Atlantic Salmon Aquaculture Subprogram: Macroalgal monitoring in Macquarie Harbour, Tasmania

Christine Crawford, Colin Buxton and Adam Main

Australian Government

Fisheries Research and Development Corporation

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Non-technical summary

2011/086: Atlantic Salmon Aquaculture Subprogram: Macroalgal monitoring in Macquarie Harbour, Tasmania

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Objectives

1. To conduct preliminary baseline monitoring for macroalgae in Macquarie Harbour in autumn
2. Develop a macroalgal monitoring program for Macquarie Harbour
3. Test monitoring program and conduct seasonal (spring) baseline monitoring

Outcomes achieved to date

The distribution and percentage cover of common macroalgal species at 40 sites throughout the Harbour in autumn and spring 2012 were documented and photographs of each site and the algal species have been collated and stored on CD. This has established a baseline against which the effects of proposed increases in salmon production on macroalgal composition and abundance can be assessed.

Keywords

Macroalgae, Macquarie Harbour, intertidal monitoring, environmental effects of salmon aquaculture

Acknowledgements

The project was jointly funded by the Fisheries Research and Development Corporation (FRDC project 2011/086), and the Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. We wish to thank the salmon farming companies Tassal and Huon Aquaculture Company (HAC) for their support for this project, in particular Dom O'Brien from HAC and Belinda Yaxley from Tassal who organised a boat and driver for us in Macquarie Harbour. Special thanks go to Sam O'Doherty, our skipper, for expertly transporting us around the Harbour and providing local information.

2011/086 Atlantic Salmon Aquaculture Subprogram: macroalgal monitoring in Macquarie Harbour, Tasmania

Background

The Tasmanian salmonid aquaculture industry is the largest seafood sector in Australia. In the 2010 – 2011 financial year the industry produced 32,328t of salmonids with a farm gate value of $379 million. The industry plans to double its salmon production by 2030, and a major component of their strategic plan is an expansion of salmon aquaculture in Macquarie Harbour. A draft amendment to the Macquarie Harbour Marine Farming Development Plan was submitted to the Tasmanian Government in late 2011 and State approval was granted in mid 2012. This Plan provides for a 64% increase in lease area from a current total of 564 ha to 926 ha.

As documented in the Environmental Impact Statement prepared for the assessment of the expansion in Macquarie Harbour (available at http://www.dpiw.tas.gov.au/inter.nsf/WebPages/ALIR-4YS3VE?open#DraftAmendmentstoMar), the increase in production will result in an increase in nutrients – nitrogen and phosphorous – from salmon farming waste products into the environment. These nutrients have the potential to increase primary production of micro and macro-algae in the Harbour, although the extent of increased production and the potential for eutrophication of the system is not fully understood. Macroalgae are largely restricted to the intertidal zone in Macquarie Harbour because light can only penetrate a short distance into the darkly coloured tannin waters.

Community stakeholders have voiced concerns about the potential for increased macroalgal growth in Macquarie Harbour as a result of fish farming. The Tasmanian salmonid industry recognised these concerns and supported baseline research on macroalgal communities before the proposed expansion occurred.

Need

There was a pressing need to monitor the distribution and abundance of intertidal macroalgae in Macquarie Harbour before the expansion of salmon farming commenced to provide 'baseline' data against which the effects of the expanded salmon production on the Harbour environment could be assessed. As different species of macroalgae occur at different times of the year, surveys in autumn and spring were required.

Objectives

1. To conduct preliminary baseline monitoring for macroalgae in Macquarie Harbour in autumn
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Methods

Surveys were conducted of macroalgal abundance at intertidal sites in Macquarie Harbour using 0.5 x 0.5 m quadrats containing 100 point intersects. The location of sites was based on habitat mapping of the Harbour by IMAS SeaMap Tasmania (Figure 1), advice from industry and the community and chosen to provide a representative cover of the Harbour intertidal area. They were also chosen so that other sources of anthropogenic impact, such as storm water outlets, were avoided. At each site 6 quadrat locations were haphardly selected, and the percentage cover of substrate type, macroalgal species and macro-epibenthic species (such as mussels) in each quadrat was quantified and documented (Figure 2). At sites with a uniform substrate type an overall percentage cover was provided, e.g. 100% sand. Photographs were taken at each site and temperature, salinity, dissolved oxygen concentration and GPS coordinates were recorded.

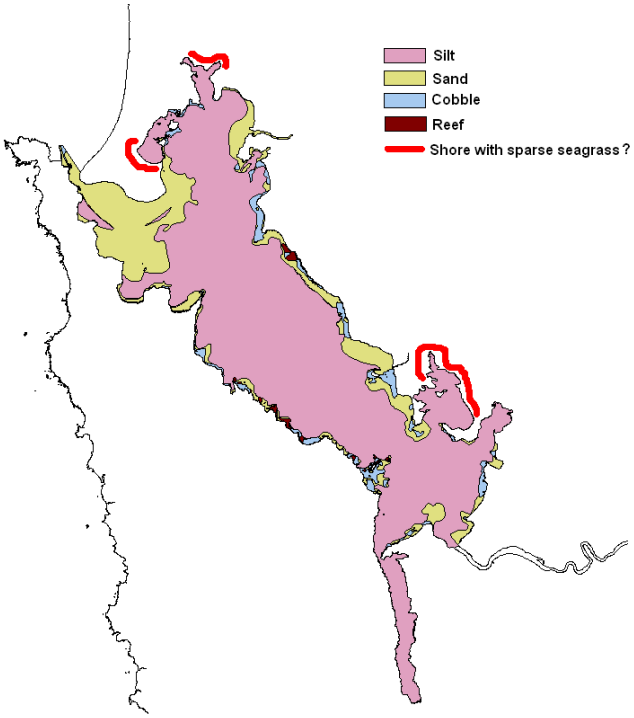

Figure 1. Habitat map of Macquarie Harbour (SeaMap Tasmania.

In March 2012 a total of 52 sites were sampled (Figure 2), and from this preliminary sampling an ongoing monitoring program was developed.

The data from these 52 sites were assessed and the number of sites was reduced to 40 (Figure 3) because of similarity between some sites. This final report provides the data on percentage cover of macroalgae from these 40 sites in autumn and spring 2012 (Table 1)). However, some sites in spring were located up to 100m away from the autumn sites because of strong wave action and the need to sample in more sheltered locations. These new GPS locations are provided below. Most of the common algal species were identified to species level and specimens of these species have been preserved and labelled.

Figure 2. The use of quadrats to assess percentage cover of algae and substrate.

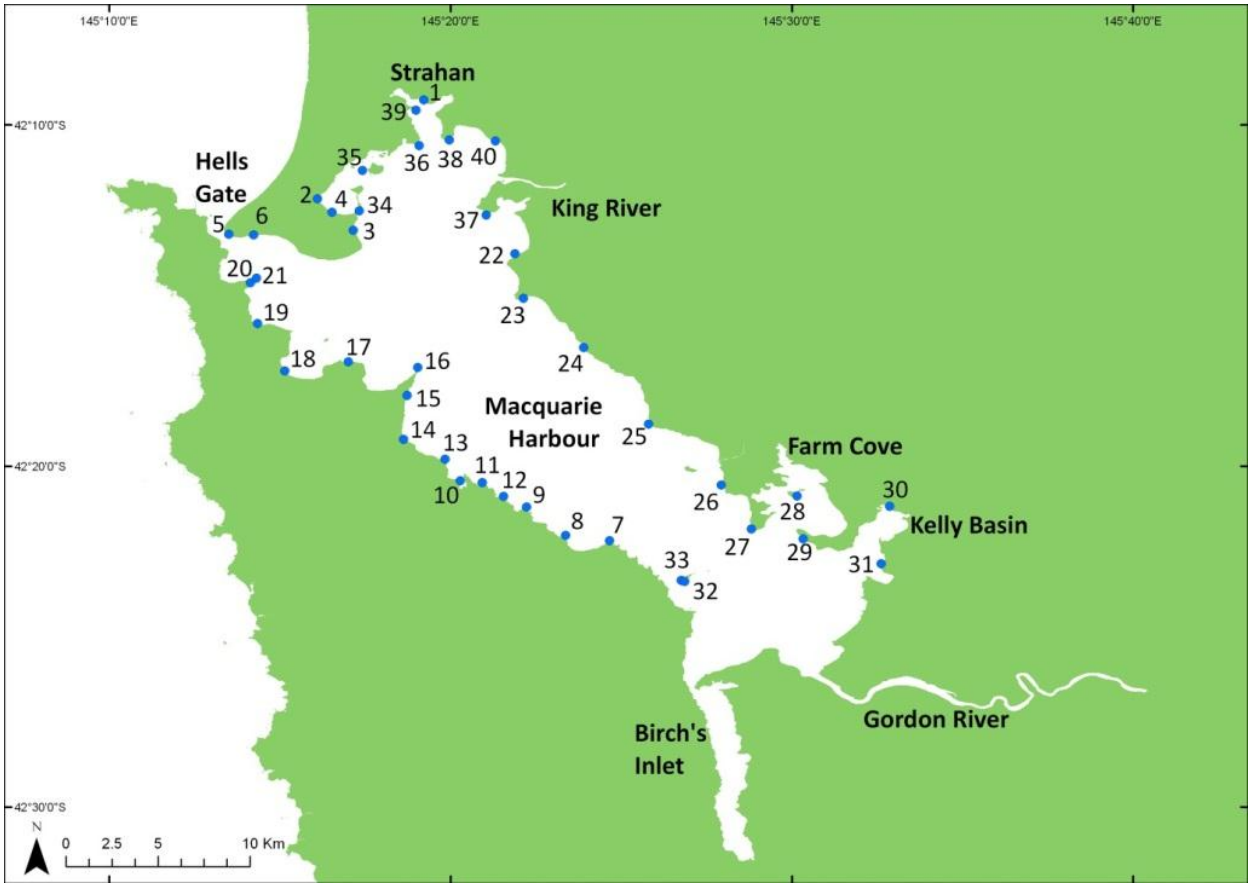

Figure 3. Location of sampling sites in Macquarie Harbour

Results and discussion

The percentage cover of macroalgae and substrate type at each site are shown in Table 1. Comments relating to each site are provided in Appendix 3. Photographs of each site and of the common algal species have been collated and stored on CD and website.

Differences in algal abundance and composition were apparent throughout the Harbour. The northern bay, including sandy beaches at Strahan, Swan Basin and the Heads had no macroalgal growth or epibenthic fauna present, except for a little filamentous green in a couple of transects. Most of these sites have coarse substrate and experience rapid changes in salinity with changing tides and exposed conditions at times; even so such low biodiversity is unusual. Similarly, sites around the King River outflow into Macquarie Harbour were generally devoid of algae, presumably because of accumulations of heavy metals in the sediments from past deposition of mining tailings and acid leachate from upstream mining activities (Koehnken 1996).

Filamentous red/browns were abundant at most sites at the top, south eastern section of the Harbour, around Farm Cove-Kelly Basin and Sarah Island, especially in Autumn 2012. Turfing algae were more common in this section of the Harbour in Spring, whereas filamentous greens were common at several sites in March but not recorded in Spring.

Macroalgae on the middle northern shore of the Harbour varied between sites and over the two sampling periods, with filamentous browns being common at sites 24 and 25 and turfing algae at site 23 in Autumn. In Spring no filamentous browns were observed at these sites; filamentous greens were common at sites 24 and 25, and turfing brown was present at site 25.

Similarly, the middle southern section of the Harbour, closest to the salmon farm sites, had a varied coverage of macroalgae with filamentous browns dominating at many sites in Autumn, although turfing algae and filamentous greens were also common at several sites. In Spring this section of the Harbour was dominated by turfing algae, with filamentous browns and greens common at two sites in the lower Harbour. The mussel *Xenostrobulus pulex* was also present at several sites.

However, it should be noted that the weather conditions affected sampling along the southern middle section of the Harbour in the Autumn sampling and several sites had to be relocated by 50-100 m to more sheltered conditions, often on the other side of a point. This is likely to have some effect on algal species composition.

In this survey algae were classified into functional groups, such as filamentous greens or turfing algae. Only the common species were classified to species and photographs of these species have been collated for future comparisons. Of particular interest is the species *Melosira moniliformis,* which was common in the middle Harbour in Spring which we described as being filamentous brown/white because of its filamentous like characteristics. However, it is a chain forming diatom, and has a cosmopolitan distribution.

Although the same personnel conducted the surveys in autumn and spring, some minor differences in classification may have occurred and would need to be clarified if sampling continues. For example, clearer definitions of substrate particle size need to be established.

Table 1. Percentage cover of macroalgae and substrate type at 40 sites in Macquarie Harbour.

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
1	Strahan Park , near police station	2	98		all sand, little organic matter, no algae											100											
2	Swan Basin picnic area, left of water entry	5	95												30			30			50						
		5	90					5							5	50		45									
		100													100												
		100																25			75						
		25			50			25							10			90									
		40	50		10										15	5		80									
3	Swan Basin sandy track before steep hill, steps to shore		50		50											55		45									
			50		50											50		50									
			50		50											45		55									
			50		50											100											
			50		50											15		85									
			50		50											95		5									
4	200m towards Strahan, wooden fishing table	34	33	33											30	70											
5	oppos lighthouse at Heads		100													100											
6	Heads, just past jetty, camping site					100										20		80									
						100										85		15									
			50		50										5	40		55									
			50		50											20		80									
					100											65		35									
			10		90											35		45			20						
7	Steadman Pt						80		20										55		5		10	30			
							90		10													90	10				
							80		20											100							
							100													60	5		35				
							70		30											40	5	10		45			
							10	90													5	5	40	50			
8	next rocky point				10		10		85											60	5		20	15			
							50		50											45	5		30	20			
					30		10		60										5	65		30					
					10		10		80											65			35				
							20		80											70			25				
							40		60											50			50				

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
9	Hogan Point, rocky outcrop						20		85											80		5	10	5			
							60		40											20			80				
					60				40									50	5				20	25			
							40		60										65				10	25			
					70		10		20									10	75		5		10				
							80		20										50				50				
10	Double Cove, near HAC farm						30	10	55			5								100							
							25		75											55			40	5			
								5	90		5									85	5		10				
							10		60		30									60			40				
							15	5			75	5								30			70				
									75	25										5			95				
11	just down coast, next point, S end Pelias cove						60	10	30											100							
					10		50	10	30											80		20					
	Nov site moved ~ 100m, inside bay, more sheltered				60		20	10	10											100							
						55		20	25											100							
							70	30																			
						95		5																			
12	Point N of Hogans Cove						10	75	15								too windy										
							80	20																			
							20	60	20																		
								15	5	80																	
					80				20																		
					10		10		80																		
13	N Double Cove, small pebbly beach						40	30	30									10		90							
	Nov 100m S, other side of point, much calmer						30	50	20											90			5	5			
							5	50	40		5									95				5			
							20	20	30		30									80	10			10			
							50				50									65			15	20			
							30				70							30		70							
14	Butt of Liberty, N of creek, offloading 4w bikes				60				40											95			5				
						60		5	30		5									95			5				
			25			50		5	20									60		30			10				
						5		5		90										93	2		5				
						95				5								50	50								
						55			25	20								30		70							

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
15	half way to Libery Pt					50		50											100								
							15	75	10										95				5				
						50		50											100								
						10		85	5										65				35				
						50		50											75				25				
							50	50												100							
16	Liberty Pt						25		75											5	5		80	10			
	Nov. South side of point (oppos Mar)							10	90											80			10	10			
								30	70		30									20	5		75				
								30	40											45			65				
							10	10	70	10										75	10		5	10			
								5	95											80		10	5	5			
17	Table Head						40	30	30											45	50		5				
							10			90										50	50						
								50	45			5								20	80						
							5	95												100							
								30		70										20	75		5				
										100										100							
18	Betsey Bay, middle right					100										35			65								
						100										25			75								
			50			50										5			95								
	Nov. ~ 50m to right		100													60			40								
						100										20			80								
						100										30			70								
19	Cosy Corner					100												85		15							
						100												30		70							
						100														100							
						100												40		60							
						98						2						40		60							
			30			70										5		15	80								
20	Round Head, water clearer						5			95								50		45	5						
							100													90	5			5			
							90			10										85	5			10			
							5			90		5								90	10						
							85			15										90	5			5			
						90						10								95				5			

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
15	half way to Libery Pt					50		50											100								
							15	75	10										95				5				
						50		50											100								
						10		85	5										65				35				
						50		50											75				25				
							50	50												100							
16	Liberty Pt						25		75											5	5		80	10			
	Nov. South side of point (oppos Mar)							10	90											80			10	10			
								30	70		30									20	5		75				
								30	40											45			65				
							10	10	70	10										75	10		5	10			
								5	95											80		10	5	5			
17	Table Head						40	30	30											45	50		5				
							10			90										50	50						
								50	45			5								20	80						
							5	95												100							
								30		70										20	75		5				
										100										100							
18	Betsey Bay, middle right					100										35			65								
						100										25			75								
			50			50										5			95								
	Nov. ~ 50m to right		100													60			40								
						100										20			80								
						100										30			70								
19	Cosy Corner					100												85		15							
						100												30		70							
						100														100							
						100												40		60							
						98						2						40		60							
			30			70										5		15	80								
20	Round Head, water clearer						5			95								50		45	5						
							100													90	5			5			
							90			10										85	5			10			
							5			90		5								90	10						
							85			15										90	5			5			
						90						10								95				5			

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
21	Green post at end of training wall					100														70	5	20		5			
						50			50											45	20	20		15			
						10			90											40	5	20	5	30			
						95			5											40	10	25		25			
							80		20											60	10	25		5			
						80			20											20	70	10					
22	Pine Cove - Connellys point					100													100								
						100													100								
						100													100								
						100													100								
						100													100								
						100													100								
23	Sophia Pt rocky outcrop									90				10					100								10
										100									100								
										100									100								
										90				10					100								10
										100									100								
										100									100								
24			70						30											5	95						
							5	95												50	50						
							60		20		20					85				15							
							30		30		40									50	45			5			
							50	5	40		5									45	5			50			
							65		30		5									10	90						
25	Coal Head, rocky outcrop just off shore		50				5	40	5							5			45		30		15	5			
			70						30							10			80		5		5				
			25			5			70										95		5						
			50						50										45		25		30				
			30		30				40											85	10		5				
			25						75							10			50		10		30				
26	Just N of Dingy Point, base of cliffs		100																95				5				
			100																95				5				
			95				5									15			85								
			80				10	10											95				5				
			50				30	20											95				5				
			75					25								5			90				5				
27	Gould Pt		70					30										5	70				25				
						75		25							5				55				40				
			30		25			45							5			5	80				10				
			30					35	35									5	95								
							35	35	30									10	65				25				
			10				20	35	35						5				65				30				

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
28	Farm Cove, RHS island, rocky outcrop w weeds just offshore						30		70												5	95					
									100													100					
									100													85				15	
									95				5							20		80					
									100											15		85					
									100													80				20	
29	Between Farm					10			85				5						5				80		10	5	
						5		5	90														5		95		
						5		15	80										5				60		5	30	
						20		15	65										5						85	5	
						15		10	75										10				80			10	
						10		10	80										10				5		80	5	
30	Kelly Basin , rock wall, top of Basin		25											75					80				20				
			25				25							50			10		85				5				
		10	25				25							40		50			10				40				
			90											10					50				50				
		10	80											10					70				30				
			60											40		95			5								
31	S end Kelly Basin cliffs				50			5	40				5			15			80						5		
			50				5	10	35						5	30			60				5				
			30				20	30	20										90				10				
			50					20	30											95			5				
							70		30							10				70			20				
								50	50																		
32	Sarah Is rocky outcrop between 2 jetties, walking track above								100										5			95					
									100						5							95					
									100										10			40	50				
							10		90										5			50	45				
									100										5			80	15				
						15			85										5			80	15				
33	Below old gaol						25	30	35									25		75							
							65		35									40	10			5	45				
							40	10	50							20			25			10	45				
							15	10	75									30		5			20			45	
					45		30	15	10										80				20				
					15		15		70										70			10	20				

Site	Description	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red	OM	sand	mud	pebble	stone	rock	fil. green	fil. brown	turf alga	mussel	erect green	sea grass	fine red
		March 2012													November 2012												
34	Neck Is causeway					100													100								
35	Inside Cat Island gravel spit 50m				100													50	50								
36	other side Smiths						100													100							
37	Pine Cove Point				50				50										100								
38						100													100								
39	Yolla Pt (Recho Pt)					100													100								
40	Lettes Bay, beside train track			100											5		70			25							
															20		20		60								
															5		75		25								
																	25		75								
																	20		80								
															5	20	25		50								

Benefits and adoption

The beneficiaries of this research are the stakeholders involved in salmon aquaculture in Macquarie Harbour. However, the real benefits will not be identified until after the production of salmon has significantly increased when before-after expansion comparisons can be made to assess whether salmon farming is impacting on the environment of the Harbour.

Further development

Although the priority of this project was to collect scientifically robust baseline data, the macroalgal monitoring program was developed with a view towards later community involvement in the monitoring. Preliminary discussions have been held with the Community Liaison Officer from Tassal and the coastal representative from NRM Cradle Coast about expanding the project to include community monitoring, and both organisations have expressed a clear interest in developed this work in 2013.

Planned outcomes

This project is contributing to the planned outcome of a “well managed and sustainable salmon farming industry in Macquarie Harbour that is accepted by the general community” by providing a monitoring program that can be adapted to community involvement and by documenting the current distribution and cover of intertidal macroalgae before salmon farm production increases.

Conclusions

This project has achieved its objectives of developing an intertidal macroalgal monitoring program for Macquarie Harbor and collecting baseline data before the expansion of salmon production occurs. The distribution and percentage cover of the common macroalgal species at 40 sites throughout the Harbour in autumn and spring 2012 have been documented and photographs of each site and the algal species have been collated and stored on CD to enable assessment of change in the future.

References

Koehnken, L 1996, *Macquarie Harbour – King River Study, Technical Report, June 1996*. Dept. Of Environment and Land Management, Tasmania, 232pp.

Appendix 1 Intellectual Property

There are no intellectual issues associated with the project.

Appendix 2 Staff

Principal Investigator: Christine Crawford

Casual staff: Amelia Fowles

Appendix 3 Location of proposed salmon farm leases in Macquarie Harbour

Appendix 4 Comments on monitoring sites

Site	comments March	comments Nov
1	few twigs and leaves	all sand, little organic matter, no algae except couple of clumps near sag bases
2	green slime amongst sags, ~20cm submerged & bottom of logs, & submerged debris	some floating degrading fil. Green, little Enteromorpha
		sand under OM
		pebbles under
3	Boobyalla over shore	all pebbles/sand, no algae
		5-10% OM floating on top
4		lot of OM twigs/leaves, few spots green and brown fil alage, temp 21.1 C,sal 7.53, DO 11.3
5		all sand
6		
		Enteromorpha
7	low tide @1-2' depth, rocks coming out from point	temp 17.2 C, sal 6.8 ppt, 10.1 mg/l , TG3
	brown turf, branched filamentous brown	
8	temp 15.1 C, sal 16.1 ppt, DO 10.1 mg/l	temp 17.4 C, sal 4.5 ppt, 10.6 mg/l
	fil/turfing v fine	snorkelling 30m from shore, 80% mussels, half rock, half stones
		all sites sp change at 10-15cm depth
		most quadrats in 30 cm depth
9	temp 14.8 C, sal 14.2 ppt, DO 9.6 mg/l	temp 19.3 C, sal 7.85 ppt, 11.1 mg/l
		tide low, turf algae on top of rocks out of water
		G3
10	temp 15.8 C, sal 17.6 ppt, DO 10.6 mg/l	temp 17.0 C, sal 10.1 ppt, 9.6 mg/l
	site moved ~ 100m N, inside bay, more sheltered, just N of beach on rocks	
	short erect green	green slime
	10% long fil, 50% short fil.	
	25% encrusting green, bubble with midrib	
11	temp 15.5 C, sal 16.8 ppt, DO 11.1 mg/l	temp 17.0 C, sal 9.2 ppt, 9.6 mg/l. Site just N of beach on rocks, conditions poor
		42.34207 145.34657
	5% Cladophera, 5% foliose, 20% fil green	
12	temp 15.8 C, sal 14.7 ppt, DO 10.9 mg/l	

	sample of bubble green	
	80% bubble green	
13	green epiphytic and fil. Sample of balls of red	temp 16.2 C, sal 13.8 ppt, 9.4 mg/l.
		G4
14		temp 16.5 C, sal 12.9 ppt, 9.6 mg/l.
	90% turf like brown	
	5% bubble green	
	20% bubble green	
15	temp 15.8 C, sal 17.3 ppt, DO 10.9 mg/l	temp 16.9 C, sal 12.5 ppt, 10.45 mg/l.
	5% epiphytic red	
16	fil brown long fine sp	temp 16.0 C, sal 14.25 ppt, 9.3 mg/l. G4
	temp 15.8 C, sal 18.2 ppt, DO 9.9 mg/l	
		G4
	turf B	
17	temp 15.5 C, sal 18.0 ppt, DO 10.8 mg/l	temp 15.8 C, sal 17.2 ppt, 9.3 mg/l. G4
		G5
	fil green with some epi. Red	
	turf B ~ 1cm	
	turf B	
18	temp 15.8 C, sal 17.0 ppt, DO 9.0 mg/l	temp 15.5 C, sal 23.3 ppt, 7.7 mg/l. G4
19	temp 15.2 C, sal 20.5pt, DO 8.9 mg/l	temp 17.1 C, sal 24.5 ppt, 9.9 mg/l. G4 erect
20	turf B	temp 16.4 C, sal 31.1 ppt, 11.0 mg/l. G4
	temp 15.8 C, sal 28.0 ppt, DO 8.9 mg/l bottom	G4, Mytilus
	temp 15.4 C, sal 23.3 ppt, DO 9.1 mg/l surface	
	turf B	G4,
21	temp 16.2 C, sal 30.7 ppt, DO 9.0 mg/l 2.5 m	temp 16.1 C, sal 28.1 ppt, 10.35 mg/l. Fil green =curly sp, fil brown new
	long fil brown/red?	
	2 branched red/brown	Mytlis
	temp 15.2 C, sal 22 ppt, DO 9.1 mg/l surface	
	5% segmented curly red	
	branched redS	rock has fine layer of sediment, little slime
22	temp 13.9 C, sal 19.3 ppt, DO 8.9 mg/l	temp 20.2 C, sal8.5 ppt, 11.3 mg/l. G4
	stones with slime and finelayer of sediment	all stones, fine sediment, no algae
23	temp 14.5 C, sal 18.0 ppt	temp 21.7 C, sal 8.7 ppt, 11.75 mg/l.
	all turf is mixed with fine sediment	all stones with fine layer of sediment

		slime layer on rock
	new sp red	
24	branched fil red w epiphytic balls	temp 19.4 C, sal 8.5 ppt, DO 10.7 mg/l Fil green - Cladophera
	fil green with epiphytic branched red	
	rock w sediment, fil mix	
	photos taken at 20-30 cm depth epi red	
	temp 14.3 C, sal 18.8 ppt, DO 8.4 mg/l surface	
	fil combo of red and brown	
25	photos on Cannon	temp 19.7 C, sal 7.9 ppt, DO 10.2 mg/l Fil green - Cladophera
	fil combo	
	fil combo	
	fil combo	
	fil combo	
	fil combo	
26	temp 14.9 C, sal 16.2 ppt, DO 10.9 mg/l	temp 18.6 C, sal 7.8 ppt, DO 10.2 mg/l
	fil green erect fine branched	
	close to shore large rocks covered in fil green (% higher closer to shore	
	epi red on erect green (not balls)	
27	temp 14.4 C, sal 15.8 ppt, DO 8.9 mg/l	temp 17.8 C, sal 7.6 ppt, DO 10.2 mg/l
	fil green as above	
	fil brown-green combo	
	fil brown-green combo	
	fil brown-green combo	
28	temp 15.4 C, sal 15.4 ppt, DO 10.2 mg/l	temp 18.5 C, sal 6.65 ppt, 10.7 mg/l
	all mix of fine branched/fil species	entangled white/brown matt on rocks , 1-3 cm ht
	all with few blades seagrass	
	few blades seagrass	few mussels
29	temp 15.8 C, sal 15.9 ppt, DO 13.5 mg/l	temp 17.8 C, sal 6.6 ppt, 10.6 mg/l, Ruppia sp ?,
	all fil brown is fil mix	erect green branched with spirals G2 mat 2-3 cm high
		G2
	stones with green bubble & turf	turfing brown 1.5 cm high, long cells mid rib
	bubble green in fil brown mix	
30	temp 13.7 C, sal 2.7 ppt, 8.8 mg/l	temp 17.3 C, sal 8.2, DO 9.3
	all reds segmented	
	all sand with OM	
31	temp 16.9 C, sal 14.4 ppt, 11.2 mg/l	temp 17.5 C, sal 6.8 ppt, 9.7 mg/l, erect green TG1

	rocks w green bubbles	
32	temp 14.4 C, sal 10.0 ppt, 9.4 mg/l	temp 17.4 C, sal 4.5 ppt, 10.6 mg/l
	high tide rocks w bulbous green, below rocks w fil brown	
33	temp 15.2 C, sal 11.8 ppt, 10.7 mg/l	temp 17.8 C, sal 6.3 ppt, 10.5 mg/l
34	all small stones, no algae	
35	temp 14.3 C, sal 18.2 ppt, 8.9 mg/l	temp 16.0C, sal 19.0 ppt, 9.8 mg/l
36	rocks with mud/slime, no algae,	
37	rocks & pebbles, 2-3mm silt on top, towards shore 2-3 cm sludge	temp 21.5C, sal 8.2 ppt,10.6 mg/l
	temp 14.3 C, sal 18.4 ppt, 9.1 mg/l	100% fine sediment on rocks, 2mm deep (may be fil brown)
38	v slippery sediment/slime on stones 2-5mm, thicker in places	temp 18.6C, sal 9.4 ppt,11.0 mg/l Rocks & King R slime, v fine sediment
39	fine sediment on stones	rocks with 0.5 cm sludge
40	intertidal large rocks and mud, low tide all mud	no algae at site
		reeds