophytes, single kelp blades also scattered around	

Site	Time Film Started (24hr)	Total Duration (min)	Site Type	Comments	Images
V.L	13.03.28 to 13.12.21	11:20	Lease	**Seabed**: Disturbed pale sand areas, occasional/few feeding pits, sometimes numerous dark spots **Fauna**: Stingarees *Trygonoptera testacea* and *Urolophus cruciatus*, seapen, encrusting sponge **Flora**: Small and frequent attached macrophytes, some small drift macroalgal fragments, larger pieces drift kelp, some with holdfast, some single kelp blades	

4. Sedimentary characteristics and benthic macroinvertebrates

Invertebrates and sediment were collected using a 3L Ekman grab within 200 m of the centre point of each sampling site. Six samples were taken from each site, with 30 g sub-samples taken for Total Organic Carbon (TOC) and grain size analyses. All samples were placed into separate, labelled plastic bags and on ice until the end of the day. TOC and grain size samples were then frozen until analysis. Invertebrate samples were kept chilled until the following day, where they were sieved through a 1 mm mesh and preserved in 70% ethanol.

4.1. Grain size and total organic carbon

Samples for grain size were dried for 24 hours at 65°C, weighed to the nearest 2 dp then put through a sediment shaker containing a nested series of sieves (0.063, 0.125, 0.250, 0.500, 1.000, 2.000 and 4.000 mm), with a tray below for those sediment particles of < 0.063 mm in size. The shaker was operated for 5 min for each sample. Sediment on each sieve was weighed to 2 dp and GRADISTAT (Blott & Pye, 2001) was used to calculate the mean grain size and percentage (%) mud in each sample. TOC was expressed as a percentage of the weight of the total sample for each sample (raw data for TOC is provided in Appendix D). The grain size, % mud and TOC data were analysed using a one-way ANOVA.

There was a significant difference in mean grain size among sites ($F_{8,43} = 7.542$, $P < 0.000$), but no significant difference among sites within a location (i.e. CN.C1 = CN.C2 = CN.L; CS.C3 = CS.C4 = CS.L; V.C5 = V.C6 = V.L). Similarly, there was a difference among sites for both %mud ($F_{8,43} = 13.684$, $p < 0.000$), and % TOC ($F_{8,43} = 4.733$, $P < 0.000$), but no significant difference among sites within a location (i.e. CN.C1 = CN.C2 = CN.L; CS.C3 = CS.C4 = CS.L; V.C5 = V.C6 = V.L).

Site CN.C1 has the largest mean grain size (323.2 µm) and site V.L the smallest grain size (186.5 µm; Fig. 4.1a). Conversely, site VL has the highest % mud (0.131) and site CN.C1 had the smallest % mud (0.006 %; Fig. 4.1b). The highest total organic carbon (TOC) was at site V.6 (0.177 % TOC) and the lowest % TOC was at site CS.C3 (0.045 % TOC; Fig. 4.1c).

The cumulative grain size curves for the different sampling locations each approach the asymptote (>90%) at 0.250 mm (Figures 4.2a, b and c). Locations Callala North and Callala South have similar cumulative grain size curves, however, an increase in the importance of smaller grain sizes at Vincentia, particularly site V.L, shows a different curve.

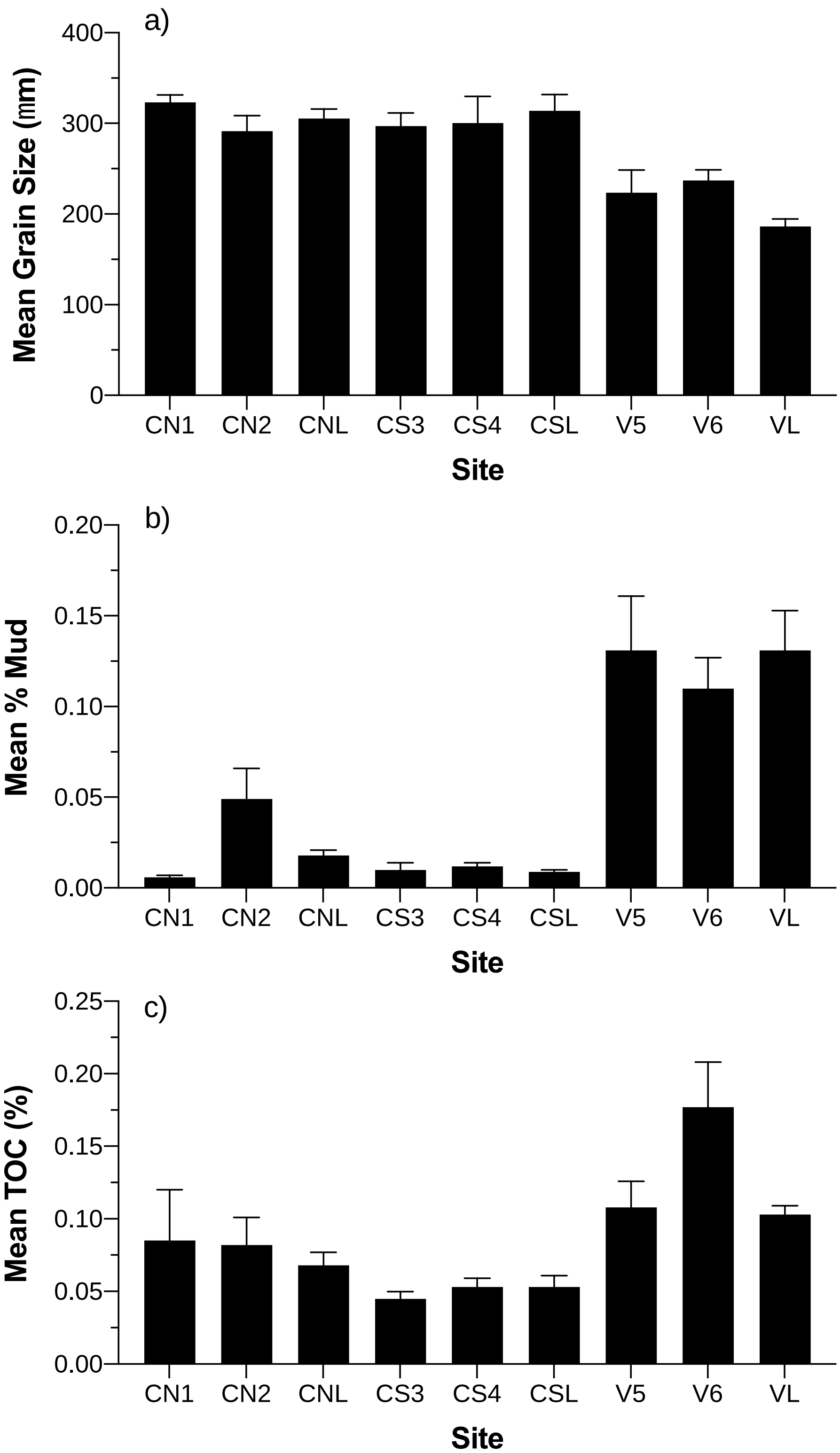

Figure 4.1. Mean (+ SE) of (a) grain size (µm), b) percentage mud and c) percentage total organic carbon (TOC, %) for each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

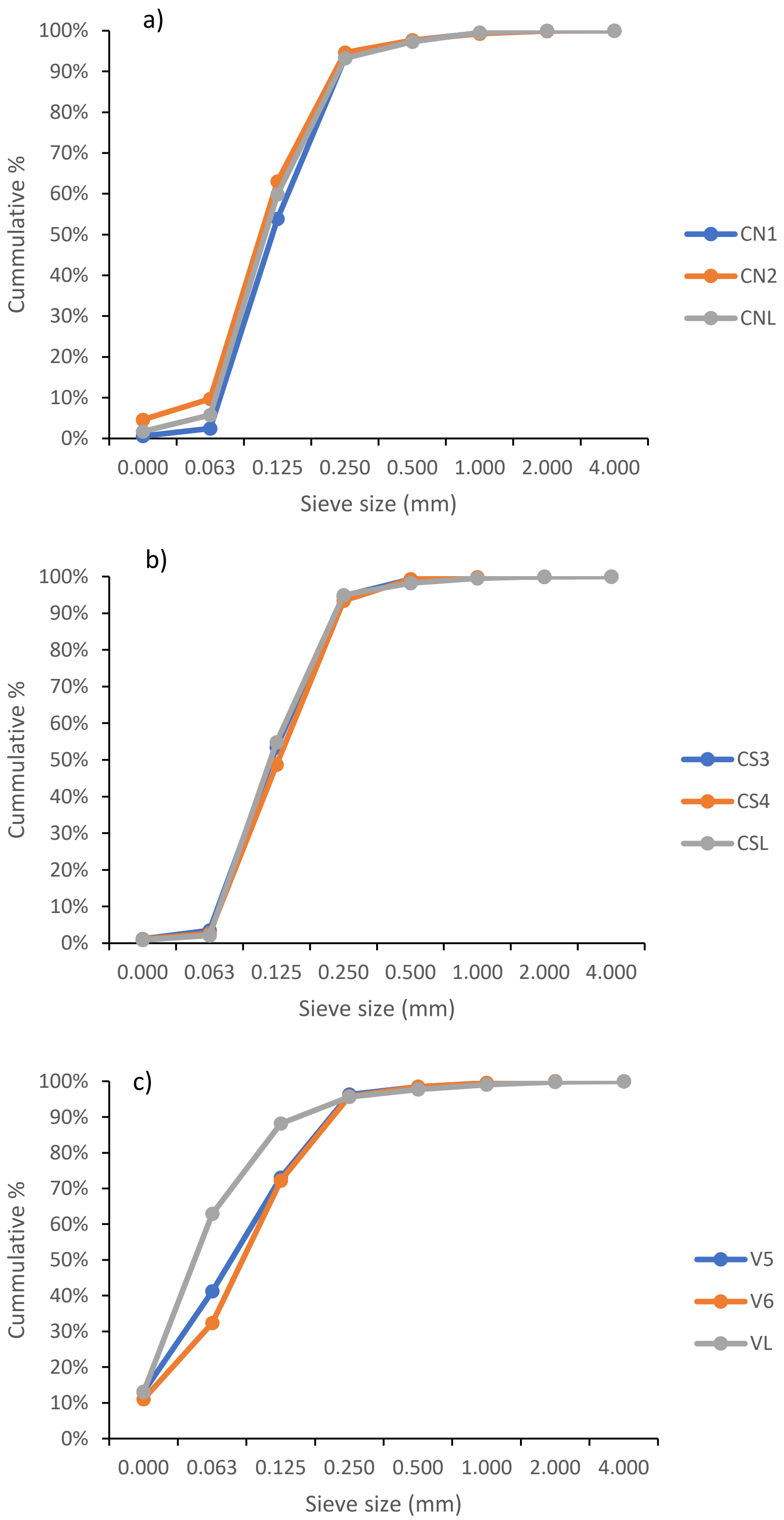

Figure 4.2. Cumulative percentage (%) grain size for (a) Callala North, (b) Callala South and (c) Vincentia locations for each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

4.2. Benthic macroinvertebrates

4.2.1. Collection and treatment

All samples containing benthic macroinvertebrates were stored on ice upon collection and sieved through a 1 mm mesh brass sieve within one day of collection onsite at the South Coast Mariculture Operations shed (Figure 4.3). The residue on the sieve – which contained macroinvertebrates, small amounts of sediment, some algae and shell grit (Figure 4.3) was generally less than 200 mL in volume. Samples were stored separately in 70% ethanol (500 ml containers) and transported to UoN Ourimbah campus for subsequent laboratory examination.

Figure 4.3. Sampling of benthic macroinvertebrate samples, showing (left) sieving set up – including tray for sieves, basin for rinsing (on top of blue drums), ethanol container (on vehicle tailgate) and (right) benthic macroinvertebrates on a 1 mm sieve, with a heart urchin at bottom right and a pteriid bivalve in the upper part.

Once in the laboratory, each sample was rinsed with water through a fine-mesh sieve (250 µm), such that all material was retained and then examined under a dissecting microscope. Animals were removed using fine forceps (picking), identified (sorting) and each of the different taxa then counted and entered directly into Microsoft Excel™. Taxa were identified to family level for polychaetes, bivalves and gastropods and certain crustaceans, and to order, class or phylum for other taxa – the level depended on the intactness of the specimen and the taxonomic references available, including Fauchald (1977), Beasley et al. (1998), Underwood and Hoskin (1999), Jansen (2000) and Poore (2004), as well as online keys – Grove and de Little (2017) and Wilson et al. (2017). A reference collection with the different taxa was built during the sorting and enumeration processes.

4.2.2. General description

Summaries of the abundances of the main taxa for each site, their totals across all sites and percentage contributions to the totals at each site are shown in Table 4.2, with raw data provided in Appendix E.

A total of 5127 benthic macroinvertebrates was recorded overall. Site CN.C1 (252) had the lowest abundance, increasing to 388-412 (CN.L and CS.L), 501-568 (CN.C2, CS.C3, CS.C4 and V.C6), 738 (V.L) and the highest at site V.C5 (1237) (Table 4.1). The Crustacea contributed 44.9% overall, with the greatest contributions from gammarid amphipods (31.8%), followed by the Mollusca (39.5%) of which the vast majority was bivalves (28.4%), mainly belonging to the Family Pteriidae (27.3%). Polychaetes contributed 13.5%, of which no family was particularly dominant overall, and Echinodermata (1.2%), which mainly comprised loveniids (heart urchins). There were some differences within the contributions of the different taxa at the different sites (Table 4.1).

4.2.3. Univariate analyses

The number of benthic macroinvertebrate taxa at the lowest possible taxonomic level, which varied among the different phyla, subsequently termed taxa richness and the total abundance of benthic macroinvertebrates were each analysed using one-way ANOVA with Site as the factor. Levene's test showed that the taxa richness had similar variances across each group (Levene's$_{8,45}$ = 1.412, P = 0.180), and thus no transformation was applied. This same test showed that the total abundance of benthic macroinvertebrates had significantly different variances across groups (Levene's$_{8,45}$ = 3.144, P = 0.007), but the extent of these differences were reduced (but still significant) following $\log_{10}$ transformation (Levene's$_{8,45}$ = 2.341, P = 0.034). As this was still significant, the von Bonferroni correction was applied, i.e. significance in the ANOVA test only if P<0.01 rather than P<0.05.

One-way ANOVA showed that the taxa richness differed significantly with Site (Table 4.2). Tukey's HSD test showed that taxa richness was significantly greater at all sites at Vincentia (V.C5, V.C6 and V.L) in comparison to CN.C1, CN.L, CS.C3, CS.C4, CS.CL, and for V.C6 vs CN.C2, with no significant differences between any of the Vincentia sites. The mean taxa richness ranged between 9 and 14 in both CN and CS locations, being greatest at CN.C2 (14) but was 19 or greater in all Vincentia sites (Fig. 4.4a).

One-way ANOVA found no significant difference in the total abundance between Site (Table 4.2). The mean abundances were lowest at CN.C1 (42), highest at V.C5 (206) and ranged between 65 and 123 for the remaining seven sites (Fig. 4.4b).

Table 4.1. Numbers of the benthic macroinvertebrates for each higher-level taxa (bold) and important taxa groups (non-bold) for selected higher-level taxa, and the total and percentage contribution of each to the overall fauna for each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

MACROINVERTEBRATES	CN.C1	CN.C2	CN.L	CS.C3	CS.C4	CS.L	V.C5	V.C6	V.L	Total	%
Other invertebrate phyla (4)	**10**	**4**	**5**	**3**	**0**	**5**	**2**	**9**	**3**	**41**	**0.7**
Annelida: Polychaeta	**39**	**85**	**39**	**20**	**22**	**36**	**129**	**226**	**97**	**693**	**13.5**
Polychaeta: Cirratulidae	-	10	-	-	-	-	4	67	2	83	**1.6**
Polychaeta: Glyceridae	12	18	13	12	10	13	11	14	14	117	**2.3**
Polychaeta: Magelonidae	-	-	-	1	1	-	21	23	32	78	**1.5**
Polychaeta: Nephtyidae	2	10	1	1	-	2	3	11	2	32	**0.6**
Polychaeta: Onuphidae	12	3	-	-	-	-	26	15	8	64	**1.2**
Polychaeta: Orbiniidae	-	-	7	-	6	4	2	26	6	51	**1.0**
Polychaeta: Oweniidae	-	18	5	-	2	3	1	-	1	30	**0.6**
Polychaeta: Sabellidae	5	2	2	-	-	-	12	26	5	47	**0.9**
Polychaeta: Spionidae	6	1	2	-	1	9	14	5	1	39	**0.8**
Polychaeta: other families	2	23	9	6	2	5	35	39	26	165	**3.2**
Mollusca (Total)	**26**	**340**	**18**	**234**	**216**	**64**	**823**	**110**	**196**	**2027**	**39.5**
Mollusca: Bivalvia	**26**	**339**	**7**	**228**	**212**	**58**	**813**	**104**	**184**	**1971**	**38.4**
Bivalvia: Galeommatidae	5	1	-	62	-	-	-	-	-	68	**1.3**
Bivalvia: Mesodesmatidae	2	53	5	19	41	52	64	74	120	430	**8.4**
Bivalvia: Pteriidae	7	281	-	143	169	2	737	12	48	1399	**27.3**
Bivalvia: Veneridae	7	2	1	-	-	-	2	3	2	17	**0.3**
Bivalvia: other families	5	2	1	4	2	4	10	15	14	57	**1.1**
Mollusca: Gastropoda	**-**	**1**	**-**	**6**	**4**	**2**	**5**	**5**	**9**	**32**	**0.6**
Gastropoda: Marginellidae	-	1	-	4	2	2	-	2	6	17	**0.3**
Gastropoda: other families	-	-	-	2	-	-	5	3	3	13	**0.3**
Mollusca: Scaphopoda	**-**	**-**	**11**	**-**	**-**	**4**	**5**	**1**	**3**	**24**	**0.5**
Pycnogonida	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4**	**4**	**<0.1**
Crustacea (Total)	**174**	**92**	**340**	**308**	**261**	**275**	**271**	**148**	**433**	**2302**	**44.9**
Crustacea: Ostracoda	**6**	**30**	**13**	**59**	**57**	**11**	**47**	**25**	**31**	**279**	**5.4**
Crustacea: Amphipoda	**106**	**48**	**270**	**224**	**171**	**241**	**184**	**58**	**329**	**1631**	**31.8**
Amphipoda: Gammaridea	106	47	270	224	171	240	146	56	139	1399	**27.3**
Amphipoda: Caprellidae	**-**	1	**-**	-	-	1	38	2	190	232	**4.5**
Crustacea: Isopoda	**46**	**8**	**42**	**10**	**18**	**8**	**20**	**37**	**61**	**250**	**4.9**
Isopoda: Anthurida	44	3	41	10	17	8	16	27	20	186	**3.6**
Isopoda: Arcturidae	1	2	-	-	-	-	2	6	41	52	**1.0**
Isopoda: other classes	1	3	1	1	1	-	2	4	-	13	**0.3**
Crustacea: Cumacea	**6**	**1**	**12**	**11**	**9**	**12**	**12**	**17**	**7**	**87**	**1.7**
Crustacea: Tanaidacea	**10**	**1**	**1**	**3**	**-**	**-**	**4**	**-**	**-**	**19**	**0.4**
Crustacea: Decapoda	**-**	**4**	**2**	**1**	**6**	**3**	**4**	**11**	**5**	**36**	**0.7**
Decapoda: Caridae	-	3	2	1	6	3	2	5	-	22	**0.4**
Decapoda: other families	-	1	-	1	-	-	2	6	-	10	**0.2**
Echinodermata (Total)	**3**	**1**	**12**	**2**	**1**	**10**	**14**	**10**	**7**	**60**	**1.2**
Echinodermata: Loveniidae	3	1	11	1	-	10	11	6	5	48	**0.9**
Echinodermata: others	-	-	1	1	1	-	3	4	2	12	**0.2**
TOTAL	**252**	**522**	**412**	**568**	**501**	**388**	**1237**	**509**	**738**	**5127**	

Table 4.2. Results of one-way ANOVA of Site of the taxa richness and the total abundance of benthic macroinvertebrates obtained from six replicate grabs at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019. Df, degrees of freedom; MS mean squares. Significant values are in bold.

Source	Df	MS	F	*P*
Taxa richness				
Site	8	171.25	11.437	**0.000**
Residual	45	14.974		
Total abundance				
Site	8	0.188	1.916	0.081
Residual	45	0.098		

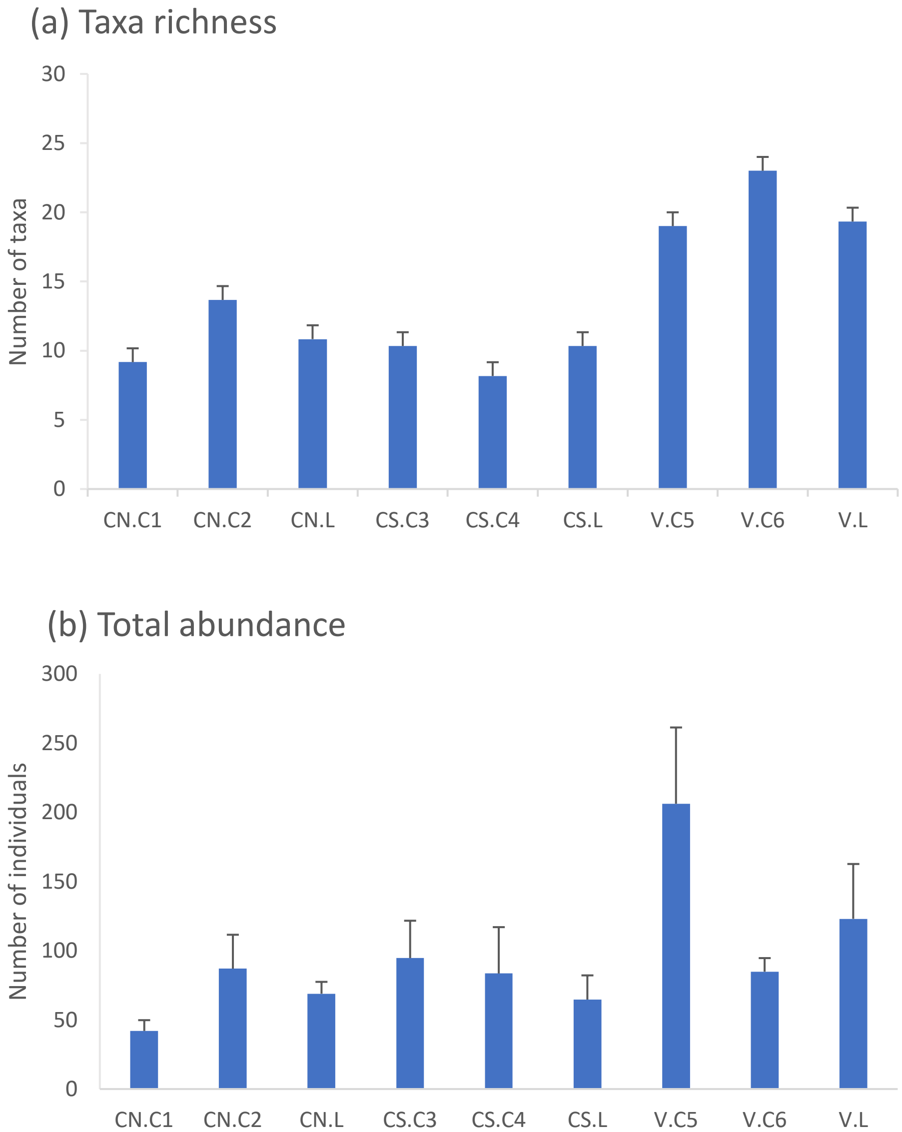

Figure 4.4. Mean (+ SE) taxa richness (a) and the total abundance of benthic macroinvertebrates (b) obtained from six replicate grabs at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

4.2.4. Multivariate comparisons

The abundances of the various benthic macroinvertebrate taxa recorded for the 54 samples were imported from Excel to PRIMER 7 (Clarke and Gorley, 2016), each $\log_{10}$ transformed and the Bray-Curtis measure used to calculate a similarity matrix. This matrix was analysed using one-way PERMANOVA (Anderson et al., 2008), with the single factor of Site, for both a main and pairwise test, using unrestricted permutations of the raw data and Type III sums of squares.

PERMANOVA showed that there was a significant overall difference in the benthic macroinvertebrate faunas between the nine sampling sites (P = 0.001, Table 4.3). Pairwise PERMANOVA showed that significant differences existed between all pairs of sampling sites, except CN and CS Lease sites (P = 0.094) and CS.C4 vs both CS.C3 (P = 0.194) and CS.L (P = 0.092).

Table 4.3. Results of one-way PERMANOVA, based on Site, of the Bray-Curtis similarity matrix derived from the $\log_{10}$ transformed abundances of the benthic macroinvertebrate taxa obtained from six replicate grabs at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019. Df, degrees of freedom; MS, mean squares. Significant values are in bold.

Source	Df	MS	Pseudo-*F*	*P* (perm)
Site name	8	4722.2	4.418	**0.001**
Residual	45	1069.0		
Total	53			

On the nMDS ordination plot generated from the same similarity matrix, which provides a visual representation of that similarity matrix in two-dimensional space, it is evident that the six replicate samples from each of the sampling sites tend to lie in close association with each other (except for Replicate 4 from CS.L and Replicate 5 from V.C5) and, for each site, tend to lie in a different part of the plot to each other (Fig. 4.5). It is also clear that the sites for the three leases (square symbols) lie in the centre line of the plot, those for Vincentia (blue) mostly lie to the right or beneath those for both Callala North (green) and Callala South (red).

One control site for Callala North (CN.C2, green triangles) forms a group distinct from the other control and lease sites for that sampling location (CN.C2 and CN.L, green circles and squares, respectively) (Fig. 4.5). There is also some overlap between the replicate samples for both CN Lease and CS Lease (green and red squares), and between CS Control 4 (red triangles) and both CS Control 3 (red circles) and CS Lease (red squares).

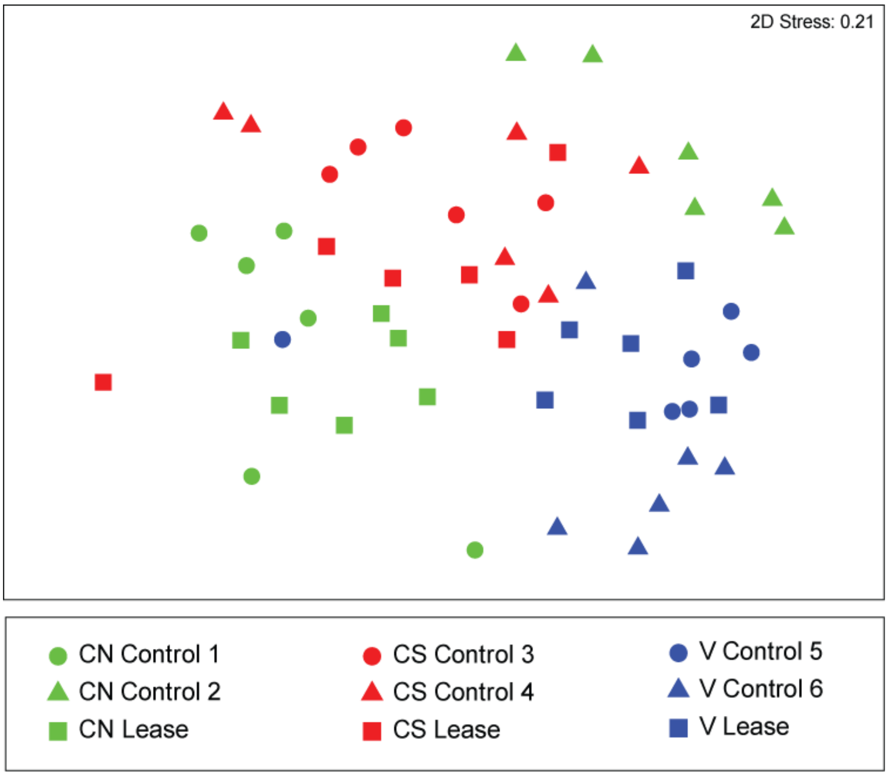

Figure 4.5. nMDS ordination of the Bray-Curtis similarity matrix derived from the log_{10} transformed abundances of the benthic macroinvertebrate taxa obtained from six replicate grabs at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

SIMPER analyses (Clarke and Gorley, 2016) were used on the abundances and occurrences of the benthic macroinvertebrate taxa to firstly identify the taxa that typified the fauna at the different sites, i.e. those in which their cumulative abundances add up to at least 70% of the total abundances recorded at the site. SIMPER was also used to identify the benthic macroinvertebrate taxa that contribute most to the differences between sites, i.e. distinguishing taxa, representing those that are found in consistently higher or lower densities in different pairwise comparisons of sites. These analyses were used to compare the fauna at the sites within each of the three locations, Callala North, Callala South and Vincentia (Appendix Fa,b and c), and between the three Lease sites (Appendix Fd).

These results collectively showed that gammarid amphipods were the most important of the typifying taxa at all nine sampling sites, with other common typifying taxa including glycerid polychaetes, anthurid isopods, pteriid and mesodesmatid bivalves. Although loveniid echinoderms (heart urchins) were conspicuous upon collection, they typified only the benthic macroinvertebrate fauna at the CN.L site.

For Callala North, the faunas at the Lease site (CN.L) were distinguished from both Control sites (CN.C1 and CN.C2) by having consistently greater abundances of gammarid amphipods (Appendix Fa). These faunas were further distinguished from CN.C1 by more scaphopods and loveniids, and from CN.C2 by more anthurid isopods and consistently lower abundances of pteriid and mesodesmatid bivalves (Appendix Fa).

For Callala South, the faunas at the Lease site (CS.L) were distinguished from those of only one control sites (CS.C3), as CS.C4 did not show a significant difference (see above), by having consistently greater numbers of ostracod crustaceans and galeommatid and pteriid bivalves, and fewer mesodesmatid bivalves (Appendix Fb).

For Vincentia, there were consistently higher numbers of individuals of the typifying taxa for the three sites at this location than for any of the sites for either Callala North or Callala South (Appendix Fc). There were consistently greater abundances of arcturid isopods and caprellid amphipods at the Lease site (V.L) in comparison to the two control sites (V.C5 and V.C6), while a greater number of pteriid bivalves were recorded at V.L than at V.C6 but the opposite was true for V.C5 (Appendix Fc).

For comparisons between Lease sites, Vincentia (V.L) had consistently greater numbers of caprellid amphipods, mesodesmatid and pteriid bivalves, magelonid polychaetes and arcturid isopods but fewer gammarid amphipods than both Callala North and Callala South (CN.L and CS.L) (Appendix Fd).

5. Fish

5.1. Methods of observation and video analysis

Fish communities were investigated using baited remote underwater video systems (BRUVS), consisting of a GoPro camera mounted on a 5 kg free weight, attached to a 50 cm PVC pipe at the end of which a mesh bait bag was attached (Figure 5.1). A 15-20 m rope, with a marked float, was attached to the 5 kg weight for easy retrieval. Four separate BRUVS were baited with 3-4 crushed pilchards and deployed within 200 m of the centre point of each sampling site for a period of 30 min. The six northern sites were sampled on 10 July and the three Vincentia sites on 11 July 2019 – with all cameras retrieved.

Figure 5.1. BRUVS setup, showing the float and rope, 5 kg weight, attached GoPro and PVC arm – bait bag not shown. Photo by Hika Rountree.

Video footage was downloaded from each GoPro, placed on the UoN Marine Research cloud storage into clearly marked folders and later viewed using Event Measure™ to determine the species present at each sampling site and their MaxN (maximum number of fish viewed at any one time) recorded. To assist with species identifications and correct nomenclature for fishes, Kuiter (1990), Gomon et al. (2008) and FishBase (2020) were used, while for the invertebrates, Edgar (1997) was used.

5.2. General description

Of the 36 BRUVS drops, eight did not return usable footage, with the water either being too turbid, or by having fell in awkwardly (sometimes vision obscured by algae). Thus, all CN sites, CS.C3 and V.C5 had four replicates for each site, with three for each of V.C6 and V. L. and one only for both CS.C4 and CS.L (Appendix G).

At least 19 species and a total of 805 organisms were observed, including 14 sharks, 39 rays, 735 bony fishes and 12 invertebrates (Table 5.1). The most numerous fish was Yellowtail Scad (687), in which large schools were observed at all sites except CN.C1. Next most abundant were the Flathead (32) and Eastern Fiddler Ray (30), both of which were observed at all sites. Echinoderms and molluscs were occasionally observed and made low contributions (Table 5.1). The dominant presence of Yellowtail Scad was also documented by Rees et al. (2018) in their extensive study of fishes in Jervis Bay using BRUVS, and who recorded 21 fish species over unvegetated substrates.

Table 5.1. MaxN of the sharks, rays, fish and invertebrate taxa, overall, for the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019.

Main groups	Common Name	Species Name	Number
Sharks	Port Jackson Shark	*Heterodontus portusjacksoni*	13
	Gummy Shark	*Mustelus antarcticus*	1
Rays	Black Stingray	*Bathytosia lata*	2
	Common Stingaree	*Trygonoptera testacea*	4
	Eastern Fiddler Ray	*Trygonorrhina fasciata*	30
	Eastern Shovelnose Ray	*Aptychotrema rostrata*	1
	Southern Eagle Ray	*Myliobatis tenuicaudatus*	2
Fish	Flathead	*Platycephalus* spp.	32
	Broken-line Wrasse	*Stethojulis interrupta*	10
	Unknown Wrasse		2
	Fanbelly Leatherjacket	*Brachaluteres jacksonianus*	1
	Orange-spotted Puffer	*Torquigener vicinus*	2
	Sand Whiting	*Sillago ciliata*	1
	Yellowtail Scad	*Trachurus novaezelandiae*	687
Molluscs	Sea Snail		10
	Octopus	*Octopus australis*	2
Echinoderms	Common Seastar	*Luidia australiae*	2
	Brittle Star	*Ophionereis schayeri*	2
	Brittle Star	*Allostichaster polyplax*	1
		Total	**805**

5.3. Univariate analyses

The number of fish taxa (taxa richness) and the total MaxN of fish were each analysed using one-way ANOVA with Site as the factor, using those sites for which there was either 3-4 replicates, i.e. excluding CS.C4 and CS.L. Levene's test showed that both = taxa richness and total MaxN had similar variances across each group (Levene's$_{6,18}$ = 1.330 and 1.919, *P* = 0.295 and 0.133, respectively), and thus no $\log_{10}$ transformation was applied.

One-way ANOVA of the seven remaining sites did not detect a significant difference with Site for either taxa richness or total MaxN (*P* = 0.855 and 0.960, respectively), and there was a relatively large amount of variation not accounted for by Site (Table 5.2). The mean taxa richness ranged from 2 (V.C6) to 3.5 (CN.C1 and CN.C2) and the total MaxN from 4.5 (CN.C1) to between approximately 30-40 (other six sites), with large standard errors observed (Fig. 5.2). For those sites with only one replicate, six taxa and 43 fish were recorded for CS.C4, and two taxa and four fish from CS.L.

Table 5.2. Results of one-way ANOVA of Site of the taxa richness and the total MaxN of sharks, rays and fishes (b) obtained from up to four replicate BRUVS (single values only for CS.C4 and CS.L) for the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019. Df, degrees of freedom; MS mean squares. Significant values are in bold.

Source	Df	MS	F	*P*
Taxa richness				
Site	6	0.924	0.422	0.855
Residual	18	2.190		
Total MaxN				
Site	6	558.7	0.232	0.960
Residual	18	2406.6		

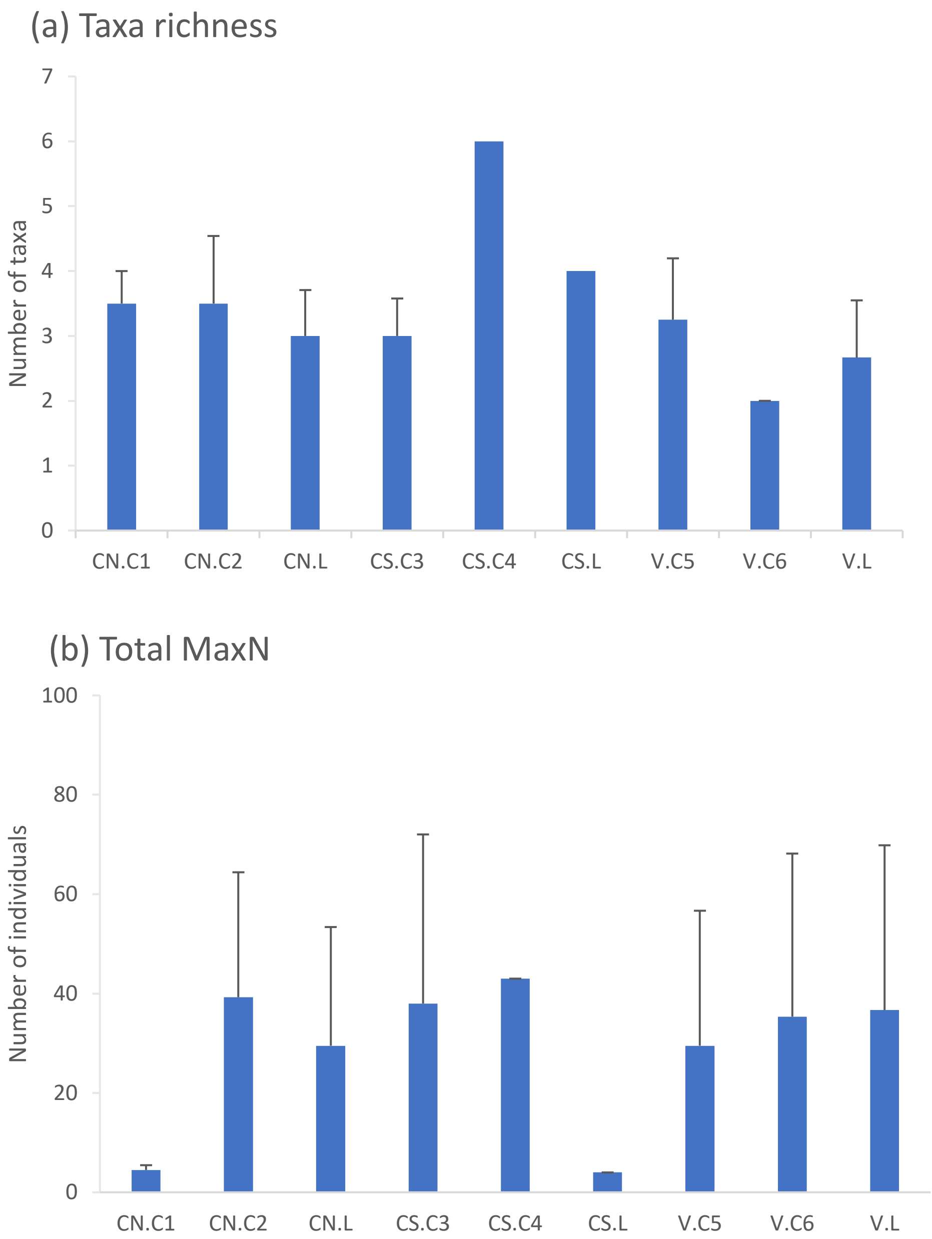

Figure 5.2. Mean (+ SE) taxa richness (a) and the total MaxN of of the sharks, rays and fishes (b) obtained from up to four replicate BRUVS (single values only for CS.C4 and CS.L) for the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019.

5.4. Multivariate analyses

Multivariate analyses were used to examine for trends in the fish assemblages (including fish, sharks and rays), using samples from all sites as such analyses cope better with unbalanced replication. Invertebrates were excluded from the analyses, as they were not the focus of this report. Note that one sample recorded only invertebrates (CS.C3.2).

The MaxN of the different sharks, rays and fishes recorded for the 27 samples were imported from Excel to PRIMER 7 (Clarke and Gorley, 2016), each $\log_{10}$ transformed and the Bray-Curtis measure used to calculate a similarity matrix. This matrix was analysed using one-way PERMANOVA (Anderson et al., 2008), with the single factor of Site, for both a main and pairwise test, using unrestricted permutations of the raw data and Type III sums of squares.

PERMANOVA showed that there was a significant overall difference between the fish assemblages between the nine sampling sites (P = 0.022, Table 5.3). Pairwise PERMANOVA showed that significant differences existed only between CN.C1 and the four other sites, i.e. CN.C2, CN.L., V.C6 and V.L. (P = 0.022-0.029), which represented those sites in which there was full replication.

Table 5.3. Results of one-way PERMANOVA, based on Site, of the Bray-Curtis similarity matrix derived from the $\log_{10}$ transformed MaxN of the various sharks, rays and fish obtained from up to four replicate BRUVS at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019. Df, degrees of freedom; MS, mean squares. Significant values are in bold.

Source	Df	MS	Pseudo-*F*	*P* (perm)
Site name	8	3398.6	2.032	**0.02**
Residual	18	1672.8		
Total	26			

On the nMDS ordination plot generated from the same similarity matrix used for PERMANOVA, the four replicate samples from CN.C1 lie close together on the left of the plot, with those for the other sites lying scattered over the rest of the plot (Fig. 5.3). It is obvious that the samples for CN.C2 and CN.L lie well away from those of CN.C1, and intermingled with the samples from all CS sites and there is a tendency for the three points for V.L to lie below the others (Fig. 5.3).

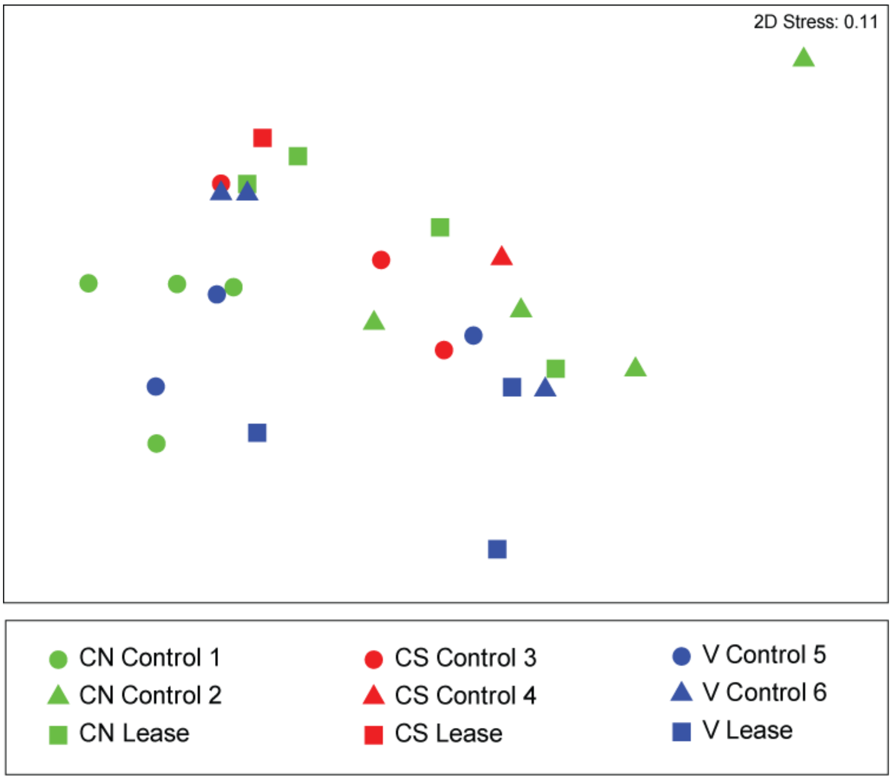

Figure 5.3. nMDS ordination of the Bray-Curtis similarity matrix derived from the log_{10} transformed abundances of the sharks, rays and fishes observed in up to four replicate BRUVS at each of the nine sites for the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019.

SIMPER analyses (Clarke and Gorley, 2016) were used only where PERMANOVA showed significant differences, i.e. between CN.C1 versus CN.C2, CN.L., V.C6 and V.L. The MaxN and occurrences of the various shark, ray and fish taxa were used to firstly identify the taxa that typified the fauna at those sites and then to identify those that contribute most to the differences between sites, i.e. distinguishing taxa.

These results showed that the fauna at CN.C1 was typified by Port Jackson Shark and flathead, with Port Jackson sharks also being consistently more abundant at CN.CL than the other four sites, and this was also true for flathead, except at CN.CL. Other sites were typified by the Yellowtail Scad (CN.C2 and V.L), Eastern Fiddler Ray (CN.L and V.C6) and the Broken-lined Wrasse (CN.C2). Full results are in Appendix Ha, b and c.

6. Summary and conclusions

Baseline sampling of the water quality and seabed environment at the pre-existing southern (Vincentia, V) and new northern (Callala North and Callala South, CN & CS) lease sites, with two associated controls for each lease demonstrated the following:

Water depth: Ranged between 8.5 m (Vincentia Lease) and 14.2 m (Callala North Control 2).

Water quality: Varied little among the nine sites and between bottom and surface waters. Average salinity was that of seawater (35-36), waters were cool (15°C), pH was typical (8.4) and waters were well-oxygenated (95 to 100%).

Seabed ROV: Seabed was characterised by pale sand, small attached macrophytes and drift algae and observations of stingarees, seastars, flathead and seapens. Differences between sites were related to the presence of branching sponges (CN.C1), extensive drift algae rows (CN.C2, CS.C3 & CS.C4), and the presence of bioturbation and limited drift algae (Vincentia location). The drift algae rows are also likely to be associated with apogonid fish (not detected in BRUVS) and pteriid bivalves (readily detected in the benthic macroinvertebrate grabs)

Sediments: Grain sizes were similar within each of the three study locations, but finer sediments, containing a greater %mud and %TOC were recorded at Vincentia study location. It is noted that the scope of future sampling will be dictated by any changes in %TOC from Baseline, as outlined in the South Coast Mariculture (2015) Benthic Monitoring Plan for Jervis Bay.

Benthic macroinvertebrates: The 5127 benthic macroinvertebrates were dominated by crustaceans (45%), bivalve molluscs, mainly associated with drift algae (40%) and polychaetes (13%), with heart urchins being relatively large and conspicuous, but contributing <1% to all animals. Taxa richness was greatest at the Vincentia location, while the numbers of animals did not differ consistently between the nine sites. All replicate collections were successful, and the benthic macroinvertebrate assemblages showed obvious differences between the Vincentia lease vs the other lease locations, and significant differences were recorded between most sites. It is noted that the scope of future sampling will be dictated by any changes in the mean TOC from Baseline, as outlined in the South Coast Mariculture (2015) Benthic Monitoring Plan for Jervis Bay. It is also recognised that, following 18 months of mussel long-lining in a nearby embayment, no consistent infaunal effects from this aquaculture were reported (Lasiak et al., 2006) and that the infaunal taxa in this bay were not conspicuously different from those in that older study.

Fish: 19 species and 805 organisms were observed, mainly fish and particularly large schools of Yellowtail Scad (687), with small numbers of flathead and Eastern Fiddler Ray observed at all sites. Although the detection of significant differences among the fish assemblages at the nine sites was affected by eight of the 36 drops being unusable and one recording only invertebrates, it was evident that differences occurred, e.g. Port Jackson sharks were more abundant at CN.C1.

The results from this Baseline Study provide a robust background, based on water quality, gross seabed characteristics, sedimentary characteristics (including % TOC), benthic macroinvertebrates and fish, against which any potential future changes from mussel aquaculture activities can be detected. It is noted that sampling is to be continued at the same time of year (winter), with the next occasion expected to be in July 2020.

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8. Appendices

Appendix A: Sampling

Sampling in (a) original Benthic Monitoring Plan and (b) extended plans by UoN

(a) Original sampling planned:

1. 6 replicate samples of Total Organic Carbon (TOC) from each of the nine sites.
2. 6 replicate samples of benthic macroinvertebrates from each of the nine sites.

(b) Further sampling agreed to:

1. Surface and bottom measurements of water quality at each of the nine sites.
2. Measurements of sediment granulometry at each of the nine sites.
3. 4 replicate Baited Underwater Remote Video Systems at each of the nine sites.
4. 4 replicate 2 min ROV visualisations of the seabed at each of the nine sites.

Appendix B: Water quality raw data

Water quality parameters measured at the surface and bottom of the water column for the nine sites at the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

Site Code	Water column	Temperature (°C)	Salinity	pH	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)
CN.C1	Surface	14.95	36.2	8.33	5.9	8.27	106.0
CN.C2	Surface	15.21	36.5	8.38	10.6	7.32	94.6
CN.L	Surface	15.51	36.2	8.41	9.9	6.85	88.8
CS.C3	Surface	14.64	33.7	8.39	7.6	7.90	101.7
CS.C4	Surface	15.50	36.1	8.36	4.8	6.81	88.0
CS.L	Surface	15.16	35.1	8.38	4.0	7.11	91.7
V.C5	Surface	15.87	36.0	8.36	6.3	6.87	89.6
V.C6	Surface	16.67	36.1	8.38	4.1	7.94	105.1
V.L	Surface	15.98	36.4	8.37	13.8	7.22	94.4
CN.C1	Bottom	15.51	36.2	8.35	13.2	8.28	107.9
CN.C2	Bottom	15.87	36.4	8.38	14.6	8.43	109.7
CN.L	Bottom	15.65	36.3	8.30	9.4	8.75	103.6
CS.C3	Bottom	14.64	36.3	8.39	7.6	7.45	96.2
CS.C4	Bottom	15.67	36.2	8.38	6.2	7.16	93.1
CS.L	Bottom	15.58	36.2	8.38	7.6	6.72	87.2
V.C5	Bottom	16.13	36.5	8.40	4.9	7.23	94.9
V.C6	Bottom	16.42	36.4	8.41	4.5	8.50	112.6
V.L	Bottom	16.14	36.3	8.39	5.6	7.42	97.3

Appendix C: ROV raw data

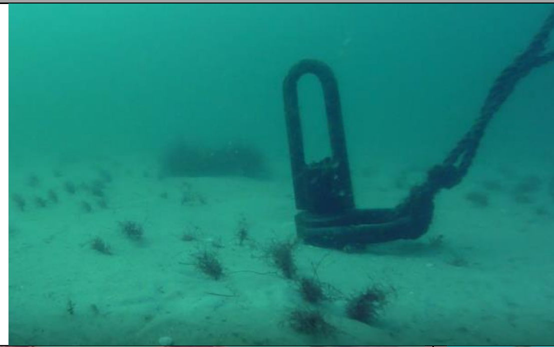
Details of the ROV footage at each replicate site, for the South Coast Mariculture operations in Jervis Bay, recorded 10 July 2019. Note that a question mark before the name of an organism indicates that this name is most likely to be accurate, but its identificiation cannot be confirmed owing to key features not being observed.

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CN.C1.1	08.51.44	3:20	Control	**Seabed**: Rippled pale sand, some shell debris **Fauna**: Large seapen (0:40), occasional, sometimes large, branching sponge (1:47, 2:01, 2:15, 2:19, 2:31) **Flora**: Sparse drift algae	
CN.C1.2	08.55.12	2:52	Control	**Seabed**: Rippled pale sand, some shell debris, inc. unid (0:56, 1:45) and scallop (1:25), occasional feeding pits **Fauna**: Occasional branching sponges (,0:28, 0:30, 0:43, 1:01 to 1:13, see right, 1:25, 1:52; 2:24, 2:38), seapen (1:06, 1:56), large *Luidia* seastar (1:56) **Flora**: Sparse drift algae and small attached macrophytes	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CN.C1.3	08.58.14	1:54	Control	**Seabed**: Rippled pale sand, some shell debris, inc. scallop shells, occasional feeding pits **Fauna**: Occasional branching sponges but more developed than in other videos (0:00 to 0.25), small fish over sponge (0:25, see right), large *Luidia* seastar (1:00), stingaree *Urolophus cruciatus* (1:00), small flathead (1:38), wormtube (1:49) **Flora**: A few larger attached macrophytes (0:25), limited small attached macrophytes, sparse drift algae	
CN.C1.4	09.00.14	2:49	Control	**Seabed**: Rippled pale sand, some shell debris (large shell 1:21, 1:50), occasional feeding pits **Fauna**: Occasional branching sponges (0:12; 0:26; 1:03; 1:44), corals, flathead (0:08, 0:23), partially buried ray fleeing (0:36, 1:37), orange sessile organism, perhaps seapen, on sponge (1:05, see right), suspected encrusting sponges (2:18), wormtube (2:39) **Flora**: Sparse drift algae, limited small attached macrophytes, a few larger accumulations of drift algae	
CN.C2.1	08.15.22	3:32	Control	**Seabed**: Rippled pale sand patches between drift algae, small rock outcrop (2:22) **Fauna**: One fish (3:18) **Flora**: Dense rows of drift algae (see right), high and profuse in places	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CN.C2.2	08.20.02	3:27	Control	**Seabed**: Rippled pale sand patches **Fauna**: School of 100+ pelagic fish (1:20), suspected sandy sprat, apogonid (2:50), large flathead (3:07), suspect *Platycephalus bassensis* **Flora**: Dense rows of drift algae, high and profuse in places. When ROV light activated, appears as composed entirely of red algae (1:07) with white encrusting bivalves (suspect pteriid) (3:20, see lower right of image)	
CN.C2.3	08.23.43	2:07	Control	**Seabed**: Rippled pale sand patches **Fauna**: Small fish (0:07, 1:57), fanbellied leatherjacket *Monacanthus chinensis* (0:10, see lower middle of image right), school of apogonids over algae (0:33) **Flora**: Dense rows of red drift algae, high and profuse in places, with white encrusting organisms	
CN.C2.4	08.26.26	3:33	Control	**Seabed**: Rippled pale sand patches **Fauna**: School of apogonids over algae (0:26, 1:13, 1:43) and sand (1:59), wrasse (1:11), school of pelagic carangids (3:01, see right), *Luidia* seastar (3:08) **Flora**: Dense rows of red drift algae, high and profuse in places, with many white encrusting organisms	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CN.CL.1	09.52.50	2:22	Lease	**Seabed**: Rippled pale sand, little shell debris, frequent feeding pits **Fauna**: Suspected soft corals, small slender fish (0:28), swimming aplysiid (0:46, to right) **Flora**: Small/medium attached macrophytes, sparse drift algae, a few larger accumulations of drift algae	
CN.CL.2	09.55.21	3:25	Lease	**Seabed**: Rippled pale sand, little shell debris, occasional feeding pits (to right of image) **Fauna**: Medium fish (0:05), large seapen (0:46), 2 x *Luidia* seastars (2:51, 3:00) **Flora**: Small attached macrophytes, sparse drift algae, a few larger accumulations of drift algae	
CN.CL.3	09.58.54	3:09	Lease	**Seabed**: Rippled pale sand, little shell debris, occasional feeding pits **Fauna**: *Luidia* seastar (0:10, see right), swift small fish (1:09) **Flora**: Small attached macrophytes, sparse drift algae, a few larger accumulations of drift algae	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CN.CL.4	10.02.11	4.08 (first part 2:07)	Lease	**Seabed**: Rippled pale sand, little shell debris, occasional feeding pits, mooring sighted (2:07, see right) **Fauna**: None observed **Flora**: Small attached macrophytes, sparse drift algae, some larger drift algae (e.g. 2:07, see also right)	
CN.CL.4	10.02.11	4.08 (second part 2:01)	Lease	**Mooring base: S**corpaenid on top (see right) **Mooring** line: Some algal growth (3:05), more extensive towards surface (3:15, see right) **Mooring top**: Two floats clearly seen	 
CN.CL.	10.35.57	11:02 (up to 3:55 informative)	Lease	**Inspection of underwater infrastructure** See right for example.	

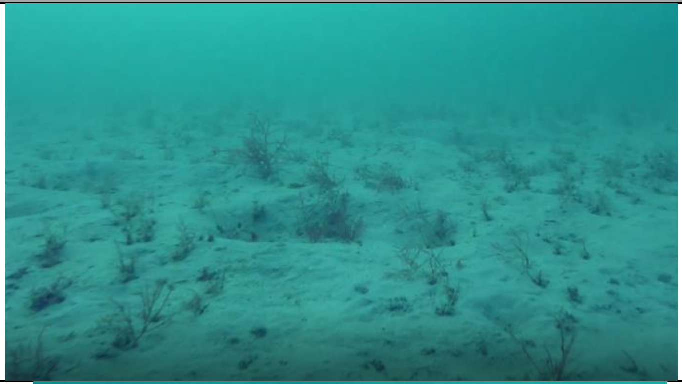
Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CS.C3.1	10.48.06	3:07	Control	**Seabed**: Rippled pale sand patches between drift algae **Fauna**: Large branching sponge (0:23, 2:27), small fish, suspect apogonids/labrids (0:20-0:30), school of apogonids (2:13) **Flora**: Dense rows of drift algae, appears a mixture of red and green/brown branching algae, some white encrusting organisms, small attached macrophytes	
CS.C3.2	10.51.26	2:21	Control	**Seabed**: Rippled pale sand patches between drift algae **Fauna**: Swift fish (0:25),?damselfish (058; 2:03), **Flora**: Dense rows of drift algae (see right), appears a mixture of red and green branching algae, some white encrusting organisms, small attached macrophytes (evident at 0:49, see right)	
CS.C3.3	10.53.56	3:07	Control	**Seabed**: Rippled pale sand patches between drift algae **Fauna**: Small fish (1:57-2:00) **Flora**: Dense rows of drift algae (see right), appears a mixture of red and green/brown algae (large specimen of kelp 0:07 on right), some white encrusting organisms (some suspect pteriids), small attached macrophytes	

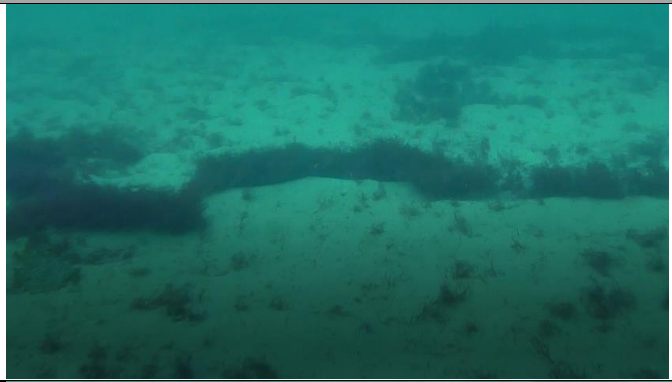
Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CS.C3.4	10.57.12	3:31	Control	**Seabed**: Rippled pale sand patches between drift algae, little shell debris **Fauna**: Small fish (0:25, 0:39, 2:04),?damselfish (0:42), apogonids (2:19), male eastern fiddler ray *Trygonorrhina fasciata* (2:50, see right) **Flora**: Dense rows of drift algae, appears a mixture of red and green/brown algae, some areas profuse, some white encrusting organisms, small attached macrophytes	
CS.C4.1	11.23.20	3:24	Control	**Seabed**: Rippled pale sand patches between drift algae, little shell debris **Fauna**:?Damselfish (1:59), stingaree *Urolophus cruciatus* (2:50, see right), apogonids (3:13), octopus garden (3:23) **Flora**: Dense rows of drift algae), appears a mixture of red and green/brown algae, very few white encrusting organisms, small attached macrophytes	
CS.C4.2	11.26.42	3:43	Control	**Seabed**: Rippled pale sand patches between drift algae, some shell debris **Fauna**: Port Jackson Shark *Heterodontus portusjacksoni* (1:12, see right), large school (200 +) pelagic fish (1:34), ?damselfish (1:59), 2 x stingaree *Trygonoptera testacea* (3:00, 3:19) **Flora**: Dense rows of drift algae (see right), appears a mixture of red and green/brown algae, some white encrusting organisms, small attached macrophytes	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CS.C4.3	11.30.37	4:26	Control	**Seabed**: Rippled pale sand patches between drift algae, some shell debris **Fauna**: 2 x stingaree *Trygonoptera testacea* (2:02, 4:13) **Flora**: Dense rows of drift algae, appears a mixture of red and green/brown algae, small amount of kelp, some white encrusting organisms, small attached macrophytes, very tall macrophyte (4:12, see right)	
CS.C4.4	11.35.10	3:05	Control	**Seabed**: Rippled pale sand patches between drift algae, some shell debris **Fauna**: Stingaree *Trygonoptera mucosa* (0:00), flathead (0:25), swift fish (0:35), striped wrasse (2:10) **Flora**: Dense rows of drift algae (see right), appears a mixture of red and green/brown algae, small amount of kelp, some white encrusting organisms, small attached macrophytes	
CS.L.1	12.18.56	3:19	Lease	**Seabed**: Rippled pale sand areas, some larger areas, between drift algae, some shell debris (large white gastropod shells (1:39, see right), occasional feeding pits **Fauna**: *Luidia* seastar (0:39), stingaree *Trygonoptera mucosa* (2:20) **Flora**: Some rows, some scattered drift algae (see right), appears a mixture of red and green/brown algae, some white encrusting organisms, small attached macrophytes	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
CS.L.2	12.22.24	2:48	Lease	**Seabed**: Rippled pale sand areas, some larger areas (see right), between drift algae, some shell debris (large white shells), a few feeding pits **Fauna**: 2 small fish (0:14), 2 x stingaree *Trygonoptera mucosa* (1:23, 2:13) **Flora**: Some rows, some scattered drift algae (see right), appears a mixture of red and green/brown algae, some white encrusting organisms, small attached macrophytes	
CS.L.3	12.25.22	2:44	Lease	**Seabed**: Rippled pale sand areas, some medium areas (see right), between drift algae, some shell debris, a few feeding pits **Fauna**: Stingaree *Urolophus cruciatus* (0:44), striped wrasse (1:22), swift fish (2:12) **Flora**: Some rows, some scattered drift algae (see right), appears a mixture of red and green/brown algae, some white encrusting organisms, small attached macrophytes	
CS.L.4	12.28.16	2:14	Lease	**Seabed**: Rippled pale sand areas, some medium areas (see right), between drift algae, some shell debris, occasional feeding pits **Fauna**: Stingaree *Trygonoptera mucosa* (0:05), flathead (1:26), isolated sponge (1:37, see right) **Flora**: Some rows, some scattered drift algae (see right), appears a mixture of red and green/brown algae, some white encrusting organisms, small attached macrophytes	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
V.C5.1	12.42.29	3:22	Control	**Seabed**: Disturbed pale sand areas, frequent feeding pits **Fauna**: *Luidia* seastar (0:32, see right), 2 x buried stingaree *Trygonoptera mucosa* (2:06, 3:21) **Flora**: Small drift and attached macrophytes (see right), larger pieces drift kelp (2:21, 3:09, 3:12 with holdfast)	
V.C5.2	12.46.05	3:10	Control	**Seabed**: Disturbed pale sand areas, some feeding pits), piece of conglomerate (1:25) **Fauna**: Buried stingaree (0:29, 0:56), 200 + school of carangids (1:30-2:35, see right), seapen (1:56, see right) **Flora**: Small drift and attached macrophytes (see right), larger pieces drift kelp (0:09, 0:10, 1:00, 1:13)	
V.C5.3	12.49.18	2:49	Control	**Seabed**: Disturbed pale sand areas, quite a few feeding pits **Fauna**: Suspect same carangids as in V.C5.2 (0:00), sand-covered swimming stingaree (1:30) **Flora**: Small drift and attached macrophytes (see right), larger pieces drift kelp (1:20, one with holdfast 2:30, see right)	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
V.C5.4	12.52.18	2:56	Control	**Seabed**: Disturbed pale sand areas, quite a few feeding pits, numerous small dark spots (1:05, see right) **Fauna**: Stingaree *Trygonoptera mucosa* (2:01) **Flora**: Small drift and attached macrophytes (see right), larger piece drift kelp (2:33)	
V.C6.1	13.24.35	3:00	Control	**Seabed**: Disturbed pale sand areas, some ripples, frequent feeding pits **Fauna**: ?Flying fish (0:00), branching sponge (1:13, see right) **Flora**: Small drift and attached macrophytes, larger pieces drift kelp (0:28, 0:35, 0:37, 0:50, 1:15, 1:24, 1:38, 2:36), some rows of drift macrophytes (e.g. 0:58), single blades also scattered around (see right)	
V.C6.2	13.27.42	2:26	Control	**Seabed**: Disturbed pale sand areas, occasional feeding pits **Fauna**: Stingaree *Trygonoptera mucosa* (1:57), another stingaree near recently vacated feeding pit (2:26) **Flora**: Small drift and attached macrophytes, larger pieces drift kelp (0:03, 0:19, 0:24, 0:33, 0:50, 1:24, 1:38, 2:06, 2:13 with holdfasts see right), some rows of drift macrophytes, single blades also scattered around)	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
V.C6.3	13.30.19	3:54	Control	**Seabed**: Disturbed pale sand areas, occasional feeding pits **Fauna**: Large stingaree *Trygonoptera mucosa* left feeding pit (2:48) spotted (2:58), odd ?pipefish (3:26) **Flora**: Small drift and attached macrophytes, larger pieces drift kelp (0:17, 0:32, 0:47, 0:50, 1:01, 2:06, 2:30), some rows of drift macrophytes (e.g. 1:15 see right), single blades also scattered around)	
V.C6.4	13.34.29	3:36	Control	**Seabed**: Disturbed pale sand areas, occasional feeding pits **Fauna:** Branching sponge (0:36, 2:48), odd ?pipefish (2:03, see centre right) **Flora**: Small drift and attached macrophytes (see right), larger pieces drift kelp (0:10, 0:15, 0:20 & 1:30, 1:50, 219, with holdfast, 0:50, 0:58, 1:18, 1:55, 2:30; 3:16), some rows of drift macrophytes, single blades also scattered around	
V.L.1	13.03.28	2:48	Lease	**Seabed**: Disturbed pale sand areas, occasional feeding pits **Fauna**: Stingaree *Trygonoptera mucosa* (0:37), seapen (1:10) **Flora**: Small and frequent attached macrophytes (see right), larger pieces drift kelp (0:57, 1:20 with holdfast, 2:05), some single kelp blades	

Replicate	Time Film Started (24hr)	Duration (min)	Site Type	Comments	Images
V.L.2	13.06.27	2:50	Lease	**Seabed**: Disturbed pale sand areas, few feeding pits **Fauna**: Stingaree *Urolophus cruciatus* (1:11) **Flora**: Small drift (few) and attached macrophytes, larger attached macrophyte (1:38), piece drift kelp (1:44), very few single kelp blades	
V.L.3	13.09.30	2:41	Lease	**Seabed**: Disturbed pale sand areas, few feeding pits (see right) **Fauna**: 3 x stingaree *Trygonoptera mucosa* (0:32, 1:11, 1:30), 1 x stingaree *Urolophus cruciatus* (2:33) **Flora**: Small drift (few) and attached macrophytes, piece drift kelp 2:24), few single kelp blades	
V.L.4	13.12.21	3:01	Lease	**Seabed**: Disturbed pale sand areas, some feeding pits, numerous dark spots **Fauna**: 2 x ?seapen/?salp (1:34, 1:46), encrusting sponge (2:02) **Flora**: Small drift (few) and attached macrophytes, larger attached macrophyte (1:03) piece drift kelp (0:07, 0:11, 0:46 see right, 2:57), few single kelp blades	

Appendix D: TOC raw data

Raw %TOC data for each of the replicate grab samples for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

Sample date:	Sample Code	TOC (%)
9/7/19	CN.C1.T.1	0.26
9/7/19	CN.C1.T.2	0.05
9/7/19	CN.C1.T.3	0.04
9/7/19	CN.C1.T.4	0.04
9/7/19	CN.C1.T.5	0.06
9/7/19	CN.C1.T.6	0.06
9/7/19	CN.C2.T.1	0.04
9/7/19	CN.C2.T.2	0.04
9/7/19	CN.C2.T.3	0.06
9/7/19	CN.C2.T.4	0.11
9/7/19	CN.C2.T.5	0.08
9/7/19	CN.C2.T.6	0.16
9/7/19	CN.L.T.1	0.07
9/7/19	CN.L.T.2	0.05
9/7/19	CN.L.T.3	0.06
9/7/19	CN.L.T.4	0.11
9/7/19	CN.L.T.5	0.06
9/7/19	CN.L.T.6	0.06
9/7/19	CS.C1.T.1	0.03
9/7/19	CS.C1.T.2	0.04
9/7/19	CS.C1.T.3	0.06
9/7/19	CS.C1.T.4	0.04
9/7/19	CS.C1.T.5	0.04
9/7/19	CS.C2.T.1	0.06
9/7/19	CS.C2.T.2	0.04
9/7/19	CS.C2.T.3	0.08
9/7/19	CS.C2.T.4	0.05
9/7/19	CS.C2.T.5	0.04
9/7/19	CS.C1.T.6	0.05
9/7/19	CS.C2.T.6	0.06

Sample date:	Sample Code	TOC (%)
9/7/19	V.C1.T.1	0.07
9/7/19	V.C1.T.2	0.16
9/7/19	V.C1.T.3	0.11
9/7/19	V.C1.T.4	0.15
9/7/19	V.C1.T.5	0.05
9/7/19	V.C1.T.6	0.11
9/7/19	V.C2.T.1	0.21
9/7/19	V.C2.T.2	0.28
9/7/19	V.C2.T.3	0.22
9/7/19	V.C2.T.4	0.06
9/7/19	V.C2.T.5	0.14
9/7/19	V.C2.T.6	0.15
9/7/19	V.L.T.1	0.09
9/7/19	V.L.T.2	0.1
9/7/19	V.L.T.3	0.12
9/7/19	V.L.T.4	0.1
9/7/19	V.L.T.5	0.12
9/7/19	V.L.T.6	0.09

Appendix E: Benthic macroinvertebrate raw data

Raw benthic macroinvertebrate data, with numbers of the different taxa for each of the replicate grab samples at (a) Callala North, (b) Callala South and (c) Vincentia, for the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019.

(a) Callala North

	CN.C1.1	CN.C1.2	CN.C1.3	CN.C1.4	CN.C1.5	CN.C1.6	CN.C2.1	CN.C2.2	CN.C2.3	CN.C2.4	CN.C2.5	CN.C2.6	CN.L.1	CN.L.2	CN.L.3	CN.L.4	CN.L.5	CN.L.6
Scleractinia TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Scleractinia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Polychaetes TOTAL	**2**	**5**	**1**	**1**	**0**	**1**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**1**	**0**	**1**
Nemertea	2	-	1	1	-	-	-	1	-	-	-	1	-	1	2	1	-	-
Oligochaeta	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
?Phoronida	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	1
Polychaetes TOTAL	**23**	**4**	**3**	**3**	**1**	**5**	**17**	**8**	**13**	**20**	**10**	**17**	**1**	**9**	**5**	**14**	**2**	**8**
Capitellidae	-	-	-	-	-	-	-	-	-	1	-	7	-	-	1	-	1	4
Cirratulidae	-	-	-	-	-	-	1	-	2	3	3	1	-	-	-	-	-	-
Dorvilleidae	-	1	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Eunicidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyceridae	-	3	2	3	-	4	5	4	5	2	1	1	-	4	1	5	-	3
Hesionidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lumbrineridae	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	1
Magelonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maldanidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Nephtyidae	2	-	-	-	-	-	2	1	-	3	-	4	-	-	1	-	-	-
Nereididae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Onuphidae	12	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-
Orbiniidae	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	2	-	-
Oweniidae	-	-	-	-	-	-	5	2	-	8	2	1	1	1	-	3	-	-
Pectinariidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phyllodocidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisionidae	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-
Sabellidae	4	-	1	-	-	-	-	-	1	1	-	-	-	-	-	2	-	-
Sigalionidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Spionidae	5	-	-	-	1	-	1	-	-	-	-	-	-	1	-	1	-	-
Syllidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebellidae	-	-	-	-	-	-	2	-	4	-	1	-	-	-	-	-	-	-
Molluscs TOTAL	**12**	**4**	**0**	**1**	**7**	**2**	**3**	**4**	**104**	**96**	**125**	**8**	**0**	**0**	**5**	**5**	**4**	**4**
Molluscs: Bivalves TOTAL	**12**	**4**	**0**	**1**	**7**	**2**	**3**	**3**	**104**	**96**	**125**	**8**	**0**	**0**	**1**	**2**	**2**	**2**

	CN.C1.1	CN.C1.2	CN.C1.3	CN.C1.4	CN.C1.5	CN.C1.6	CN.C2.1	CN.C2.2	CN.C2.3	CN.C2.4	CN.C2.5	CN.C2.6	CN.L.1	CN.L.2	CN.L.3	CN.L.4	CN.L.5	CN.L.6
Corbulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galeommatidae	1	3	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Mesodesmatidae	1	-	-	1	-	-	3	2	8	21	13	6	-	-	1	1	1	2
Myochamidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Mytilidae	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pharidae	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Psammobidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteriidae	7	-	-	-	-	-	-	1	96	71	111	2	-	-	-	-	-	-
Tellinidae	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneridae	-	-	-	-	6	1	-	-	-	1	1	-	-	-	-	-	1	-
Molluscs: Gastropods TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Acteonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aplysiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marginellidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Naticidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Olivellidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ranellidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molluscs: Scaphopods TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**3**	**2**	**2**
Scaphopoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	2	2
Pycnogonida TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Pycnogonida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crustaceans TOTAL	**38**	**26**	**23**	**14**	**37**	**36**	**10**	**8**	**26**	**15**	**13**	**20**	**36**	**48**	**78**	**71**	**52**	**55**
Ostracod	1	2	1	-	2	-	4	3	7	5	7	4	1	3	-	6	-	3
Gammarid amphipod	31	10	17	8	16	24	2	5	16	7	4	13	31	37	62	49	45	46
Caprellid amphipod	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Anthurid isopod	6	11	4	5	11	7	3	-	-	-	-	-	2	6	11	10	6	6
Arcturid isopod	-	-	-	-	1	-	-	-	1	-	-	1	-	-	-	-	-	-
Flabelliferan isopod	-	-	-	-	-	1	1	-	-	2	-	-	-	-	-	1	-	-
Cumacea	-	3	1	1	1	-	-	-	-	-	1	-	2	1	5	3	1	-
Tanaidacea	-	-	-	-	6	4	-	-	1	-	-	-	-	-	-	1	-	-
Caridae	-	-	-	-	-	-	-	-	1	1	-	1	-	1	-	1	-	-
Callianassidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenosomatidae	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Echinoderms TOTAL	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**3**	**3**	**2**	**2**
Asteroidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinoidea: Loveniidae	1	-	1	-	1	-	-	1	-	-	-	-	1	-	3	3	2	2
Holothuroidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiuroidea	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

(b) Callala South

	CS.C3.1	CS.C3.2	CS.C3.3	CS.C3.4	CS.C3.5	CS.C3.6	CS.C4.1	CS.C4.2	CS.C4.3	CS.C4.4	CS.C4.5	CS.C4.6	CS.L.1	CS.L.2	CS.L.3	CS.L.4	CS.L.5	CS.L.6
Scleractinia TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**1**
Scleractinia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1
Non-Polychaetes TOTAL	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**
Nemertea	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Oligochaeta	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
?Phoronida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychaetes TOTAL	**2**	**6**	**4**	**2**	**1**	**5**	**1**	**6**	**5**	**4**	**3**	**3**	**9**	**5**	**3**	**0**	**12**	**7**
Capitellidae	-	-	1	-	-	1	-	-	-	-	1	-	2	1	-	-	-	-
Cirratulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dorvilleidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Eunicidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyceridae	2	4	3	1	1	1	-	1	1	4	1	3	2	3	2	-	2	4
Hesionidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lumbrineridae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Magelonidae	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Maldanidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nephtyidae	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-
Nereididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Onuphidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orbiniidae	-	-	-	-	-	-	-	1	4	-	1	-	3	-	-	-	1	-
Oweniidae	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
Pectinariidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phyllodocidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisionidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabellidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sigalionidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spionidae	-	-	-	-	-	-	-	1	-	-	-	-	2	-	-	-	7	-
Syllidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebellidae	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-
Molluscs TOTAL	**9**	**7**	**63**	**141**	**1**	**13**	**2**	**142**	**38**	**1**	**14**	**19**	**21**	**10**	**3**	**0**	**22**	**8**
Molluscs: Bivalves TOTAL	**7**	**7**	**61**	**141**	**1**	**11**	**1**	**140**	**38**	**0**	**14**	**19**	**19**	**9**	**1**	**0**	**21**	**8**
Corbulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Galeommatidae	5	4	52	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mesodesmatidae	1	-	9	2	1	6	1	4	10	-	13	13	18	8	1	-	19	6
Myochamidae	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Mytilidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	CS.C3.1	CS.C3.2	CS.C3.3	CS.C3.4	CS.C3.5	CS.C3.6	CS.C4.1	CS.C4.2	CS.C4.3	CS.C4.4	CS.C4.5	CS.C4.6	CS.L.1	CS.L.2	CS.L.3	CS.L.4	CS.L.5	CS.L.6
Pharidae	-	-	-	-	-	1	-	-	2	-	-	-	-	1	-	-	-	-
Psammobidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pteriidae	-	3	-	138	-	2	-	136	26	-	1	6	1	-	-	-	1	-
Tellinidae	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molluscs: Gastropods TOTAL	**2**	**0**	**2**	**0**	**0**	**2**	**1**	**2**	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**
Acteonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aplysiidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Marginellidae	2	-	2	-	-	-	1	-	-	1	-	-	2	-	-	-	-	-
Naticidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Olivellidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ranellidae	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Molluscs: Scaphopods TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**1**	**0**
Scaphopoda	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	-
Pycnogonida TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Pycnogonida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crustaceans TOTAL	**55**	**32**	**92**	**48**	**21**	**60**	**18**	**80**	**79**	**11**	**12**	**61**	**106**	**63**	**15**	**20**	**27**	**44**
Ostracod	2	12	21	13	6	5	-	23	21	-	-	13	4	5	1	-	-	1
Gammarid amphipod	51	15	63	31	14	50	15	56	44	9	7	40	93	57	10	18	25	37
Caprellid amphipod	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Anthurid isopod	2	1	1	2	-	4	2	1	7	2	3	2	3	-	2	-	1	2
Arcturid isopod	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flabelliferan isopod	0	0	0	0	0	0	-	-	-	-	1	-	-	-	-	-	-	-
Cumacea	-	4	5	1	1	-	-	-	5	-	-	4	4	1	2	1	-	4
Tanaidacea	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caridae	-	-	-	-	-	1	1	-	2	-	1	2	1	-	-	1	1	-
Callianassidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenosomatidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinoderms TOTAL	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**3**	**1**	**0**	**4**	**0**	**2**
Asteroidea	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinoidea: Loveniidae	-	-	-	-	-	1	-	-	-	-	-	-	3	1	-	4	-	2
Holothuroidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiuroidea	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

(c) Vincentia

	V.C5.1	V.C5.2	V.C5.3	V.C5.4	V.C5.5	V.C5.6	V.C6.1	V.C6.2	V.C6.3	V.C6.4	V.C6.5	V.C6.6	V.L.1	V.L.2	V.L.3	V.L.4	V.L.5	V.L.6
Scleractinia TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Scleractinia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Polychaetes TOTAL	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**4**	**1**	**2**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**
Nemertea	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	1
Oligochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
?Phoronida	1	-	-	-	1	-	1	4	-	1	-	1	-	1	-	-	-	-
Polychaetes TOTAL	**38**	**30**	**15**	**17**	**3**	**26**	**26**	**63**	**30**	**38**	**32**	**37**	**13**	**17**	**10**	**27**	**21**	**9**
Capitellidae	-	3	2	-	-	2	-	3	-	4	3	1	-	1	-	3	1	-
Cirratulidae	-	1	-	2	-	1	19	10	5	3	12	18	-	2	-	-	-	-
Dorvilleidae	3	-	-	-	-	-	-	4	4	-	2	-	1	-	-	-	2	-
Eunicidae	4	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	-	-
Glyceridae	5	1	-	-	1	4	2	3	2	2	4	1	3	3	2	3	2	1
Hesionidae	-	-	-	2	-	-	-	1	-	3	-	1	-	-	-	-	-	-
Lumbrineridae	-	-	-	-	1	-	-	-	-	-	-	-	1	1	1	1	-	-
Magelonidae	4	4	4	3	-	6	-	9	1	5	2	6	2	4	4	9	8	5
Maldanidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nephtyidae	-	2	1	-	-	-	1	2	1	2	3	2	-	-	1	-	1	-
Nereididae	-	1	1	1	1	-	-	1	-	-	-	-	2	1	-	3	2	-
Onuphidae	5	10	1	8	-	2	1	3	4	4	2	1	-	3	-	2	3	-
Orbiniidae	1	-	-	-	-	1	-	10	4	11	1	-	4	-	-	1	-	1
Oweniidae	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Pectinariidae	-	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-
Phyllodocidae	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
Pisionidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabellidae	4	4	-	-	-	4	-	13	6	3	-	4	-	-	-	3	2	-
Sigalionidae	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Spionidae	11	2	-	-	-	1	-	2	1	-	1	1	-	-	1	-	-	-
Syllidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebellidae	-	1	6	1	-	4	3	1	-	-	-	1	-	1	1	2	-	2
Molluscs TOTAL	**39**	**57**	**149**	**347**	**1**	**230**	**11**	**30**	**23**	**2**	**28**	**16**	**9**	**41**	**39**	**16**	**57**	**34**
Molluscs: Bivalves TOTAL	**37**	**54**	**146**	**347**	**0**	**229**	**10**	**29**	**22**	**2**	**26**	**15**	**9**	**38**	**39**	**11**	**53**	**34**
Corbulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galeommatidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mesodesmatidae	15	19	13	14	-	3	6	28	13	2	12	13	8	31	34	5	13	29
Myochamidae	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-
Mytilidae	2	6	-	-	-	-	-	-	7	-	-	-	-	-	-	1	3	-
Pharidae	-	-	1	1	-	-	-	-	-	-	-	-	1	3	3	1	1	1

	V.C5.1	V.C5.2	V.C5.3	V.C5.4	V.C5.5	V.C5.6	V.C6.1	V.C6.2	V.C6.3	V.C6.4	V.C6.5	V.C6.6	V.L.1	V.L.2	V.L.3	V.L.4	V.L.5	V.L.6
Psammobidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteriidae	19	29	132	331	-	226	4	1	-	-	7	-	-	4	2	3	35	4
Tellinidae	-	-	-	-	-	-	-	-	-	-	5	1	-	-	-	-	-	-
Veneridae	1	-	-	1	-	-	-	-	1	-	2	-	-	-	-	1	1	-
Molluscs: Gastropods TOTAL	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**2**	**1**	**0**	**3**	**0**	**3**	**3**	**0**
Acteonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-
Aplysiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marginellidae	2	1	1	-	-	1	1	-	-	-	1	-	-	3	-	2	1	-
Naticidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Olivellidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Ranellidae	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Molluscs: Scaphopods TOTAL	**0**	**2**	**2**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**
Scaphopoda	-	2	2	-	1	-	-	-	1	-	-	-	-	-	-	2	1	-
Pycnogonida TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Pycnogonida	-	-	-	-	-	-	-	1	1	-	1	1	-	-	-	-	-	-
Crustaceans TOTAL	**83**	**49**	**21**	**48**	**22**	**48**	**23**	**31**	**20**	**25**	**30**	**19**	**25**	**25**	**59**	**65**	**237**	**22**
Ostracod	19	6	4	7	2	9	6	6	1	2	6	4	3	5	10	4	8	1
Gammarid amphipod	53	24	9	24	15	21	8	11	13	9	8	7	7	10	36	25	49	12
Caprellid amphipod	6	10	2	8	-	12	-	2	-	-	-	-	3	3	6	23	152	3
Anthurid isopod	1	4	4	3	1	3	4	5	3	4	6	5	3	4	5	3	4	1
Arcturid isopod	-	-	-	2	-	-	-	2	-	-	4	-	7	-	-	8	22	4
Flabelliferan isopod	-	-	1	-	-	1	1	-	-	-	3	-	-	-	-	-	-	-
Cumacea	4	1	-	2	4	1	3	2	-	9	2	1	2	2	1	1	1	-
Tanaidacea	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Caridae	-	2	-	-	-	-	1	2	1	-	-	1	-	1	1	1	1	1
Callianassidae	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-
Hymenosomatidae	-	1	-	1	-	-	-	1	1	-	1	-	-	-	-	-	-	-
Echinoderms TOTAL	**4**	**4**	**1**	**0**	**1**	**4**	**1**	**1**	**0**	**0**	**6**	**2**	**0**	**4**	**1**	**0**	**2**	**0**
Asteroidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinoidea: Loveniidae	4	4	1	-	1	1	1	-	-	-	5	-	-	3	1	-	1	-
Holothuroidea	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Ophiuroidea	-	-	-	-	-	3	-	1	-	-	-	1	-	1	-	-	1	-

Appendix F: SIMPER outputs for benthic macroinvertebrates

SIMPER analyses, showing typifying (shaded cells) and distinguishing benthic macroinvertebrate taxa, with an (*) denoting that the taxon makes a consistently greater contribution to the faunas at the top of the column, for (a) Callala North, (b) Callala South and (c) Vincentia locations, and (d) the three Lease sites at the South Coast Mariculture operations in Jervis Bay, recorded 9 July 2019. NS = no significant difference shown by pairwise PERMANOVA.

(a) Callala North	Control 1	Control 2	Lease
Control 1	Gammarid amphipods Anthurid isopods		
Control 2	Pteriid bivalves Anthurid isopods* Mesodesmatid bivalves Ostracod crustaceans Oweniid polychaetes	Gammarid amphipods Ostracod crustaceans Mesodesmatid bivalves Pteriid bivalves Glycerid polychaetes	
Lease	Gammarid amphipods Scaphopod molluscs Loveniid echinoderms	Pteriid bivalves* Gammarid amphipods Anthurid isopods Mesodesmatid bivalves*	Gammarid amphipods Anthurid isopods Loveniid echinoderms Cumacean crustaceans

(b) Callala South	Control 3	Control 4	Lease
Control 3	Gammarid amphipods Ostracod crustaceans Glycerid polychaetes		
Control 4	NS	Gammarid amphipods Anthurid isopods Mesodesmatid bivalves	
Lease	Ostracod crustaceans* Galeommatid bivalves * Mesodesmatid bivalves Pteriid bivalves*	NS	Gammarid amphipods Mesodesmatid bivalves Glycerid polychaetes Cumacean crustaceans

(c) Vincentia	Control 5	Control 6	Lease
Control 5	Gammarid amphipods Pteriid bivalves Ostracod crustaceans Mesodesmatid bivalves Anthurid isopods Caprellid amphipods Magelonid polychaetes		
Control 6	Pteriid bivalves* Cirratulid polychaetes Caprellid amphipods* Orbiniid polychaetes	Gammarid amphipods Cirratulid polychaetes Mesodesmatid bivalves Anthurid isopods Ostracod crustaceans Glycerid polychaetes Onuphid polychaetes Nephtyid polychaetes Magelonid polychaetes	
Lease	Pteriid bivalves* Arcturid isopods* Caprellid amphipods* Onuphid polychaetes	Cirratulid polychaetes* Caprellid amphipods Arctturid isopods Pteriid bivalves Sabellid polychaetes*	Gammarid amphipods Mesodesmatid bivalves Caprellid amphipods Magelonid polychaetes Ostracod crustaceans Anthurid isopods Glycerid polychaetes Pteriid bivalves

(d) Lease sites	Callala North	Callala South	Vincentia
Callala North	Gammarid amphipods Anthurid isopods Loveniid echinoderms Cumacean crustaceans		
Callala South	NS	Gammarid amphipods Mesodesmatid bivalves Glycerid polychaetes Cumacean crustaceans	
Vincentia	Mesodesmatid bivalves Caprellid amphipods Magelonid polychaetes Arcturid isopods Caprellid amphipods Pteriid bivalves Ostracod crustaceans Gammarid amphipods*	Caprellid amphipods Magelonid polychaetes Mesodesmatid bivalves Arcturid isopods Pteriid bivalves Ostracod crustaceans Gammarid amphipods*	Gammarid amphipods Mesodesmatid bivalves Caprellid amphipods Magelonid polychaetes Ostracod crustaceans Anthurid isopods Glycerid polychaetes Pteriid bivalves

Appendix G: BRUVS raw data

Raw data for shark, ray, fish and invertebrate taxa, with MaxN of the different taxa for each of the replicate BRUV samples at (a) Callala North, (b) Callala South and (c) Vincentia, for the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019.

(a) Callala North

Common name	Species name	CN.C1.1	CN.C1.2	CN.C1.3	CN.C1.4	CN.C2.1	CN.C2.2	CN.C2.3	CN.C2.4	CN.L.1	CN.L.2	CN.L.3	CN.L.4
Port Jackson Shark	*Heterodontus portusjacksoni*	1	1	1	1	0	1	0	0	0	0	0	0
Gummy Shark	*Mustelus antarcticus*	1	0	0	0	0	0	0	0	0	0	0	0
Black Stingray	*Bathytosia lata*	0	1	1	0	0	0	0	0	0	0	0	0
Common Stingaree	*Trygonoptera testacea*	0	0	0	0	0	0	0	0	0	0	1	0
Eastern Shovelnose Ray	*Aptychotrema rostrata*	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Fiddler Ray	*Trygonorrhina fasciata*	1	0	1	1	0	1	0	1	1	1	1	0
Southern Eagle Ray	*Myliobatis tenuicaudatus*	0	0	0	0	0	0	0	0	0	0	0	0
Flathead	*Platycephalus* spp.	0	1	2	3	0	2	0	1	2	2	2	1
Broken-line Wrasse	*Stethojulis interrupta*	0	0	0	0	1	3	2	3	0	1	0	0
Wrasse (unknown)		0	0	0	0	0	0	2	0	0	0	0	0
Fanbelly Leatherjacket	*Brachaluteres jacksonianus*	0	0	0	0	0	1	0	0	0	0	0	0
Orange-spotted Puffer	*Torquigener vicinus*	0	0	2	0	0	0	0	0	0	0	0	0
Sand Whiting	*Sillago ciliata*	0	0	0	0	0	0	0	0	0	1	0	0
Yellowtail Scad	*Trachurus novaezelandiae*	0	0	0	0	0	3	29	107	0	5	0	>100
Sea Snail	Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0
Octopus	*Octopus australis*	0	1	0	0	0	0	0	0	0	0	1	0
Common Seastar	*Luidia australiae*	1	0	0	0	0	0	1	0	0	0	0	0
Brittle Star	*Ophionereis schayeri*	0	0	0	0	0	0	0	0	1	1	0	0
Brittle Star	*Allostichaster polyplax*	0	0	0	0	0	0	0	0	0	0	0	0

(b) Callala South

Common name	Species name	CS.C3.1	CS.C3.2	CS.C3.3	CS.C3.4	CS.C4.2	CS.L.2
Port Jackson Shark	*Heterodontus portusjacksoni*	0	0	0	2	0	0
Gummy Shark	*Mustelus antarcticus*	0	0	0	0	0	0
Black Stingray	*Bathytosia lata*	0	0	0	0	0	0
Common Stingaree	*Trygonoptera testacea*	0	0	0	0	1	0
Eastern Shovelnose Ray	*Aptychotrema rostrata*	0	0	0	0	1	0
Eastern Fiddler Ray	*Trygonorrhina fasciata*	2	0	1	2	2	3
Southern Eagle Ray	*Myliobatis tenuicaudatus*	0	0	0	0	1	0
Flathead	*Platycephalus* spp.	1	0	1	2	3	1
Broken-line Wrasse	*Stethojulis interrupta*	0	0	0	0	0	0
Wrasse (unknown)		0	0	0	0	0	0
Fanbelly Leatherjacket	*Brachaluteres jacksonianus*	0	0	0	0	0	0
Orange-spotted Puffer	*Torquigener vicinus*	0	0	0	0	0	0
Sand Whiting	*Sillago ciliata*	0	0	0	0	0	0
Yellowtail Scad	*Trachurus novaezelandiae*	3	0	0	>100	35	0
Sea Snail	Gastropoda	2	1	1	1	0	1
Octopus	*Octopus australis*	0	0	0	0	0	0
Common Seastar	*Luidia australiae*	0	0	0	0	0	0
Brittle Star	*Ophionereis schayeri*	0	0	0	0	0	0
Brittle Star	*Allostichaster polyplax*	0	0	0	0	0	1

(c) Vincentia

Common name	Species name	V.C5.1	V.C5.2	V.C5.3	V.C5.4	V.C6.1	V.C6.2	V.C6.3	V.L.1	V.L.3	V.L.4
Port Jackson Shark	*Heterodontus portusjacksoni*	1	1	1	1	0	0	0	1	1	0
Gummy Shark	*Mustelus antarcticus*	0	0	0	0	0	0	0	0	0	0
Black Stingray	*Bathytosia lata*	0	0	0	0	0	0	0	0	0	0
Common Stingaree	*Trygonoptera testacea*	0	0	1	0	0	0	0	0	1	0
Eastern Shovelnose Ray	*Aptychotrema rostrata*	0	0	0	0	0	0	0	0	0	0
Eastern Fiddler Ray	*Trygonorrhina fasciata*	1	1	5	1	1	1	1	1	0	0
Southern Eagle Ray	*Myliobatis tenuicaudatus*	0	0	1	0	0	0	0	0	0	0
Flathead	*Platycephalus* spp.	0	1	3	0	1	2	0	0	1	0
Broken-line Wrasse	*Stethojulis interrupta*	0	0	0	0	0	0	0	0	0	0
Wrasse (unknown)		0	0	0	0	0	0	0	0	0	0
Fanbelly Leatherjacket	*Brachaluteres jacksonianus*	0	0	0	0	0	0	0	0	0	0
Orange-spotted Puffer	*Torquigener vicinus*	0	0	0	0	0	0	0	0	0	0
Sand Whiting	*Sillago ciliata*	0	0	0	0	0	0	0	0	0	0
Yellowtail Scad	*Trachurus novaezelandiae*	0	0	>100	0	0	0	>100	1	>100	4
Sea Snail	Gastropoda	0	0	0	0	0	4	0	0	0	0
Octopus	*Octopus australis*	0	0	0	0	0	0	0	0	0	0
Common Seastar	*Luidia australiae*	0	0	0	0	0	0	0	0	0	0
Brittle Star	*Ophionereis schayeri*	0	0	0	0	0	0	0	0	0	0
Brittle Star	*Allostichaster polyplax*	0	0	0	0	0	0	0	0	0	0

Appendix H: SIMPER outputs for fish via BRUVS

SIMPER analyses, showing typifying (shaded cells) and distinguishing fish taxa, with an (*) denoting that the taxon makes a consistently greater contribution to the fauna at the top of the column, for (a) Callala North, (b) Callala South and (c) Vincentia locations, and (d) the three Lease sites at the South Coast Mariculture operations in Jervis Bay, recorded 10-11 July 2019. NS = no significant difference shown by pairwise PERMANOVA.

Callala North	Callala North Control 1	Callala North Control 2	Callala North Lease	Vincentia Control 6	Vincentia Lease
Callala North Control 1	Port Jackson Shark Flathead				
Callala North Control 2	Yellowtail Scad Broken-line Wrasse Flathead* Port Jackson Shark*	Broken-line Wrasse Yellowtail Scad			
Callala North Lease	Yellowtail Scad Port Jackson Shark* Flathead*	NS	Flathead Eastern Fiddler Ray		
Vincentia Control 6	Yellowtail Scad Port Jackson Shark* Flathead*	NS	NS	Eastern Fiddler Ray Flathead	
Vincentia Lease	Yellowtail Scad Flathead*	NS	NS	NS	Yellowtail Scad