Environmental Impact Monitoring Program (EIMP) - Spring 2013

Lot 1 on RP804106, Trent Road via Ayr

PREPARED FOR

Pacific Reef Fisheries (Australia) Pty Ltd

December, 2013

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1 Introduction

1.1 Background

This report has been prepared for Pacific Reef Fisheries (Australia) Pty Ltd (PRF) by Gassman Development Perspectives to fulfil the requirements of the Environmental Impact Monitoring Program (EIMP) developed by BTEQ in March, 2005 and updated by Gassman Development Perspectives in November, 2013. This monitoring program was developed in part to satisfy ongoing licensing requirements determined by the Department of Environment and Heritage Protection (DEHP, formerly Department of Environment and Resource Management), Great Barrier Reef Marine Park Authority (GBRMPA) and the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC, formerly Department of Environment, Water, Heritage and the Arts).

This report outlines the results for this sampling event which continued the three year monitoring program. This monitoring occurred on 4th and 5th of December, 2013. The purpose of the annual monitoring program is to determine any changes that occur to the receiving environment as a result of adjacent prawn farm activities by comparing various environmental parameters.

PRF has the following approvals which allow for the discharge of aquaculture of aquaculture waste to the surrounding environments:

- DEHP – Integrated Authority NR0280
- GBRMPA – Permit no. G01/352.2
- DSEWPC – EPBC 2001/402

1.2 Site description

The farm is located on Trent Road, Alva Beach which is 15km east of Ayr, Queensland (Figure 1). The site consists of 75 operational ponds covering 68 hectares for the production of Marine prawns (*Penaeus monodon*). 30 additional ponds covering 30 hectares are currently under construction. The facility also has a hatchery, processing plant, 10.3 hectares of settlement-treatment ponds and 7 hectares of constructed mangrove wetland designed to reduce contaminants in the aquaculture waste prior to release into the receiving environment. Aquaculture waste generated on-site is treated prior to discharge into Little Alva Creek. An aerial image of the site can be found in Figure 2.

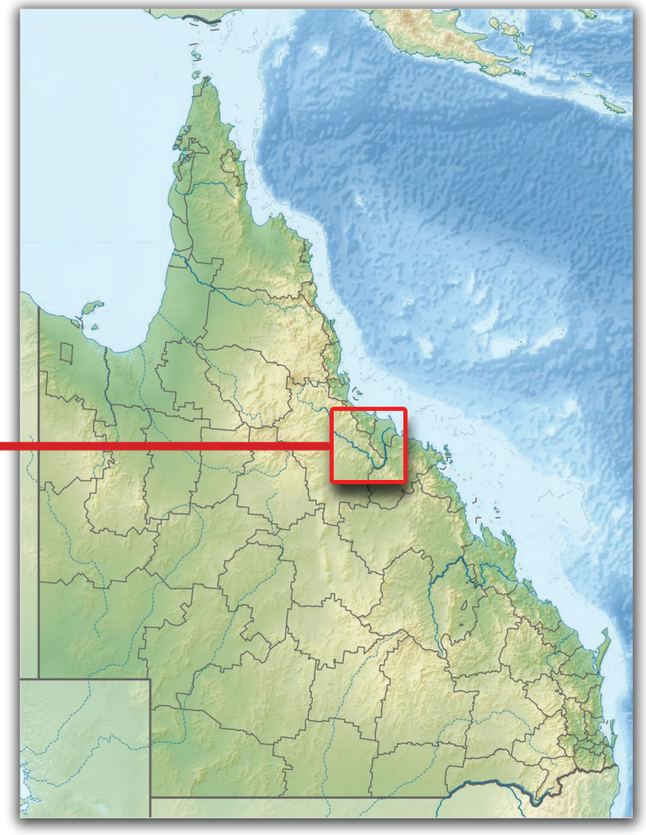

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Figure 2 – Aerial photograph of the Pacific Reef Fisheries Prawn Farm

1.3 Objectives of the monitoring program

The purpose of this monitoring program is to detect any measureable environmental effects on the receiving waters of Little Alva Creek by regularly monitoring sites on both Little Alva Creek and nearby reference sites along Alva Creek. Observed intra-site differences in the following parameters will determine any measurable impacts that aquaculture waste discharge is having upon Little Alva Creek:

- Mangrove health including species composition, canopy cover, canopy height, density of mature trees and density of saplings;
- Abundance and spatial extent of epiphytic algae;
- Abundance and diversity of benthic macro-invertebrates; and
- Total organic carbon and grain-size distribution of benthic sediments
- Monthly water quality monitoring

2 Methodology

2.1 Sampling locations

Eight (8) locations have been selected for sampling. They are identified as follows:

A Discharge point into Little Alva Creek
B 500m downstream in Little Alva Creek
C 250m north of mouth of Little Alva Creek
D Location in Alva Creek corresponding with G
E Location in Alva Creek corresponding with B
F 250m north of mouth of Alva Creek
G 250m upstream of discharge point in Little Alva Creek
H Location in Alva Creek corresponding with A

Figure 3 shows the locations of all sampling sites.

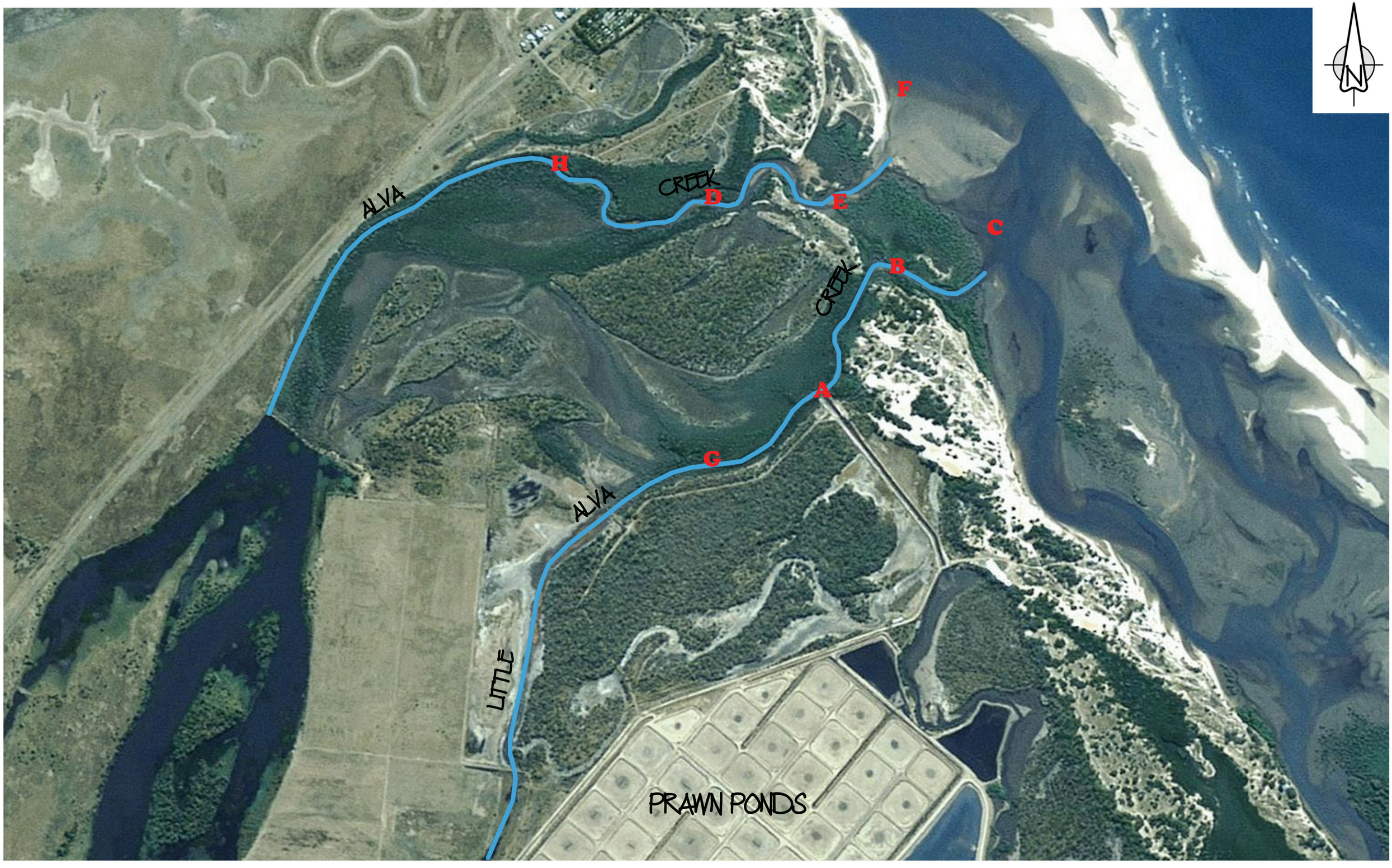
All sites were accessible on this monitoring occasion.

2.2 Mangrove health monitoring

Mangrove health was monitored at sites A, B, D, E, G and H. At each site, permanent 400m^2 (20m x 20m) quadrats were established at the water extent of the mangrove edge and extended back into the mangrove stands. At each location the following parameters were measured:

- Species composition;
- Canopy cover;
- Canopy height;
- Density of mature trees (over 3m);
- Density of saplings and small trees (under 3m).

Additionally, two to three permanent photographic reference points were established at each monitoring location on the first monitoring occasion (photographs in Appendix 1). These reference points continue to be utilised.



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EIMP Sampling Locations

Alva Beach
Pacific Reef Fisheries

date: 23-07-10
scale:
design: MS/SJH
plan: 4541 E 00 01

2.3 Sediment sampling methods

At locations B, C, E and F sediments were sampled for the following parameters:

- Total organic carbon;
- Grainsize distribution;
- Species composition and abundance of benthic macroinvertebrates.

Three samples were taken and analysed for each parameter at each site. Averages were calculated from the three samples and this average value used for analysis. All results from each sample of macroinvertebrates collected are presented.

2.4 Water quality monitoring

Each month, water quality is measured at sites A, B, D and E as per procedures outlined in the EIMP document and in accordance with licence conditions. The following parameters are measured:

- Temperature
- pH
- Dissolved oxygen
- Salinity
- Total Suspended Solids
- Turbidity
- Total Nitrogen
- Total Phosphorous

The results from the previous 12 months of monitoring are included in Appendix 2 of this report.

3 Results and Discussion

3.1 Mangrove health

The results of the mangrove quadrats for the four sites monitored are summarised in **Table 1**. The same species at each site were detected consistent with last monitoring occasion, however an additional species was detected at each site A and site D. These were *Aegiceras corniculatum* and *Aegalitis annulata* respectively. Trees and saplings under 3m in height continue to outnumber mature trees at all sites. Small increases in the density of trees over 3m in height were observed at sites A and E. All other sites remained similar to last monitoring occasion with the exception of trees under 3m in height at site D which experienced a slight decrease. No substantial changes were observed visually across all sites in comparison to last monitoring occasion.

Photographs of the quadrats are found in **Appendix 1**.

Table 1 – Mangrove observations for permanent quadrats

Quadrat	Species Present	Density of trees >3m (per m^2)	Density of trees <3m (per m^2)	GPS coordinates
A	*Ceriops australis; Avicennia marina; Rhizophora stylosa; Aegiceras corniculatum*	0.0625	0.75	-19.469, 147.486
B	*Avicennia marina; Rhizophora stylosa*	0.02	0.05	-19.4654, 147.49
D	*Avicennia marina; Rhizophora stylosa; Ceriops australis; Aegalitis annulata*	0.4	1.15	-19.4655, 147.473
E	*Avicennia marina; Rhizophora stylosa; Aegalitis annulata*	0.035	0.8	-19.4632, 147.487
G	*Avicennia marina; Rhizophora stylosa*	0.8	0.75	-19.4703, 147.4837

Quadrat	Species Present	Density of trees >3m (per m^2)	Density of trees <3m (per m^2)	GPS coordinates
H	*Rhizophora stylosa; Avicennia marina; Aegalitis annulata; Osbornia octodonta*	0.5	0.05	-19.4644, 147.4802

3.2 Sediment biogeochemistry

3.2.1 Particle size distribution

The results of the particle size distribution (PSD) analysis are presented in Figure 4 and Table 2**.** On this occasion, sites E and F displayed high levels of uniformity. Site C displayed a higher concentration of finer grained sediments whereas Site B displayed slightly more uniformity in distribution than the other sites.

Sites B, E and F appeared to display slightly coarser PSDs on this monitoring occasion in contrast to that undertaken in Spring 2012. However, site C displayed high concentrations of silt/clay.

Because of the uniformity among the other samples, it is not likely that the differences are related to aquaculture activities. Various seasonal and environmental factors, including possible sampling anomalies are likely to be responsible for this difference. However, if this pattern continues on the next monitoring occasion, further investigations may be required to determine the potential source of the variation.

A minimum of eight (8) samples per site would be required to analyse the data statistically, however visual trends observed from charts such as Figure 4 are considered to be sufficiently indicative of changing trends over time. Figure 5 contains the comparison plot from the spring sampling occasion from 2012.

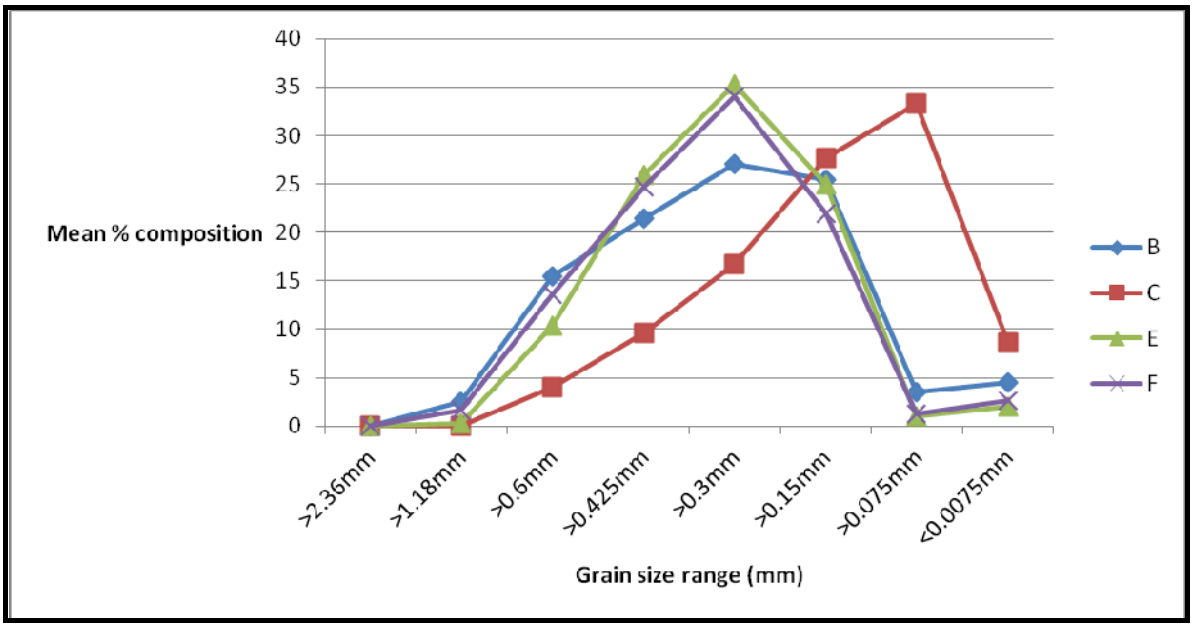

Figure 4 – Particle size distribution chart for sites B, C, E and F

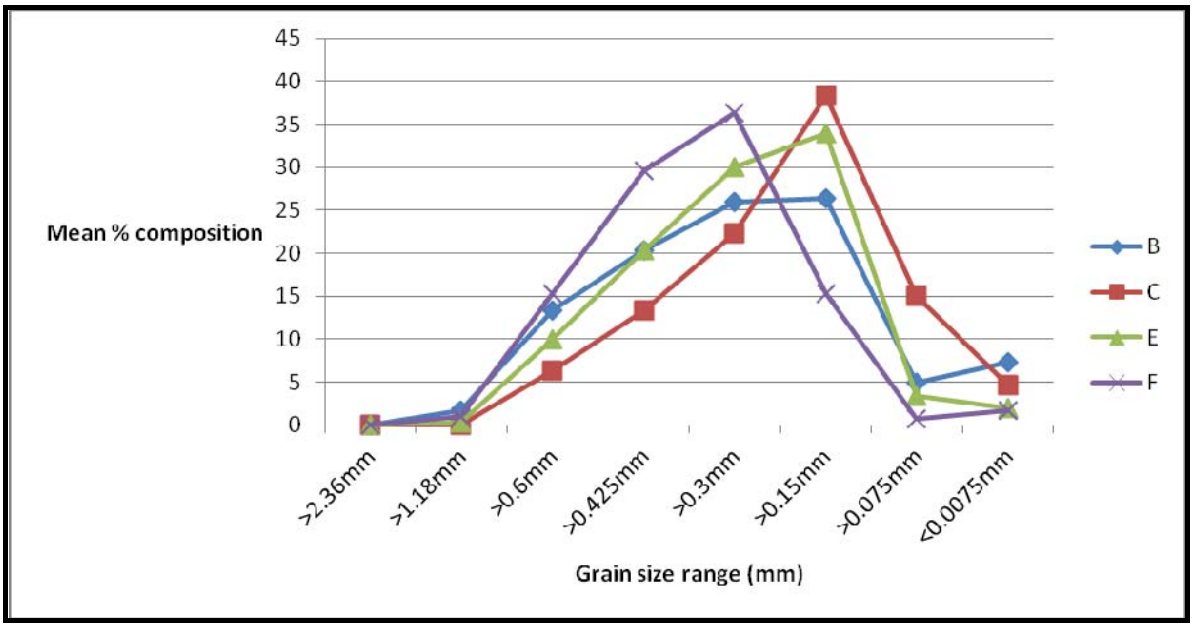

Figure 5 – Comparative Particle size distribution chart for sites B, C, E and F from Spring 2012 sampling

Table 2 –Particle Size Analysis of Sediments from sites B, E and F

Size parameter	Sampling site											
%	B1	B2	B3	C1	C2	C3	E1	E2	E3	F1	F2	F3
<2.36 >1.18mm Coarse sand	0	0	-	0	0	0	0	0	0	0	0	0
<1.18 >0.6mm Coarse sand	2	3	-	0	0	0	0	0	1	2	1	2
<0.6 >0.425mm Medium sand	15	16	-	4	4	4	10	7	14	12	12	17
<0.425 >0.3mm Medium sand	20	23	-	9	10	10	29	20	29	23	25	26
<0.3 >0.15mm Fine sand	27	27	-	15	18	17	35	39	32	34	35	33
<0.15 >0.075mm Fine sand	26	25	-	26	28	29	23	31	21	24	23	19
<0.075mm Silt and clay	4	3	-	39	30	31	1	1	1	1	2	1

3.2.2 Total Organic Carbon

Total Organic Carbon (TOC) is an indicator of organic matter preserved within sediment. Organic matter has a high propensity to be retained in finer grained sediments. In **Table 3** it is represented as a percentage of the total weight of sediment collected. On this occasion, site C exhibited the highest proportion of TOC in the sediment which is in contrast to last monitoring occasion when site B was highest. The monitoring occasion before in Spring 2011 also had site C exhibiting the highest

concentration of TOC. The remainder of the samples continued to exhibit low concentrations of TOC.

Table 3 – Total Organic Carbon

Site	Total Organic Carbon (%)
B1	0.16
B2	0.1
B3	0.22
C1	0.21
C2	0.26
C3	0.17
E1	0.09
E2	0.06
E3	0.18
F1	0.1
F2	0.17
F3	0.07

3.2.3 Benthic macroinvertebrate assemblages

Communities of benthic macroinvertebrates are a robust indicator of the relative health of an aquatic ecosystem. As they often have narrow environmental tolerances, even minor anthropogenic changes to a receiving environment are reflected in changes to macroinvertebrate communities.

The results of the macroinvertebrate species composition for sites B, C, E and F can be found in **Table 4**. Changes in the diversity and abundance of benthic macroinvertebrates over time are considered to be a reliable indicator of changing environmental conditions which may be attributable to discharge from the prawn farm.

Table 5 provides a comparison in diversity between the previous autumn sampling and this occasion. Diversity has again noticeably increased between monitoring events within sites B and C, however it has slightly decreased back to previous levels in sites E and F. However, as sites B and

C are located within the discharge creek, it is clear that on the basis of macroinvertebrate diversity the farm is not causing discernible impacts on the receiving system.

Table 4 – Macroinvertebrates detected at sites B, C, E and F

Sample Code	Phylum	Order / Class	Family	Count
B1	Annelida	Polycheata	Capitellidae	2
B1	Annelida	Polycheata	Chaetopteridae	1
B1	Crustacea	Brachyura	Ocypodidae	1
B1	Insecta	Diptera	Chrionominae	1
B1	Mollusca	Bivalvia	Mactridae	2
B1	Mollusca	Bivalvia	Mesodesmatidae	1
B1	Mollusca	Bivalvia	Psammobiidae	2
B2	Annelida	Polycheata	sp.	1
B2	Mollusca	Bivalvia	Mesodesmatidae	1
B3	Annelida	Polycheata	Chaetopteridae	1
B3	Annelida	Polycheata	Syllidae	7
B3	Mollusca	Bivalvia	Mactridae	2
B3	Mollusca	Bivalvia	Mesodesmatidae	1
C1	Mollusca	Bivalvia	Psammobiidae	1
C1	Mollusca	Brachiopoda	Lingulidae	2
C1	Mollusca	Gastropoda	Cerithiidae	1
C2	Annelida	Polycheata	sp.	1
C2	Crustacea	Amphipoda	Aoridae	1
C2	Crustacea	Tanaidacea	sp.	23
C2	Mollusca	Bivalvia	Mactridae	5
C2	Mollusca	Bivalvia	Veneridae	3
C2	Mollusca	Brachiopoda	Lingulidae	1
C2	Mollusca	Gastropoda	Bullidae	1
C2	Mollusca	Gastropoda	Cerithiidae	1
E2	Crustacea	Isopoda	Corallanidae	6
E2	Mollusca	Bivalvia	Mesodesmatidae	9
F1	Mollusca	Bivalvia	Mesodesmatidae	2
F1	Mollusca	Gastropoda	Nassariidae	1
F1	Mollusca	Bivalvia	Veneridae	2
F2	Mollusca	Bivalvia	Mesodesmatidae	6
F2	Mollusca	Bivalvia	Veneridae	1
F3	Mollusca	Bivalvia	Mesodesmatidae	37

Table 5 – Comparison of diversity in taxa between sampling occasions

Spring 2012 sampling	Spring 2013 sampling
B = 4 taxa collected	B = 7 taxa collected
C = 7 taxa collected	C = 8 taxa collected
E = 5 taxa collected	E = 2 taxa collected
F = 4 taxa collected	F = 3 taxa collected

4 Conclusion

On this sampling occasion, all sites were accessible and were sampled. For all parameters including mangrove densities, particle size distribution, total organic carbon, no substantial variances were observed between sampling occasions. In contrast to last sampling occasion, TOC was higher at site C than the other sites, and for all other sites TOC were comparable to last occasion.

Comparisons between all sample sites did not detect significant differences between the two sampling occasions and no environmental impacts were detected that could be attributed to activities relating to prawn production. Macroinvertebrate assemblages were more diverse and numerous in comparison to last monitoring occasion in the discharge creek, but less diverse in the reference creek. The next sampling event will be around November/December, 2014.

Appendix 1 – Photoplates

Quadrat A – two photos

Quadrat B – two photos

Quadrat D – two photos

Quadrat E – two photos

Quadrat G – Two Photographs

Quadrat H – two photos

Appendix 2 – Water quality data

Monthly Boat Sampling									
Date:	**11-Dec-12**								
Site		**DO**	**Sal**	**pH**	**Temp**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	5.19	36.8	8.25	27.1	13	5.9	0.27	0.033
	2	5.11	37.3	8.36	26.7				
	3	5.15	37.4	8.41	26.9				
B	1	5.27	36.9	8.32	27.6	12	4.2	0.285	0.021
	2	5.36	36.8	8.38	27.8				
	3	5.42	36.9	8.39	27.9				
D	1	5.05	37	8.31	27	22	7.7	0.259	0.041
	2	5.18	37.2	8.32	27.2				
	3	5.16	37.3	8.39	27.2				
E	1	4.93	36.8	8.34	27.7	10	3.9	0.234	0.017
	2	5.05	36.9	8.28	27.6				
	3	5.04	36.9	8.3	27.8				
Date:	**21-Jan-13**								
Site		**DO**	**Sal**	**pH**	**Temp**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	5.08	35.9	7.74	27.8	27	15	0.407	0.033

	2	5.37	36.3	8.42	27.6				
	3	5.02	35.9	7.89	28				
B	1	5.6	36.1	8.03	28.2	24	15	0.274	0.025
	2	5.46	36.1	8.43	28.1				
	3	5.26	36.1	8.21	28.2				
D	1	5.25	36.1	8.06	27.8	30	16	0.506	0.043
	2	5.31	36.2	8.26	27.7				
	3	5.17	35.9	7.93	27.9				
E	1	5.49	36.2	7.92	27.9	30	20	0.271	0.02
	2	5.47	36.2	8.5	28				
	3	5.36	36.1	7.45	28				
Date:	**12-Feb-13**								
Site		DO	Sal	pH	Temp	TSS(mg/L)	Turbidity	TN(mg/L)	TP(mg/L)
A	1	2.93	15.1	6.99	28.4	35	10	0.293	0.07
	2	3.51	21.3	7.67	28.4				
	3	4.49	28.9	7.94	28.7				
B	1	5.4	32.3	7.95	28.9	22	12	0.204	0.124
	2	5.31	32.3	8.12	28.9				
	3	5.43	32.4	8.1	29				
D	1	5.07	31.8	8.06	28.5	39	22	1.333	0.381
	2	5.22	31.5	8.15	28.8				
	3	5.42	32.1	8.19	28.9				
E	1	5.3	32.3	8.16	29	40	20	0.266	0.04
	2	5.22	32.3	8.24	29.1				
	3	5.47	31.9	8.25	29.4				

Date:	**13-Mar-13**								
Site		DO	Sal	pH	Temp	TSS(mg/L)	Turbidity	TN(mg/L)	TP(mg/L)
A	1	5.14	30.3	8.42	26.1	27	18	0.315	0.05
	2	5.22	31.1	8.29	26.2				
	3	5.4	30.9	8.63	26.5				
B	1	5.5	31.1	8.41	26.8	32	26	0.209	0.026
	2	5.32	31.8	8.13	27.6				
	3	5.44	32.3	8.88	27.5				
D	1	2.74	18.2	7.19	25.8	26	15	0.99	0.229
	2	3.54	24.2	8.22	25.6				
	3	4.34	28.7	8.62	25.8				
E	1	5.47	31.8	8.3	27.4	74	65	0.281	0.038
	2	5.35	32.3	8.42	27.7				
	3	5.25	32.5	8.68	27.9				
Date:	**09-Apr-13**			ph probe malfunction					
Site		DO	Sal	pH	Temp	TSS(mg/L)	Turbidity	TN(mg/L)	TP(mg/L)
A	1	5.34	33	5.79	24.8	30	20	0.288	0.021
	2	5.74	33.6	6.36	25				
	3	5.62	33.6	5.98	25				
B	1	5.85	32.9	5.98	25.5	23	12	0.204	0.01
	2	5.95	33.8	6.42	25.7				
	3	5.79	33.7	6.59	25.9				
D	1	4.04	32.7	5.66	24.6	26	18	0.393	0.021

	2	5.11	32.5	5.38	24.7				
	3	5.27	32.8	5.67	24				
E	1	6.01	33.5	6.7	25.7	19	12	0.176	0.012
	2	6.08	32.9	5.42	25.9				
	3	5.89	33.1	5.46	25.9				
Date:	**07-May-13**								
Site		DO	Sal	pH	Temp	TSS(mg/L)	Turbidity	TN(mg/L)	TP(mg/L)
A	1	4.86	33.5	7.29	21.6	23	24	0.848	0.142
	2	5.08	33.6	7.46	22.3				
	3	4.86	33.8	7.38	22.3				
B	1	6.8	34.8	7.97	23.6	17	13	0.16	0.052
	2	6.82	34.6	7.96	23.7				
	3	6.82	34.8	7.96	23.8				
D	1	4.07	31.1	7.25	22.5	25	14	0.384	0.069
	2	4	31.3	7.22	22.7				
	3	3.86	31.4	7.18	22.8				
E	1	4.09	34.6	7.3	22.9	32	19	0.139	0.044
	2	6.81	34.7	8	23.2				
	3	6.76	34.8	8.01	23.5				
Date:	**23-Jun-13**								
Site		DO	Sal	pH	Temp	TSS(mg/L)	Turbidity	TN(mg/L)	TP(mg/L)
A	1	6.35	36.3	7.38	18.8	18		0.278	0.11
	2	6.49	36.4	7.41	18.9				

	3	6.55	36.4	7.39	18.8				
B	1	7.31	36.3	6.83	19.2	9.4		0.382	0.05
	2	7.42	36.3	6.86	19.2				
	3	7.46	36.4	6.88	19.4				
D	1	6.78	32.2	6.55	17.4	13		0.557	0.149
	2	6.84	32.3	6.54	17.6				
	3	7.02	32.3	6.59	17.6				
E	1	7.89	34.6	6.78	19.3	10.2		0.146	0.227
	2	7.99	34.7	6.83	19.4				
	3	7.95	34.8	6.87	19.4				
Date:	**01-Jul-13**								
Site		**Temp**	**pH**	**DO**	**Sal**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	Unable to sample and record data due to tides							
	2								
	3								
B	1								
	2								
	3								
D	1								
	2								
	3								
E	1								
	2								
	3								

Date:	20-Aug-13								
Site		**Temp**	**pH**	**DO**	**Sal**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	23.4	7.63	3.11	35.8	11	6.9	0.529	0.083
	2	23.5	7.61		35.7				
	3	23.5	7.6		35.8				
B	1	23.8	7.97	5.41	35.3	8.9	6.1	0.551	0.046
	2	23.8	7.98		35.3				
	3	23.8	7.99		35.3				
D	1	22.6	7.08	3.64	37	21	18	0.706	0.094
	2	22.5	7.1		36.9				
	3	22.6	7.12		36.9				
E	1	23.9	8.05	5.97	35.3	11	5.4	0.558	0.034
	2	23.9	8.05		35.3				
	3	23.9	8.06		35.3				
Date:	**18-Sep-13**								
Site		**Temp**	**pH**	**DO**	**Sal**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	24.5	7.91	4.67	36.9	13	9.5	0.292	0.062
	2	24.8	7.69	3.83	36.9				
	3	24.8	7.68	3.76	37.2				
B	1	24.8	8.07	6.35	36.6	16	8.6	0.213	0.024
	2	24.9	8.07	6.62	36.6				
	3	25	8.08	6.59	36.6				
D	1	24.6	7.07	2.75	39.3	18	19	0.413	0.072
	2	24.7	7.06	2.79	39.3				

	3	24.7	7.04	2.75	39.3				
E	1	24.5	8.07	6.53	36.6	9.4	5.2	0.181	0.016
	2	24.6	8.05	6.28	36.5				
	3	24.9	8.05	6.3	36.5				
Date:	**20-Oct-13**								
Site		**Temp**	**pH**	**DO**	**Sal**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	25.5	7.97	6.77	37.1	21	13	0.22	0.064
	2	25.8	7.96	6.67	37.1				
	3	25.8	8.03	6.63	37.1				
B	1	26.2	8	6.88	39	26	11	0.198	0.032
	2	26.3	7.99	6.84	39.2				
	3	26.4	8.08	6.79	39.3				
D	1	26.2	7.32	5.2	39	20	17	0.327	0.089
	2	26.1	7.26	5.07	39.2				
	3	26.1	7.22	4.98	39.3				
E	1	26.1	8.02	6.94	36.9	14	10	0.19	0.027
	2	26.2	8.02	6.96	36.9				
	3	26.3	8.01	6.96	36.9				
Date:	**05-Nov-13**								
Site		**Temp**	**pH**	**DO**	**Sal**	**TSS(mg/L)**	**Turbidity**	**TN(mg/L)**	**TP(mg/L)**
A	1	27.1	8.06	6.42	37.4	31	17	0.306	0.068
	2	27.2	8.06	6.43	37.4				
	3	27.5	8.08	6.55	37.4				

B	1	27.4	8.12	6.67	37.3	20	11	256	0.026
	2	27.8	8.12	6.68	37.3				
	3	27.9	8.12	6.68	37.3				
D	1	27.2	6.98	4.01	39.1	27	22	0.363	0.115
	2	26.6	7.62	5.57	38.5				
	3	27.2	7.9	6.26	37.7				
E	1	27.6	8.06	6.72	37.2	11	7.3	0.211	0.02
	2	27.8	8.12	6.81	37.3				
	3	27.9	8.12	6.84	37.3				