Fisherman Islands and Whyte Island

Mangrove Health Assessment

2010

Prepared for:

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frc environmental

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Appendix G Survey Data From Whyte Island 2010

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
GPS 10																									
9/03/10	1	516107.28	6970140.90	60	12	100				5	20		1	1	2	0	2	1	0	0	0	1	0	F	
9/03/10	2	516088.88	6970139.14	50	12	100				10	10		1	1	2	0	1	1	0	0	0	1	0	F	
9/03/10	3	516062.03	6970119.66	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	4	516062.14	6970119.82	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	5	516061.93	6970119.96	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	6	516060.81	6970122.41	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	7	516060.47	6970123.01	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	8	516059.67	6970123.58	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	9	516057.14	6970122.63	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	10	516054.36	6970121.73	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	11	516052.17	6970122.01	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	12	516051.50	6970121.88	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	13	516051.43	6970121.81	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	14	516051.17	6970121.86	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	15	516050.47	6970122.41	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	16	516049.47	6970122.76	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	17	516049.39	6970122.47	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	18	516049.60	6970121.42	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	19	516049.51	6970121.15	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	20	516049.52	6970120.65	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	21	516049.71	6970119.80	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	22	516049.65	6970115.84	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	23	516052.86	6970110.30	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	24	516053.85	6970109.69	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	25	516055.75	6970108.30	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	26	516056.86	6970109.71	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	27	516055.79	6970107.81	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	28	516056.65	6970107.19	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	29	516056.80	6970106.74	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	30	516058.16	6970105.68	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	31	516059.67	6970105.52	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	32	516059.55	6970106.75	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	33	516060.10	6970106.72	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	34	516060.69	6970106.79	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	35	516061.60	6970107.94	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	36	516061.98	6970108.29	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	37	516062.01	6970109.20	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	38	516062.78	6970110.95	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	38	516062.83	6970111.39	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	39	516063.23	6970111.80	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	40	516063.43	6970112.38	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	41	516063.52	6970112.85	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	42	516063.46	6970113.67	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	43	516059.80	6970113.23	50	14	100				20	10		1	1	2	0	1	1	0	0	0	3	0	F	
9/03/10	44	516058.59	6970113.39	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	45	516059.82	6970112.22	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	46	516060.99	6970110.27	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	47	516062.22	6970109.20	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	48	516062.37	6970107.99	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	49	516062.45	6970106.98	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	50	516061.77	6970106.05	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	51	516061.55	6970105.84	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	52	516058.03	6970105.31	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	53	516058.62	6970104.49	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	54	516058.61	6970104.74	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	55	516058.60	6970104.96	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	56	516058.88	6970108.26	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	57	516058.76	6970108.48	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	58	516059.20	6970109.60	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	59	516059.26	6970109.77	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	60	516059.06	6970110.89	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	61	516059.06	6970111.27	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	62	516059.56	6970112.11	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	63	516059.44	6970112.44	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	64	516060.15	6970113.21	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	65	516060.22	6970113.60	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	66	516060.34	6970114.03	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	67	516060.44	6970114.52	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	68	516060.55	6970114.94	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	69	516060.56	6970115.18	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	70	516012.70	6970099.57	40	14	100				5	20		0	0	1	0	1	1	2	0	0	3	0	RG	
9/03/10	71	516011.30	6970098.84	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	72	516011.26	6970098.93	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	73	516011.27	6970099.24	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	74	516011.27	6970099.66	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	75	516011.42	6970100.06	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	76	516011.66	6970100.71	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	77	516011.69	6970100.72	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	78	516011.75	6970100.35	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	79	516011.94	6970099.84	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	80	516012.16	6970099.46	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	81	516012.97	6970099.40	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	82	516013.44	6970099.10	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	83	516013.45	6970098.60	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	84	516013.02	6970098.76	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	85	516014.01	6970096.97	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	86	516014.43	6970095.01	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	87	516015.20	6970096.43	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	88	516015.98	6970097.37	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	89	516016.01	6970098.24	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	90	516017.23	6970098.54	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	91	516017.26	6970098.55	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	92	516017.21	6970098.54	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	93	516017.00	6970097.68	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	94	516016.66	6970096.00	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	95	516016.16	6970094.60	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	96	516018.66	6970091.62	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	97	516017.44	6970090.02	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	98	516018.19	6970087.67	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	99	516018.50	6970087.19	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	100	516019.94	6970089.75	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	101	516022.18	6970089.99	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	102	516025.87	6970087.25	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	103	516025.75	6970087.24	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	104	516026.21	6970086.25	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	105	516027.09	6970084.66	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	106	516026.58	6970083.95	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	107	516025.38	6970083.85	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	108	516024.93	6970083.57	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	109	516023.53	6970083.07	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	110	516023.45	6970081.42	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	111	516020.08	6970075.28	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	112	516020.41	6970075.05	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	113	516020.22	6970074.38	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	114	516019.99	6970073.73	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	115	516019.24	6970072.93	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	116	516018.65	6970072.33	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	117	516018.03	6970071.30	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	118	516017.63	6970070.69	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	119	516015.15	6970069.39	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	120	516015.02	6970068.07	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	121	516014.45	6970067.10	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	122	516013.84	6970064.99	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	123	516013.29	6970066.84	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	124	516012.13	6970066.70	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	125	516010.83	6970067.23	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	126	516010.46	6970067.71	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	127	516008.55	6970068.85	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	128	516007.23	6970071.78	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	129	516006.22	6970072.29	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	130	516005.47	6970072.06	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	131	516004.26	6970071.29	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	132	516001.52	6970070.66	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	133	515999.48	6970069.98	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	134	515997.83	6970068.71	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	135	515996.05	6970067.36	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	136	515994.65	6970067.40	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	137	515995.18	6970068.58	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	138	515994.26	6970067.42	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	139	515993.47	6970072.81	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	140	515992.85	6970073.03	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	141	515994.76	6970076.85	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	142	515997.18	6970077.08	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	143	515998.19	6970079.07	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	144	516000.32	6970079.33	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	145	516001.36	6970081.25	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	146	516006.25	6970087.64	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	147	516005.57	6970088.72	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	148	516005.64	6970089.48	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	149	516017.90	6970048.49	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	150	516014.43	6970050.90	40	14	100				30	25		1	1	2	0	2	2	2	0	0	1	0	F	
9/03/10	151	516009.36	6970051.90																3					F	
9/03/10	152	516005.79	6970051.92																3					F	
9/03/10	153	516001.92	6970049.59																3					F	
9/03/10	154	516012.11	6970010.44																3					F	
9/03/10	155	516016.48	6970006.71	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	156	516014.79	6970005.05	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	157	516010.53	6970000.10	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	158	516008.79	6969993.30	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	159	516002.12	6969980.85	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	160	515990.40	6969976.20	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	161	515985.75	6969969.14	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	162	515980.40	6969962.22	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	163	515968.23	6969949.05	50	14	90		10		10	10		1	1	2	0	1	1	4	2	0	3	0	F	
9/03/10	164	515966.36	6969950.20	45		65		10	25														2	F	
9/03/10	165	516107.28	6970140.90	45		65		10	25														2	F	
9/03/10	166	515964.72	6969950.45	45		65		10	25														2	F	
9/03/10	167	515962.96	6969951.50	45		65		10	25														2	F	
9/03/10	168	515960.37	6969953.38	45		65		10	25														2	F	
9/03/10	169	515960.25	6969953.50	45		65		10	25														2	F	
9/03/10	170	515955.03	6969955.05	45		65		10	25														2	F	
9/03/10	171	515951.82	6969955.02	45		65		10	25														2	F	
9/03/10	172	515949.68	6969956.85	45		65		10	25														2	F	
9/03/10	173	515949.84	6969953.84	45		65		10	25														2	F	
9/03/10	174	515949.48	6969952.58	45		65		10	25														2	F	
9/03/10	175	515950.95	6969952.58	45		65		10	25														2	F	
9/03/10	176	515951.48	6969951.12	45		65		10	25														2	F	
9/03/10	177	515952.36	6969950.08	45		65		10	25														2	F	
9/03/10	178	515958.26	6969947.76	45		65		10	25														2	F	
9/03/10	179	515956.22	6969943.67	45		65		10	25														2	F	
9/03/10	180	515955.80	6969941.67	45		65		10	25														2	F	
9/03/10	181	515954.74	6969939.59	45		65		10	25														2	F	
9/03/10	182	515954.70	6969938.15	45		65		10	25														2	F	
9/03/10	183	515954.84	6969937.20	45		65		10	25														2	F	
9/03/10	184	515956.20	6969936.97	45		65		10	25														2	F	
9/03/10	185	515957.13	6969937.99	45		65		10	25														2	F	
9/03/10	186	515965.30	6969936.89	45		65		10	25														2	F	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	187	515969.75	6969933.60	45		65		10	25														2	F	
9/03/10	188	515971.69	6969934.71	45		65		10	25														2	F	
9/03/10	189	515973.90	6969938.04	45		65		10	25														2	F	
9/03/10	190	515975.31	6969940.67	45		65		10	25														2	F	
9/03/10	191	515976.21	6969943.18	45		65		10	25														2	F	
9/03/10	192	515975.91	6969946.48	45		65		10	25														2	F	
9/03/10	193	515974.45	6969948.58	45		65		10	25														2	F	
9/03/10	194	515971.95	6969949.97	45		65		10	25														2	F	
9/03/10	195	515970.82	6969952.19	45		65		10	25														2	F	
9/03/10	196	515954.35	6969885.18	40		60	30		10															F	
9/03/10	197	515953.62	6969885.54	40		60	30		10															F	
9/03/10	198	515951.38	6969887.46	40		60	30		10															F	
9/03/10	199	515949.79	6969886.96	40		60	30		10															F	
9/03/10	200	515937.68	6969843.64																						
9/03/10	201	515937.84	6969843.03																						
9/03/10	202	515929.37	6969844.35																						No change
9/03/10	203	515906.72	6969821.69																					G	
9/03/10	204	515905.81	6969821.50																					G	
9/03/10	205	515908.44	6969821.60																					G	
9/03/10	206	515908.23	6969821.07																					G	2m wide patch of saltmarsh
9/03/10	207	515908.39	6969820.85																					G	
9/03/10	208	515908.96	6969829.25																					G	
9/03/10	209	515906.75	6969839.65																					G	
9/03/10	210	515891.56	6969749.80	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	211	515899.19	6969727.95																						
9/03/10	212	515914.31	6969691.41																						
9/03/10	213	515917.46	6969677.21																					RG	
9/03/10	214	515917.09	6969665.08																					RG	
9/03/10	215	515917.24	6969664.27																					RG	
9/03/10	216	515916.68	6969662.91																					RG	
9/03/10	217	515914.98	6969658.62																					RG	
9/03/10	218	515913.09	6969655.49																					RG	Area of previous dead - now RG with AM ~1-3m tall in epiphytic algae
9/03/10	219	515920.51	6969657.03																					RG	
9/03/10	220	515924.25	6969656.90																					RG	
9/03/10	221	515929.07	6969657.80																					RG	
9/03/10	222	515932.20	6969662.03																					RG	
9/03/10	223	515934.59	6969667.34																					RG	
9/03/10	224	515933.84	6969672.52																					RG	
9/03/10	225	515932.52	6969672.86																					D	Dead trees
9/03/10	226	515928.95	6969668.58																					D	
9/03/10	227	515932.22	6969667.14																					D	
9/03/10	228	515934.46	6969667.43																					D	
9/03/10	229	515936.32	6969668.91																					D	
9/03/10	230	515937.47	6969671.66																					D	
9/03/10	231	515937.64	6969672.72																					D	
9/03/10	232	515938.95	6969675.20																					D	
9/03/10	233	515936.81	6969676.36																					D	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	234	515933.72	6969680.29																					D	
9/03/10	235	515932.04	6969677.77																					D	
9/03/10	236	515935.44	6969677.80	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	237	515942.88	6969679.63	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	238	515945.62	6969674.47	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	239	515949.39	6969668.13	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	240	515955.55	6969651.42	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	241	515968.93	6969638.61	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	242	515973.49	6969633.70	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	243	515984.78	6969620.34	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	244	515986.99	6969619.16	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	245	515978.66	6969612.80	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	canopy height ~20m - older trees - very abundant epiphytic algae
9/03/10	246	515975.26	6969593.92	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	247	515971.38	6969586.96	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	248	515966.67	6969587.11	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	249	515956.49	6969584.06	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	250	515932.96	6969602.12	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	251	515927.41	6969603.88	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	252	515917.84	6969605.53	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	253	515904.15	6969606.22	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	254	515890.06	6969590.67	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	255	515884.76	6969580.71	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	256	515881.21	6969556.82	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	257	515881.61	6969559.94	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	Trees younger and denser
9/03/10	258	515881.98	6969559.33	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	259	515911.50	6969543.45																					RG	
9/03/10	260	515914.52	6969542.91																					RG	
9/03/10	261	515916.99	6969546.15																					RG	
9/03/10	262	515921.13	6969544.04																					RG	
9/03/10	263	515922.41	6969544.52																					RG	
9/03/10	264	515923.28	6969544.77																					RG	
9/03/10	265	515929.09	6969545.21																					RG	
9/03/10	266	515930.41	6969544.09																					RG	
9/03/10	267	515932.23	6969539.01																					RG	
9/03/10	268	515932.79	6969536.82																					RG	
9/03/10	269	515932.62	6969536.71																					RG	Surrounding several large dead trees
9/03/10	270	515929.46	6969534.93																					RG	
9/03/10	271	515928.58	6969535.09																					RG	
9/03/10	272	515927.52	6969534.87																					RG	
9/03/10	273	515926.25	6969534.88																					RG	
9/03/10	274	515925.68	6969534.63																					RG	
9/03/10	275	515923.95	6969534.13																					RG	
9/03/10	276	515922.19	6969534.04																					RG	
9/03/10	277	515919.85	6969535.91																					RG	
9/03/10	278	515920.03	6969538.86																					RG	
9/03/10	279	515919.91	6969539.31																					RG	
9/03/10	280	515928.29	6969544.10	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	

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GPS 10																									
9/03/10	281	515936.69	6969539.65	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	282	515940.21	6969532.08	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	283	515947.30	6969524.67	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	284	515959.80	6969519.02	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	285	515964.62	6969521.01	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	Decrease in health to fair
9/03/10	286	515961.79	6969521.96	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	287	515959.30	6969521.59	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	288	515958.01	6969518.77	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	289	515958.77	6969516.39	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	290	515957.37	6969514.60	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	291	515956.38	6969511.51	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	292	515955.03	6969511.05	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	293	515957.43	6969509.92	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	294	515958.16	6969511.62	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	295	515959.08	6969512.43	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	296	515960.09	6969512.78	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	297	515962.14	6969512.35	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	298	515964.97	6969511.82	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	299	515967.79	6969511.82	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	300	515969.65	6969510.67	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	301	515972.65	6969506.85	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	302	515976.33	6969504.62	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	303	515978.20	6969506.13	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	304	515981.19	6969507.85	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	305	515980.39	6969507.90	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	306	515982.60	6969506.81	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	307	515984.15	6969505.06	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	308	515987.22	6969503.57	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	309	515990.93	6969503.09	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	310	515993.52	6969503.65	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	311	515994.86	6969504.60	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	312	515994.22	6969507.22	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	313	515993.00	6969508.42	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	314	515991.76	6969508.80	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	315	515990.69	6969509.87	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	316	515990.98	6969512.15	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	317	515993.99	6969511.94	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	318	515993.16	6969512.80	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	319	515990.71	6969513.08	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	320	515989.42	6969515.11	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	321	515987.71	6969516.22	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	322	515983.96	6969516.12	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	323	515980.63	6969517.04	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	324	515977.99	6969517.95	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	325	515969.96	6969518.51	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	326	515963.72	6969518.13	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	327	515960.59	6969516.93	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	328	515958.24	6969517.92	40	15	80	20			25	25		1	1	2	0	1	2	2	0	0	1	2	F	
9/03/10	329	516001.60	6969494.62	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	330	516006.52	6969489.16	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	331	516007.96	6969482.90	20	2	100				50	5		1	1	1	0	1	1	2	0	0	3	3	RG	
9/03/10	332	516006.06	6969481.41																						
9/03/10	333	516004.40	6969476.14																						
9/03/10	334	516006.43	6969469.92																						
9/03/10	335	516006.72	6969470.40																						
9/03/10	336	516007.67	6969469.68																						
9/03/10	337	516010.23	6969470.44																						
9/03/10	338	516010.52	6969471.37																						
9/03/10	339	516012.98	6969472.29																						
9/03/10	340	516013.15	6969471.02																						
9/03/10	341	516013.88	6969471.64																						
9/03/10	342	516017.39	6969474.32																						
9/03/10	343	516021.95	6969478.19																						
9/03/10	344	516020.55	6969480.70																						
9/03/10	345	516018.62	6969484.77																						
9/03/10	346	516017.19	6969484.67																						
9/03/10	347	516010.47	6969484.03																						
9/03/10	348	516005.67	6969483.45																					RG	Area of regrowth - surrounding several large dead trees
9/03/10	349	515966.61	6969441.36	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	350	515967.03	6969438.67	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	351	515970.32	6969433.66	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	Trees younger and denser
9/03/10	352	515971.03	6969430.29	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	353	515965.94	6969424.69	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	354	515966.95	6969419.27	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	355	515902.49	6969405.23	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	356	515901.92	6969405.30	60	10		5			10	20		0	1	1	0	1	0	2	0	0	1	2	G	
9/03/10	357	515898.02	6969402.71			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	Area of poor health with dense salt marsh
9/03/10	358	515893.03	6969398.23			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	359	515885.36	6969393.83			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	360	515873.96	6969393.50			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	361	515864.66	6969394.33			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	362	515855.73	6969389.43			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	363	515845.72	6969391.06			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	364	515846.32	6969394.74			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	365	515846.79	6969401.63			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	366	515854.52	6969397.63			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	367	515864.23	6969396.42			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	368	515869.05	6969402.53			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	369	515868.63	6969406.07			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	370	515870.53	6969408.45			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	371	515872.81	6969415.19			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	372	515876.67	6969420.76			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	373	515880.26	6969425.50			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	374	515879.82	6969435.32			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	375	515883.81	6969434.30			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	376	515889.66	6969443.71			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	377	515901.76	6969446.20			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	378	515907.86	6969442.42			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	379	515908.49	6969438.11			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	380	515908.50	6969431.54			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	381	515914.46	6969422.47			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	382	515917.26	6969419.98			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	383	515920.37	6969422.02			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	384	515921.35	6969423.12			60	40			5	20		1	1	1	0	1	0	0	0	0	0	0	P	
9/03/10	385	515924.49	6969422.24			50	50			10	5		1	1	1	0	0	0	4	0	0	1	0	G	East of poor
9/03/10	386	516647.36	6970059.61	70	2			100		0	10		0	0	1	0	0	0	0	0	0	1	1	G	
9/03/10	387	516658.58	6970037.43	70	2			100		0	10		0	0	1	0	0	0	0	0	0	1	1	G	
9/03/10	388	516660.14	6970038.35																					B	Open salt marsh/grass
9/03/10	389	516660.57	6970038.08																					B	
9/03/10	390	516662.17	6970038.48																					B	
9/03/10	391	516667.70	6970041.09																					B	
9/03/10	392	516667.75	6970041.33																					B	
9/03/10	393	516668.60	6970040.71																					B	
9/03/10	394	516670.67	6970039.09																					B	
9/03/10	395	516673.38	6970037.39																					B	
9/03/10	396	516672.46	6970034.46																					B	
9/03/10	397	516667.99	6970034.07																					B	
9/03/10	398	516664.54	6970036.11																					B	
9/03/10	399	516661.89	6970037.13																					B	
9/03/10	400	516661.29	6970037.22			100																			All AM
9/03/10	401	516648.81	6970035.76			100																			
9/03/10	402	516646.93	6970031.19			100																			
9/03/10	403	516646.81	6970031.11			100																			
9/03/10	404	516646.50	6970030.88			100																			
9/03/10	405	516646.03	6970029.17			100																			
9/03/10	406	516642.93	6970025.93			100																			
9/03/10	407	516642.39	6970022.37			100																			
9/03/10	408	516640.67	6970018.63			100																			
9/03/10	409	516639.50	6970014.94			100																			
9/03/10	410	516636.24	6970011.77			100																			
9/03/10	411	516632.68	6970020.90			90		10		10	15		1	1	2	0	0	1	3	0	0	1	1	G	
9/03/10	412	516656.70	6970039.66																						line b/w AM & CT(running parallel to shore)
9/03/10	413	516696.44	6970036.00																						
9/03/10	414	516706.00	6970062.91	70	1.5	10		90		5	10		2	1	0	0	0	0	0	0	0	1	1	F	
9/03/10	415	516707.13	6970061.97																					P	lots of dead CT - overall health poor
9/03/10	416	516707.67	6970062.51																					P	

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9/03/10	417	516708.89	6970062.66																					P	
9/03/10	418	516710.23	6970063.10																					P	
9/03/10	419	516712.00	6970063.41																					P	
9/03/10	420	516713.38	6970064.10																					P	
9/03/10	421	516714.25	6970064.90																					P	
9/03/10	422	516715.71	6970065.52																					P	
9/03/10	423	516717.34	6970065.64																					P	
9/03/10	424	516718.48	6970065.29																					P	
9/03/10	425	516718.77	6970067.46																					P	
9/03/10	426	516720.54	6970068.84																					P	
9/03/10	427	516722.98	6970069.03																					P	
9/03/10	428	516725.69	6970068.92																					P	
9/03/10	429	516725.65	6970069.17																					P	
9/03/10	430	516725.60	6970068.56																					P	
9/03/10	431	516726.17	6970068.02																					P	
9/03/10	432	516727.22	6970070.79																					P	
9/03/10	433	516727.45	6970072.16																					P	
9/03/10	434	516727.36	6970072.37																					P	
9/03/10	435	516725.70	6970071.92																					P	
9/03/10	436	516724.39	6970072.82																					P	
9/03/10	437	516720.36	6970072.69																					P	
9/03/10	438	516717.51	6970073.89																					P	
9/03/10	439	516715.10	6970074.47																					P	
9/03/10	440	516714.67	6970074.36																						Edge of terrestrial with AC
9/03/10	441	516716.25	6970075.81																						
9/03/10	442	516717.11	6970079.48																						
9/03/10	443	516718.79	6970079.68																						
9/03/10	444	516721.82	6970079.99																						
9/03/10	445	516724.82	6970079.59																						
9/03/10	446	516727.66	6970079.22																						
9/03/10	447	516729.66	6970080.19																						
9/03/10	448	516729.72	6970080.20																						
9/03/10	449	516729.81	6970080.23																						
9/03/10	450	516733.06	6970081.09																						
9/03/10	451	516736.32	6970082.12																						
9/03/10	452	516742.31	6970083.78																						
9/03/10	453	516746.08	6970084.47																						
9/03/10	454	516749.03	6970085.07																						
9/03/10	455	516749.45	6970080.43																					P	
9/03/10	456	516752.19	6970077.89																					P	
9/03/10	457	516755.58	6970078.66																					P	
9/03/10	458	516758.54	6970079.58																					P	
9/03/10	459	516760.37	6970078.29																					P	
9/03/10	460	516759.38	6970076.76																					P	
9/03/10	461	516759.81	6970075.20																					P	
9/03/10	462	516760.60	6970074.01																					P	
9/03/10	463	516759.06	6970072.31																					P	

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9/03/10	464	516757.10	6970072.47																					P	
9/03/10	465	516755.74	6970071.85																					P	
9/03/10	466	516753.23	6970070.49																					P	
9/03/10	467	516751.84	6970070.54																					P	
9/03/10	468	516749.67	6970072.22																					P	
9/03/10	469	516749.62	6970073.11																					P	
9/03/10	470	516751.18	6970075.26																					P	
9/03/10	471	516793.23	6970070.82																					P	
9/03/10	472	516809.24	6970057.21																					D	
9/03/10	473	516811.63	6970057.01																					D	
9/03/10	474	516813.38	6970058.74																					D	
9/03/10	475	516815.20	6970061.38																					D	
9/03/10	476	516816.13	6970063.68																					D	
9/03/10	477	516817.95	6970065.15																					D	
9/03/10	478	516820.07	6970066.61																					D	
9/03/10	479	516821.36	6970066.71																					D	
9/03/10	480	516821.47	6970063.66																					D	
9/03/10	481	516821.82	6970063.62																					D	
9/03/10	482	516822.83	6970063.97																					D	
9/03/10	483	516823.33	6970063.20																					D	
9/03/10	484	516824.42	6970053.00																					D	
9/03/10	485	516823.05	6970052.40																					D	
9/03/10	486	516821.31	6970051.10																					D	
9/03/10	487	516819.01	6970047.58																					D	
9/03/10	488	516835.08	6970032.92																					D	
9/03/10	489	516834.19	6970030.94																					D	
9/03/10	490	516833.09	6970029.42																					D	
9/03/10	491	516831.61	6970027.34																					D	
9/03/10	492	516830.93	6970024.69																					D	
9/03/10	493	516830.82	6970021.58																					D	
9/03/10	494	516830.20	6970019.55																					D	
9/03/10	495	516829.61	6970014.79																					D	
9/03/10	496	516835.35	6970013.91																					D	
9/03/10	497	516838.06	6970010.62																					D	
9/03/10	498	516841.92	6970003.78																					D	
9/03/10	499	516846.99	6970001.59																					D	
9/03/10	500	516851.11	6970003.72																					D	
9/03/10	501	516851.84	6970007.39																					D	
9/03/10	502	516850.03	6970012.11																					D	
9/03/10	503	516848.46	6970021.79																					D	
9/03/10	504	516851.10	6970029.85																					D	
9/03/10	505	516851.85	6970035.76																					D	
9/03/10	506	516847.79	6970041.14																					D	
9/03/10	507	516845.87	6970045.91																						
9/03/10	508	516845.96	6970050.09																						
9/03/10	509	516846.14	6970052.56																						
9/03/10	510	516844.07	6970056.01																						

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9/03/10	511	516845.20	6970062.63																						
9/03/10	512	516846.06	6970065.04																						
9/03/10	513	516845.86	6970071.38																						
9/03/10	514	516850.09	6970068.67	50%	4	60		40		10%	10%		1	2	1	0	0	1	0	0	0	1	1	G	
9/03/10	515	516851.33	6970069.68																						
9/03/10	516	516852.67	6970070.80																						
9/03/10	517	516855.90	6970075.23																						
9/03/10	518	516876.61	6970070.05																						
9/03/10	519	516913.17	6970039.53																					P	
9/03/10	520	516950.47	6970007.33			80		20		10%	10%		1	2	1	0	0	1	0	0	0	1	1	G	
9/03/10	521	516956.08	6969993.42																						
9/03/10	522	516955.89	6969993.20																						
9/03/10	523	516955.58	6969992.82																						
9/03/10	524	516955.23	6969992.58																						
9/03/10	525	516955.51	6969992.53																						
9/03/10	526	516955.50	6969992.22																						
9/03/10	527	516955.06	6969991.98																						
9/03/10	528	516958.29	6969976.65																						
9/03/10	529	516956.64	6969962.47																						
9/03/10	530	516956.83	6969958.13																						
9/03/10	531	516942.98	6969933.11																						
9/03/10	532	516924.25	6969938.96																					G	
9/03/10	533	516890.57	6969989.17																					P	
9/03/10	534	516825.13	6970011.35																					G	
9/03/10	535	516819.30	6970078.51																						
9/03/10	536	516806.34	6970073.87																					G/P	
9/03/10	488	516835.08	6970032.92																					D	
9/03/10	489	516834.19	6970030.94																					D	
9/03/10	490	516833.09	6970029.42																					D	
9/03/10	491	516831.61	6970027.34																					D	
9/03/10	492	516830.93	6970024.69																					D	
9/03/10	493	516830.82	6970021.58																					D	
9/03/10	494	516830.20	6970019.55																					D	
9/03/10	495	516829.61	6970014.79																					D	
9/03/10	496	516835.35	6970013.91																					D	
9/03/10	497	516838.06	6970010.62																					D	
9/03/10	498	516841.92	6970003.78																					D	
9/03/10	499	516846.99	6970001.59																					D	
9/03/10	500	516851.11	6970003.72																					D	
9/03/10	501	516851.84	6970007.39																					D	
9/03/10	502	516850.03	6970012.11																					D	
9/03/10	503	516848.46	6970021.79																					D	
9/03/10	504	516851.10	6970029.85																					D	
9/03/10	505	516851.85	6970035.76																					D	
9/03/10	506	516847.79	6970041.14																					D	
9/03/10	507	516845.87	6970045.91																						
9/03/10	508	516845.96	6970050.09																						

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	509	516846.14	6970052.56																						
9/03/10	510	516844.07	6970056.01																						
9/03/10	511	516845.20	6970062.63																						
9/03/10	512	516846.06	6970065.04																						
9/03/10	513	516845.86	6970071.38																						
9/03/10	514	516850.09	6970068.67	50%	4	60		40		10%	10%		1	2	1	0	0	1	0	0	0	1	1	G	
9/03/10	515	516851.33	6970069.68																						
9/03/10	516	516852.67	6970070.80																						
9/03/10	517	516855.90	6970075.23																						
9/03/10	518	516876.61	6970070.05																						
9/03/10	519	516913.17	6970039.53																					P	
9/03/10	520	516950.47	6970007.33			80		20		10%	10%		1	2	1	0	0	1	0	0	0	1	1	G	
9/03/10	521	516956.08	6969993.42																						
9/03/10	522	516955.89	6969993.20																						
9/03/10	523	516955.58	6969992.82																						
9/03/10	524	516955.23	6969992.58																						
9/03/10	525	516955.51	6969992.53																						
9/03/10	526	516955.50	6969992.22																						
9/03/10	527	516955.06	6969991.98																						
9/03/10	528	516958.29	6969976.65																						
9/03/10	529	516956.64	6969962.47																						
9/03/10	530	516956.83	6969958.13																						
9/03/10	531	516942.98	6969933.11																						
9/03/10	532	516924.25	6969938.96																					G	
9/03/10	533	516890.57	6969989.17																					P	
9/03/10	534	516825.13	6970011.35																					G	
9/03/10	535	516819.30	6970078.51																						
9/03/10	536	516806.34	6970073.87																					G/P	
12/03/10	1	516491.36	6968883.23																					B	
12/03/10	2	516500.04	6968864.65																					B	
12/03/10	3	516502.09	6968813.31																					B	
12/03/10	4	516508.35	6968790.09																					B	
12/03/10	5	516534.80	6968776.35																					B	
12/03/10	6	516566.41	6968759.03																					B	
12/03/10	7	516570.70	6968735.94																					B	
12/03/10	8	516579.78	6968674.73																					B	
12/03/10	9	516589.66	6968621.87																					B	
12/03/10	10	516582.74	6968592.28																					B	
12/03/10	11	516543.39	6968516.98																					B	
12/03/10	12	516532.07	6968445.17																					B	
12/03/10	13	516519.10	6968397.39																					B	
12/03/10	14	516531.54	6968380.89																					B	
12/03/10	15	516536.70	6968372.64																					B	
12/03/10	16	516539.14	6968314.77																					B	
12/03/10	17	516533.85	6968298.70																					B	
12/03/10	18	516541.46	6968238.80																					B	
12/03/10	19	516542.74	6968231.64																					B	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	20	516541.69	6968201.52																					B	
12/03/10	21	516543.35	6968199.46	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	22	516559.14	6968187.81	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	23	516565.46	6968188.18	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	24	516573.94	6968185.02	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	25	516594.12	6968171.76	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	26	516629.80	6968170.24	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	27	516636.45	6968165.19	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	28	516628.92	6968159.01	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	29	516585.51	6968159.70	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	30	516563.28	6968182.55	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	31	516553.96	6968177.82	50%	3	100				0%	20%		1	1	2	0	0	1	0	0	0	1	0	D	
12/03/10	32	516553.22	6968177.85																					D	
12/03/10	33	516552.89	6968162.36																					D	
12/03/10	34	516563.00	6968130.07																					D	
12/03/10	35	516576.07	6968095.96																					D	
12/03/10	36	516595.51	6968097.12																					D	
12/03/10	37	516604.26	6968090.26																					D	
12/03/10	38	516582.65	6968088.65																					D	
12/03/10	39	516577.59	6968077.90																					F	
12/03/10	40	516566.59	6968073.50																					F	
12/03/10	41	516571.15	6968015.77																					D	
12/03/10	42	516582.63	6967958.69																					D	
12/03/10	43	516638.59	6967940.27																					D	
12/03/10	44	516639.23	6967937.93																					D	
12/03/10	45	516694.76	6967939.92																					D	
12/03/10	46	516715.25	6967921.71																					RG	
12/03/10	47	516712.04	6967899.58																					RG	
12/03/10	48	516712.06	6967898.48																					RG	
12/03/10	49	516697.46	6967903.32																					RG	
12/03/10	50	516689.65	6967920.44																					RG	
12/03/10	51	516689.78	6967926.49																					RG	
12/03/10	52	516712.70	6967899.70																					D	
12/03/10	53	516722.07	6967884.15	50%	6	100				20%	30%		2	1	2	0	2	1	0	0	0	1	1	P	
12/03/10	54	516728.64	6967893.95																					D	
12/03/10	55	516794.48	6967855.54																					D	
12/03/10	56	516781.57	6967829.80																					D	
12/03/10	57	516786.31	6967813.55																					D	
12/03/10	58	516804.30	6967772.90																					D	
12/03/10	59	516821.59	6967757.60																					D	
12/03/10	60	516826.12	6967761.37																					D	
12/03/10	61	516832.59	6967758.34																					D	
12/03/10	62	516833.97	6967736.23																					D	
12/03/10	63	516833.97	6967720.75																					D	
12/03/10	64	516814.16	6967710.31																					D	
12/03/10	65	516844.11	6967704.72																					D	
12/03/10	66	516867.25	6967754.01																					D	

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12/03/10	67	516885.87	6967747.05																					D	
12/03/10	68	516914.35	6967773.42																					D	
12/03/10	69	516924.41	6967786.00																					D	
12/03/10	70	516929.00	6967793.41																					RG	
12/03/10	71	516932.23	6967809.21																					RG	
12/03/10	72	516940.74	6967811.89																					RG	
12/03/10	73	516943.97	6967828.07																					RG	
12/03/10	74	516958.12	6967832.38																					RG	
12/03/10	75	516973.79	6967832.83																					RG	
12/03/10	76	516992.28	6967824.63																					RG	
12/03/10	77	517015.78	6967854.02																					RG	
12/03/10	78	517011.41	6967865.19																					RG	
12/03/10	79	516986.70	6967850.70																					RG	
12/03/10	80	516977.91	6967846.59																					RG	
12/03/10	81	516971.69	6967849.07																					RG	
12/03/10	82	516963.87	6967865.34																					RG	
12/03/10	83	516978.98	6967877.18																					RG	
12/03/10	84	516986.95	6967888.88																					RG	
12/03/10	85	516965.49	6967898.39																					RG	
12/03/10	86	516953.62	6967932.41																					RG	
12/03/10	87	516958.20	6967943.88																					RG	
12/03/10	88	516976.56	6967974.26																					RG	
12/03/10	89	516979.18	6967990.99																					RG	
12/03/10	90	516972.37	6968004.44																					RG	
12/03/10	91	517000.87	6968041.91																					RG	
12/03/10	92	516992.21	6968060.87																					RG	
12/03/10	93	516987.53	6968069.04																					RG	
12/03/10	94	517002.38	6968087.05																					RG	
12/03/10	95	517001.30	6968093.14																					RG	
12/03/10	96	516995.96	6968110.30																					RG	
12/03/10	97	516984.15	6968150.01																					RG	
12/03/10	98	516988.89	6968168.68																					RG	
12/03/10	99	516989.81	6968195.56																					RG	
12/03/10	100	516995.12	6968225.19																					RG	
12/03/10	101	516975.42	6968242.06																					RG	
12/03/10	102	516961.80	6968226.58																					RG	
12/03/10	103	516958.11	6968200.84																						
12/03/10	104	516963.28	6968167.98																						
12/03/10	105	516963.66	6968158.73																						
12/03/10	106	516950.86	6968144.53																						
12/03/10	107	516951.09	6968138.48																						
12/03/10	108	516945.81	6968131.15																						
12/03/10	109	516952.18	6968108.42																						
12/03/10	110	516934.67	6968096.05																						
12/03/10	111	516915.30	6968087.10																						
12/03/10	112	516928.56	6968076.17																						
12/03/10	113	516931.15	6968058.10																						

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12/03/10	114	516919.56	6968008.15																						
12/03/10	115	516897.81	6967987.38																						
12/03/10	116	516888.62	6967983.21																						
12/03/10	117	516880.49	6967982.73																					B	
12/03/10	118	516868.99	6967988.37																					B	
12/03/10	119	516843.03	6968004.18																					B	
12/03/10	120	516818.15	6968005.20																					B	
12/03/10	121	516804.43	6968016.79																					B	
12/03/10	122	516782.54	6968043.07																					B	
12/03/10	123	516796.68	6968011.31																					B	
12/03/10	124	516814.65	6967998.46																					B	
12/03/10	125	516833.82	6968010.82																					D	
12/03/10	126	516842.11	6968018.87																					B	
12/03/10	127	516836.78	6968062.04																					B	
12/03/10	128	516818.60	6968032.84																					B	
12/03/10	129	516821.87	6968017.96																					B	
12/03/10	130	516845.02	6968016.04																					B	
12/03/10	131	516864.36	6968058.64																					D	
12/03/10	132	516870.72	6968067.17																					D	
12/03/10	133	516881.96	6968092.62																					D	
12/03/10	134	516901.42	6968132.23																					D	
12/03/10	135	516914.41	6968151.70																					D	
12/03/10	136	516932.81	6968214.43																					D	
12/03/10	137	516930.63	6968239.00																					D	
12/03/10	138	516966.76	6968282.83																					D	
12/03/10	139	517001.08	6968340.15																					D	
12/03/10	140	516984.36	6968383.21																					D	
12/03/10	141	516979.11	6968427.48																					D	
12/03/10	142	516974.55	6968471.33																					D	
12/03/10	143	516960.13	6968505.27																					D	
12/03/10	144	516900.82	6968614.60																					D	
12/03/10	145	516847.69	6968673.37																					D	
12/03/10	146	516813.46	6968643.02																					D	
12/03/10	147	516769.19	6968585.12																					D	
12/03/10	148	516774.02	6968599.80																					D	
12/03/10	149	516775.96	6968632.27																					D	
12/03/10	150	516756.62	6968666.91																					D	
12/03/10	151	516775.21	6968656.90																					D	
12/03/10	152	516789.60	6968684.92																					D	
12/03/10	153	516766.06	6968680.63																					D	
12/03/10	154	516719.16	6968745.91																					D	
12/03/10	155	516693.02	6968766.31																					D	
12/03/10	156	516674.13	6968791.09																					D	
12/03/10	157	516660.50	6968823.75																					D	
12/03/10	158	516640.79	6968848.29																					D	
12/03/10	159	516649.34	6968864.31																					D	
12/03/10	160	516624.21	6968921.81	50%	2.5	90		10		20%	30%		2	1	1	0	1	1	0	0	0	1	1	F	

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12/03/10	161	516596.41	6968870.12																					D	
12/03/10	162	516553.24	6968851.81																					D	
12/03/10	163	516521.66	6968872.45																					D	
12/03/10	164	516517.08	6968871.62																					D	
12/03/10	165	516507.06	6968909.90																					B	
12/03/10	166	516471.46	6968974.62																					B	
12/03/10	167	516604.70	6969015.07	40%	10	100				40%	20%		1	1	2	0	2	2	0	0	0	2	2	P	
12/03/10	168	516644.27	6968961.65																						
12/03/10	169	516638.86	6968951.54																						
12/03/10	170	516651.45	6968948.40																						
12/03/10	171	516822.88	6968873.33																						
12/03/10	172	516935.54	6968853.77	60%	15	100				20%	20%		1	1	0	0	1	1	3	0	0	2	2	G	
12/03/10	173	516934.19	6968836.95	60%	15	100				20%	20%		1	1	0	0	1	1	3	0	0	2	2	G	
12/03/10	174	516957.10	6968817.51	60%	15	100				20%	20%		1	1	0	0	1	1	3	0	0	2	2	G	
12/03/10	175	516986.09	6968805.74	60%	15	100				20%	20%		1	1	0	0	1	1	3	0	0	2	2	G	
12/03/10	176	517025.54	6968765.42	60%	15	100				20%	20%		1	1	0	0	1	1	3	0	0	2	2	G	
12/03/10	177	517052.79	6968751.76																					G/F	
12/03/10	178	517088.52	6968772.55																						
12/03/10	179	517145.54	6968656.42		1	100				0%	0%		1	1	2	0	0	1	1	0	0	3	1	RG	
12/03/10	180	517140.77	6968648.15																						
12/03/10	181	517171.14	6968543.64																						
12/03/10	182	517174.46	6968517.23																						
12/03/10	183	517191.45	6968436.33																						
12/03/10	184	517176.47	6968389.36																						
12/03/10	185	517177.95	6968355.33																						
12/03/10	186	517166.16	6968342.63																					G/F	
12/03/10	187	517160.72	6968294.22																					G/F	
12/03/10	188	517139.49	6968250.93	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	189	517135.99	6968262.67	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	190	517127.43	6968285.12	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	191	517129.26	6968314.56	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	192	517101.52	6968315.56	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	193	517086.33	6968291.89	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	194	517086.12	6968288.49	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	195	517101.26	6968237.02	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	196	517123.75	6968212.89	30%	10	100				50%	50%		1	1	2	0	3	2	0	0	0	2	1	P	
12/03/10	197	517130.39	6968214.60																					RG	
12/03/10	198	517132.70	6968208.14																					RG	
12/03/10	199	517131.54	6968218.97																					RG	
12/03/10	200	517128.48	6968225.50																					RG	
12/03/10	201	517142.55	6968206.56	60%	15	100							1	1	1	0	1	1	0	0	0	2	2	F	
12/03/10	202	517144.87	6968185.16																						
12/03/10	203	517147.81	6968170.47																						
12/03/10	204	517150.72	6968154.91																					F/P	
12/03/10	205	517177.87	6968112.82																					G/F	
12/03/10	206	517177.05	6968066.57																						
12/03/10	207	517177.33	6968066.49																					G	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	208	517148.21	6968040.69																					G	
12/03/10	209	517133.06	6968038.95																					G/F	
12/03/10	210	517119.21	6968005.96																					F/P	
12/03/10	211	517132.43	6968005.39																					F/P	
12/03/10	212	517098.13	6967943.62																					F	
12/03/10	213	517058.39	6967926.87																						
12/03/10	214	517032.12	6967912.00																					P	
12/03/10	215	516988.98	6967926.28																					RG	
12/03/10	216	516977.95	6967915.39																					RG	
12/03/10	217	516975.54	6967893.15																					RG	
12/03/10	218	516814.65	6967723.30																					D	
12/03/10	219	516808.07	6967711.20																					D	
12/03/10	220	516811.50	6967693.95																					D	
12/03/10	221	516661.99	6967680.21																					RG	
12/03/10	222	516654.24	6967692.39																					RG	
12/03/10	223	516664.24	6967701.45																					RG	
12/03/10	224	516666.34	6967680.71																					F	
12/03/10	225	516680.00	6967744.72																					D	
12/03/10	226	516682.86	6967755.97																					D	
12/03/10	227	516705.12	6967811.94																					F	
12/03/10	228	516651.22	6967931.59	100%		100				20%	20%			1	2	0	3	2	0	0	0	2	2	F	
12/03/10	229	516636.84	6967919.07	100%		100				20%	20%			1	2	0	3	2	0	0	0	2	2	F	
12/03/10	230	516582.87	6967927.10	100%		100				20%	20%			1	2	0	3	2	0	0	0	2	2	F	
12/03/10	231	516569.33	6967946.62	100%		100				20%	20%			1	2	0	3	2	0	0	0	2	2	F	
12/03/10	232	516568.07	6967949.74																					F	
12/03/10	233	516562.69	6967968.40																					F	
12/03/10	234	516554.24	6968003.52																					F	
12/03/10	235	516544.12	6968023.79																					F	
12/03/10	236	516546.73	6968063.18																					F	
12/03/10	237	516551.50	6968078.06																					P	
12/03/10	238	516548.53	6968122.55																					P	
12/03/10	239	516531.29	6968165.91																					P	
12/03/10	240	516521.92	6968200.85																					P	
12/03/10	241	516510.19	6968232.43																					P	
12/03/10	242	516511.77	6968342.50																					P	
12/03/10	243	516500.11	6968383.78																					P	
12/03/10	244	516516.60	6968392.26																					P	
12/03/10	245	516512.22	6968398.30																					B	
12/03/10	246	516515.80	6968409.15																					B	
12/03/10	247	516515.28	6968455.04																					B	
12/03/10	248	516523.70	6968475.33																					B	
12/03/10	249	516529.90	6968502.42																					B	
12/03/10	250	516535.20	6968535.00																					B	
12/03/10	251	516567.49	6968570.91																					B	
12/03/10	252	516581.08	6968661.71																					B	
12/03/10	253	516563.84	6968743.49																					B	
12/03/10	254	516491.88	6968834.98																					B	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	255	516489.81	6968866.68																					B	
12/03/10	256	516473.44	6968956.48																					B	
12/03/10	257	516616.76	6968642.08																					P	
12/03/10	258	516629.49	6968620.41																					P	
12/03/10	259	516663.01	6968598.90																					P	
12/03/10	260	516686.64	6968596.32																					P	
12/03/10	261	516700.28	6968587.57																					P	
12/03/10	262	516699.14	6968553.06																					P	
12/03/10	263	516736.58	6968558.32																					P	
12/03/10	264	516736.54	6968558.34																						
12/03/10	265	516723.15	6968530.41																						
12/03/10	266	516785.41	6968466.83																						
12/03/10	267	516808.59	6968425.85																						
12/03/10	268	516810.85	6968402.69																					P	
12/03/10	269	516812.76	6968377.11																					P	
12/03/10	270	516802.27	6968320.81																					P	
12/03/10	271	516826.91	6968279.15																					P	
12/03/10	272	516807.08	6968254.18																					P	
12/03/10	273	516769.61	6968204.34																					P	
12/03/10	274	516755.67	6968172.27																					P	
12/03/10	275	516759.07	6968134.92																					P	
12/03/10	276	516751.71	6968104.57																					P	
12/03/10	277	516752.17	6968103.23																					F	
12/03/10	278	516731.39	6968093.82																					F	
12/03/10	279	516713.66	6968106.32																					F	
12/03/10	280	516694.25	6968102.27																					F	
12/03/10	281	516652.73	6968157.68																					F	
12/03/10	282	516649.50	6968153.39																					F	
12/03/10	283	516655.69	6968139.31																					F	
12/03/10	284	516649.98	6968137.63																					F	
12/03/10	285	516623.97	6968143.93																					F	
12/03/10	286	516622.29	6968164.01																					F	
12/03/10	287	516577.53	6968175.75																					F	
12/03/10	288	516548.88	6968189.15																					F	
12/03/10	289	516536.43	6968203.08																					F	
12/03/10	290	516521.30	6968273.24																					B	
12/03/10	291	516520.82	6968302.18																					B	
12/03/10	292	516533.60	6968324.79																					B	
12/03/10	293	516533.21	6968363.72																					B	
12/03/10	294	516541.14	6968398.84																					B	
12/03/10	295	516795.78	6968978.96																					G/F	
12/03/10	296	516722.51	6968750.76																					P	
12/03/10	297	516754.40	6968717.96																					P	
12/03/10	298	516865.79	6968851.97																						
12/03/10	299	517130.23	6968344.74																						
12/03/10	300	517123.30	6968353.93																					RD	
12/03/10	301	517115.55	6968351.91																						

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	302	517115.81	6968358.18																						
12/03/10	303	517125.43	6968349.20																						
12/03/10	304	517073.69	6968360.15																					F/P	
12/03/10	305	517073.88	6968360.27																					D	
12/03/10	306	517038.08	6968376.82																					D	
12/03/10	307	517036.70	6968385.09																					D	
12/03/10	308	517037.11	6968390.54																					D	
12/03/10	309	517045.47	6968403.88																					D	
12/03/10	310	517029.72	6968409.56																					D	
12/03/10	311	517029.95	6968419.82																					D	
12/03/10	312	517017.07	6968414.31																					D	
12/03/10	313	517023.00	6968400.13																					D	
12/03/10	314	517016.35	6968386.35																					D	
12/03/10	315	517025.07	6968362.40																					D	
12/03/10	316	516996.19	6968179.58																					D	
12/03/10	317	517125.51	6968149.83																					RD	
12/03/10	318	517129.31	6968146.76																						
12/03/10	319	517137.78	6968144.81																						
12/03/10	320	517140.50	6968153.67																						
12/03/10	321	517136.90	6968157.19																						
12/03/10	322	517131.02	6968141.16																						
12/03/10	323	517037.55	6967633.49																					F	
12/03/10	324	517040.55	6967662.01																					RG	
12/03/10	325	517028.19	6967658.05																					RG	
12/03/10	326	517017.17	6967651.72																					RG	
12/03/10	327	517027.22	6967638.11																					RG	
12/03/10	328	517039.77	6967654.95																					RG	
12/03/10	329	517040.27	6967654.12																					RG	
12/03/10	330	517056.68	6967660.69																					RG	
12/03/10	331	517068.12	6967670.78																					RG	
12/03/10	332	517048.50	6967665.30																					RG	
12/03/10	333	516913.61	6967772.07																					D	
12/03/10	334	516918.08	6967767.87																					D	
12/03/10	335	516921.53	6967758.95																					D	
12/03/10	336	516933.94	6967769.08																					D	
12/03/10	337	516962.24	6967732.31																					D	
12/03/10	338	516948.08	6967707.37																					D	
12/03/10	339	516946.76	6967704.53																					RG	
12/03/10	340	516912.62	6967702.06																					RG	
12/03/10	341	516905.08	6967710.53																					RG	
12/03/10	342	516935.32	6967720.46																					RG	
12/03/10	343	516951.71	6967719.81																					RG	
12/03/10	344	516948.16	6967703.13																					D	
12/03/10	345	516974.99	6967689.20																					D	
12/03/10	346	516992.22	6967689.65																					D	
12/03/10	347	517040.19	6967680.78																					D	
12/03/10	348	517024.77	6967675.41																					D	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	349	516999.02	6967655.15																					D	
12/03/10	350	517024.82	6967653.39																					D	
12/03/10	351	517053.74	6967660.54																					D	
12/03/10	352	517042.74	6967688.21																					D	
12/03/10	353	517043.39	6967705.69																					D	
12/03/10	354	517040.62	6967747.21																					D	
12/03/10	355	517016.90	6967760.35																					D	
12/03/10	356	517007.27	6967741.91																					D	
12/03/10	357	516986.24	6967757.20																					D	
12/03/10	358	516962.38	6967760.92																					D	
12/03/10	359	516956.30	6967761.17																						
12/03/10	360	516957.50	6967761.77																					D	
12/03/10	361	516971.18	6967779.37																					D	
12/03/10	362	516943.41	6967788.53																					D	
12/03/10	363	516939.37	6967777.80																					D	
12/03/10	364	516926.32	6967788.35																					D	
12/03/10	365	516779.82	6967793.40																					D	
12/03/10	366	516776.88	6967782.14																					F/P	
12/03/10	367	516785.90	6967738.82																					F/P	
12/03/10	368	516789.25	6967702.25																					F/P	
12/03/10	369	516789.70	6967680.10																					F/P	
12/03/10	370	516797.96	6967654.09																					F/P	
12/03/10	371	516814.56	6967639.10																					F/P	
12/03/10	372	516824.93	6967638.44																					F/P	
12/03/10	373	516838.49	6967658.72																					F/P	
12/03/10	374	516883.80	6967684.39																					F/P	
12/03/10	375	516914.14	6967688.41																					F/P	
12/03/10	376	516926.34	6967682.98																					F/P	
12/03/10	377	516950.21	6967674.20																					RG	
12/03/10	378	516964.06	6967663.73																					F/P	
12/03/10	379	516988.28	6967635.29																					F/P	
12/03/10	380	517017.46	6967627.25																					F/P	
12/03/10	381	517052.09	6967639.57																					F/P	
12/03/10	382	517085.28	6967652.25																					F/P	
12/03/10	383	517086.78	6967653.72																					RG	
12/03/10	384	517098.30	6967673.23																					RG	
12/03/10	385	517092.75	6967680.00																						
12/03/10	386	517084.43	6967705.74																						
12/03/10	387	517084.32	6967743.59																						
12/03/10	388	517070.14	6967773.94																						
12/03/10	389	517059.20	6967794.83																					RG	
12/03/10	390	517054.45	6967848.32																					F/P	
12/03/10	391	517048.03	6967897.46																					F/P	
12/03/10	392	517053.90	6967940.47																					F/P	
12/03/10	393	517055.55	6967975.67																					F/P	
12/03/10	394	517056.88	6968003.95																					F/P	
12/03/10	395	517082.79	6968052.44																					F/P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	396	517084.39	6968087.53																					F/P	
12/03/10	397	517086.68	6968156.71																					F/P	
12/03/10	398	517089.05	6968169.48																					F/P	
12/03/10	399	517100.31	6968201.31																					F/P	
12/03/10	400	517094.39	6968235.91																					F/P	
12/03/10	401	517079.68	6968302.27																					F/P	
12/03/10	402	517067.79	6968326.26																					F/P	
12/03/10	403	517067.12	6968353.93																					F/P	
12/03/10	404	517074.86	6968377.74																					F/P	
12/03/10	405	517100.68	6968396.75																					F/P	
12/03/10	406	517095.44	6968429.84																					F/P	
12/03/10	407	517084.17	6968454.83																					F/P	
12/03/10	408	517074.25	6968481.21																					F/P	
12/03/10	409	517049.65	6968524.37																					F/P	
12/03/10	410	517038.25	6968555.03																					F/P	
12/03/10	411	517045.08	6968593.11																					F/P	
12/03/10	412	517057.55	6968609.45																					F/P	
12/03/10	413	517044.80	6968642.66																					F/P	
12/03/10	414	517043.07	6968655.76																					F/P	
12/03/10	415	517032.55	6968681.42																					F/P	
12/03/10	416	517021.14	6968701.81																					F/P	
12/03/10	417	516999.42	6968713.46																					F/P	
12/03/10	418	516970.99	6968728.36																					F/P	
12/03/10	419	516955.59	6968737.77																					F/P	
12/03/10	420	516937.27	6968766.95																					F/P	
12/03/10	421	516926.32	6968777.46																					F/P	
12/03/10	422	516890.06	6968789.20																					F/P	
12/03/10	423	516856.77	6968811.53																					F/P	
12/03/10	424	516840.89	6968819.63																					F/P	
12/03/10	425	516819.42	6968834.45																					F/P	
12/03/10	426	516809.68	6968839.49																					F/P	
12/03/10	427	516795.34	6968850.67																					F/P	
12/03/10	428	516775.09	6968851.51																					F/P	
12/03/10	429	516763.43	6968850.41																					F/P	
12/03/10	430	516748.17	6968855.12																					D	
12/03/10	431	516741.77	6968853.44																					F/P	
12/03/10	432	516721.97	6968871.97																					F/P	
12/03/10	433	516706.09	6968884.92																					F/P	
12/03/10	434	516684.65	6968903.75																					F/P	
12/03/10	435	516670.68	6968914.12																					F/P	
12/03/10	436	516658.83	6968911.76																					F/P	
12/03/10	437	516647.31	6968935.04																					F/P	
12/03/10	438	516644.58	6968945.47																					F/P	
12/03/10	439	516635.41	6968947.38																					F/P	
12/03/10	440	516627.44	6968967.55																					F/P	
12/03/10	441	516622.85	6968979.77																					F/P	
12/03/10	442	516613.56	6969009.44																					F/P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	443	516591.07	6969020.55																					F/P	
12/03/10	444	516567.32	6969023.64																					F/P	
12/03/10	445	516553.40	6969024.72																					F/P	
12/03/10	446	516551.05	6969004.17																					D	
12/03/10	447	516523.60	6969001.37																					D	
12/03/10	448	516515.54	6969009.91																					D	

Appendix F Survey Data From Fisherman Islands in 2010

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
GPS 6																									
9/03/10	1	322443.40	7362192.71																						
9/03/10	2	693225.00	7404087.02																						
9/03/10	3	516589.98	6970042.33	60	10	95			5	5	20	5	1	2	2	1	1	1	3	0	A	2	3	F	Hydrocarbons, Erosion, Litter
9/03/10	4	516682.61	6970008.01	50	9	95		5		5	15	5	1	2	2	1	1	1	2	0	A	1	2	G	
9/03/10	5	516541.28	6970053.29	40	10	100				10	10	5	1	1	2	1	1	1	1	0	A	1	1	G	
9/03/10	6	516425.94	6970001.89	40	10	100				20	20	10	1	2	2	1	2	1	2	0	A	3	1	F	Lots dead trees, Devegetated low lying patches
9/03/10	7	516411.55	6969991.67																					G	Boundary of 2008 regrowth, no longer regrowth (i.e. Growth_ - G heath both sides now. North and south of this boundary defined by built up wall with narrow channel
9/03/10	8	516411.76	6969968.92																					G	
9/03/10	9	516414.61	6969955.27																					G	
9/03/10	10	516417.40	6969928.58																					G	
9/03/10	11	516419.05	6969903.69																					G	
9/03/10	12	516408.64	6969887.59																					G	
9/03/10	13	516398.78	6969879.72																					G	
9/03/10	14	516368.88	6969879.13																					G	
9/03/10	15	516341.79	6969878.29																					G	recently formed patches with pooling water??
9/03/10	16	516357.03	6969867.58	60	12	100				10	10	5	1	2	2	0	0	0	3	0	A	4	2	G	
9/03/10	17	516346.39	6969722.70	50	10	98			5	5	10	5	1	2	2	0	0	1	2	0	A	2	1	G	
9/03/10	18	516367.09	6969673.14	40	12	90			10	10	10	10	1	1	1	0	0	1	1	0	A	1	1	G	Sand berm
9/03/10	19	516351.23	6969493.12	30	6	100				0	5	5	1	1	2	0	0	1	0	0	A	1	1	G	Sandy 1636
9/03/10	20	516352.19	6969605.68	40	10	65			5	5	5	5	1	1	1	0	1	1	1	0	A	1	1	G	
9/03/10	21	516372.35	6969637.15	50	8	90			10	5	5	5	1	1	2	0	0	1	2	0	P	1	1	G	Algae
9/03/10	22	516393.85	6969719.91	50	14	100				10	5	10	1	1	1	1	1	1	3	0	A	3	3	G	Mature forest shoots
9/03/10	23	516404.74	6969811.81	30	12	100				25	15	10	1	2	2	2	2	1	3	0	A	2	1	F	Very small batch of what was presumably 2008 fair patch; now only ~ 20m2
9/03/10	24	516440.61	6969786.89	40	12	100				10	10	5	1	1	2	0	1	1	3	0	A	2	3	G	
9/03/10	25	516492.42	6969717.36	30	14	100				5	10	15	1	1	2	1	3	2	2	0	A	1	2	G	Lots epicormic NATURAL recent death due to age and weather (wind) mature forest
9/03/10	26	516476.35	6969750.96	40	14	100				20	25	25	1	1	1	1	1	1	2	0	P	2	3	F	
9/03/10	27	516492.25	6969835.28	50	12	100				5	5	10	1	1	1	0	2	1	3	0	A	2	3	G	
9/03/10	28	516507.09	6969898.51	60	12	100				5	5	5	1	1	1	1	1	1	3	0	P	2	3	G	
9/03/10	29	516499.00	6969969.26	60	12	100				5	5	5	1	0	1	0	1	0	2	0	A	1	3	G	
9/03/10	30	516515.58	6969993.93	30	12	100				20	5	5	1	1	1	0	1	1	1	0	A	1	2	F	Nearby litter NATURAL recent death due to erosion
9/03/10	31	516457.11	6969987.49	60	10	100				5	5	5	1	1	1	0	1	1	2	0	A	2	2	G	Pooling
9/03/10	32	516456.27	6969937.38	40	12	100				5	5	10	1	1	1	0	2	1	3	0	A	3	2	G	
9/03/10	33	516471.05	6969884.34	50	10	100				10	5	5	1	1	2	1	1	1	3	0	A	2	2	G	
9/03/10	34	516447.60	6969862.47	50	12	100				5	5	10	1	1	1	0	1	1	3	0	A	1	3	G	
9/03/10	35	516196.25	6969475.93	20	18	100				0	5	5	1	1	1	0	1	1	1	0	A	0	1	F	
9/03/10	36	516141.71	6969561.42	30	10	100				5	5	5	1	1	1	1	2	1	0	1	A	0	1	F	Fair
9/03/10	37	516067.56	6969673.69	60	12	100				10	5	5	1	1	2	1	2	2	2	2	P	2	2	F	
9/03/10	38	516003.10	6969751.19	50	12	95			5	10	20	10	1	2	2	1	1	1	3	2	P	2	1	F	
9/03/10	39	518208.71	6971853.03																					RG/P	Fisherman north - half of boundary around regrowth
9/03/10	40	518204.36	6971848.13																					RG/P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	41	518191.57	6971841.82																					RG/P	area/poor area
9/03/10	42	518186.92	6971839.81																					RG/P	
9/03/10	43	518181.42	6971834.09																					RG/P	
9/03/10	44	518176.70	6971835.84																					RG/P	
9/03/10	45	518170.48	6971840.29																					RG/P	
9/03/10	46	518165.14	6971843.25																					RG/P	
9/03/10	47	518161.20	6971841.99																					RG/P	
9/03/10	48	518158.04	6971833.57																					RG/P	
9/03/10	49	518150.13	6971821.51																					RG/P	
9/03/10	50	518143.91	6971818.77																					RG/P	
9/03/10	51	518134.13	6971820.84																					RG/P	
9/03/10	52	518131.68	6971812.23																					RG/P	
9/03/10	53	518130.37	6971809.38																					RG/P	
9/03/10	54	518130.09	6971794.45																					RG/P	
9/03/10	55	518132.58	6971793.74																					RG/P	
9/03/10	56	518134.95	6971788.99																					RG/P	
9/03/10	57	518134.17	6971782.84																					RG/P	
9/03/10	58	518128.80	6971770.63																					RG/P	
9/03/10	59	518136.84	6971759.80																					RG/P	
9/03/10	60	518137.52	6971751.95																					RG/P	
9/03/10	61	518138.76	6971740.37																					RG/P	
9/03/10	62	518139.04	6971734.02																					RG/P	
9/03/10	63	518133.57	6971732.19																					RG/P	
9/03/10	64	518116.15	6971717.24																					RG/P	
9/03/10	65	518110.73	6971703.67																					RG/P	
9/03/10	66	518107.74	6971692.45																					RG/P	
9/03/10	67	518102.31	6971676.31																					RG/P	
9/03/10	68	518099.61	6971453.59	50	10	100				5	5	15	1	1	1	1	1	1	2	0	A	0	2	G	
9/03/10	69	518127.39	6971502.58	40	12	100				5	5	5	1	1	2	1	1	0	2	0	A	2	3	G	
9/03/10	70	518206.95	6971519.87	40	10	100				5	10	100	1	1	1	1	1	1	2	0	A	1	2	G	Mature Forest
9/03/10	71	518294.98	6971594.38	40	12	100				5	5	5	0	1	1	0	1	1	2	1	P	2	2	G	
9/03/10	72	518331.64	6971691.59	50	12	100				5	5	5	0	0	1	0	1	1	4	0	A	1	2	G	
9/03/10	73	518282.80	6971742.23	40	10	90			5	0	10	5	1	1	1	0	1	1	3	0	A	2	1	G	
9/03/10	74	518243.55	6971751.54	50	10	95			5	5	10	10	1	1	1	0	1	1	3	0	A	4	1	G	mudcrab burrow Seedlings
9/03/10	75	518204.47	6971790.82	40	10	100				10	15	15	1	2	2	1	2	2	1	0	A	1	1	F	Debris
9/03/10	76	518167.15	6971794.62																					RG/P	Other half of boundary
9/03/10	77	518156.24	6971774.01																					RG/P	
9/03/10	78	518159.68	6971760.49																					RG/P	
9/03/10	79	518157.76	6971742.11																					RG/P	
9/03/10	80	518147.60	6971727.60																					RG/P	
9/03/10	81	518145.28	6971711.69																					RG/P	
9/03/10	82	518141.37	6971700.90																					RG/P	
9/03/10	83	518142.54	6971692.14																					RG/P	
9/03/10	84	518122.13	6971644.62																					RG/P	
9/03/10	85	518114.82	6971633.27																					RG/P	
9/03/10	86	518111.42	6971619.82																					RG/P	
9/03/10	87	518097.70	6971619.63																					RG/P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
9/03/10	88	518093.19	6971618.81																					RG/P	
9/03/10	89	518083.40	6971605.48																					RG/P	
9/03/10	90	518081.20	6971590.88																					RG/P	
9/03/10	91	518080.85	6971584.17																					RG/P	
9/03/10	92	518066.92	6971569.35																					RG/P	
9/03/10	93	518052.87	6971567.33																					RG/P	
9/03/10	94	518038.34	6971567.33																					RG/P	
9/03/10	95	518036.20	6971559.77																					RG/P	
9/03/10	96	518032.37	6971551.28																					RG/P	
9/03/10	97	518029.44	6971545.58																					RG/P	
9/03/10	98	518024.18	6971541.81																					RG/P	
9/03/10	99	518009.27	6971545.09																					RG/P	
9/03/10	100	518003.84	6971546.18																					RG/P	
9/03/10	101	517987.85	6971543.27																					RG/P	
9/03/10	102	517963.59	6971550.35																					RG/P	
9/03/10	103	517963.02	6971552.74																					RG/P	
9/03/10	104	518089.14	6971674.45																					RG/P	
9/03/10	105	518088.79	6971686.16																					RG/P	
9/03/10	106	518091.29	6971694.44																					RG/P	
9/03/10	107	518099.31	6971701.65																					RG/P	
9/03/10	108	518109.43	6971713.10																					RG/P	
9/03/10	109	518111.65	6971719.82																					RG/P	
9/03/10	110	518111.15	6971740.23																					RG/P	
9/03/10	111	518115.22	6971749.07																					RG/P	
9/03/10	112	518122.79	6971760.19																					RG/P	
9/03/10	113	518122.14	6971765.50																					RG/P	
9/03/10	114	518116.72	6971776.36																					RG/P	
9/03/10	115	518122.85	6971791.32																					RG/P	
9/03/10	116	518136.22	6971790.17																					RG/P	
9/03/10	117	518133.84	6971821.66																					RG/P	
9/03/10	118	518142.02	6971834.80																					RG/P	
9/03/10	119	518147.34	6971841.64																					RG/P	
9/03/10	120	518162.75	6971848.24	10	1	100				50	5	5	1	1	1	1	1	3	1	3	P	1	0	P/R	
12/03/10	1	517119.92	6969818.94	60	12	95			5	5	5	5	1	1	2	0	2	1	2	0	A	3	2	G pw	
12/03/10	2	517152.31	6969870.53	50	8				5	10	5	15	1	1	1	0	1	1	0	0	A	1	1	F pw	Pore water transect
12/03/10	3	517169.50	6969882.04	20	2	50		50		30	35	40	2	1	2	2	3	3	0	0	A	1	2	P pw	
12/03/10	4	517192.47	6969894.14	0	0	30		70		100										0	P	0	1	D pw	
12/03/10	5	517191.53	6969889.26																					D	Boundary of dead area, not recently dead anymore, surrounded by P then F as per 2008
12/03/10	6	517177.06	6969900.48																					D	
12/03/10	7	517168.05	6969902.73																					D	
12/03/10	8	517166.62	6969899.65																					D	
12/03/10	9	517168.27	6969888.21																					D	
12/03/10	10	517176.83	6969882.32																					D	
12/03/10	11	517185.20	6969888.46																					D	
12/03/10	12	517195.24	6969886.04																					D	
12/03/10	13	517202.87	6969884.42																					D	
12/03/10	14	517207.62	6969883.10																					D	

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12/03/10	15	517210.53	6969887.74																					D	
12/03/10	16	517205.40	6969896.77																					D	
12/03/10	17	517193.31	6969898.89																					D	
12/03/10	18	517204.25	6969936.09	5	1	100				0	5	5	1	2	1	0	0	3	1	4	P	1	1	B pw	Sparse Am/ saltmarsh/bare
12/03/10	18	517204.25	6969936.09	40	2	100				5	5	5	1	2	1	1	1	1	0	0	A	1	1	F	
12/03/10	19	517157.69	6969863.67	50	12	5		95		20	20	25	1	2	2	1	2	3	0	0	A	2	2	P	
12/03/10	19	517157.69	6969863.67	60	10	20		80		5	10	10	1	1	1	1	1	1	1	0	A	1	3	F	
12/03/10	20	517200.76	6969826.91	60	12	40		40	20	5	5	5	1	1	1	1	2	1	2	0	A	2	3	G	Litter
12/03/10	21	517601.75	6969751.51	60	12	100				5	5	5	1	1	1	1	1	1	3	0	A	1	3	G	
12/03/10	22	517607.22	6969866.12	20	12	20		60	20	15	20	20	2	2	1	0	2	2	2	0	A	1	2	P	Due to erosion scattered areas through otherwise G forest – along creek mostly
12/03/10	23	517686.70	6969809.57	40	10	90		10		5	5	5	1	1	1	0	1	0	1	0	A	4	3	G	Seedlings
12/03/10	24	517803.49	6969888.17	40	10	85		10	5	5	5	5	1	1	1	0	1	0	1	0	A	4	3	G	
12/03/10	25	517816.62	6970046.02	50	10	85		5	10	5	5	5	1	1	1	0	1	0	1	0	A	4	2	G	
12/03/10	26	517880.72	6970053.50	10	10	100				40	50	60	1	2	2	1	4	1	0	0	A	3	2	P	Small patch, recovering
12/03/10	27	517937.62	6970028.81	15	10	95		5		40	30	30	1	2	2	1	4	1	0	0	A	3	2	P	
12/03/10	28	517979.05	6970041.55	30	12	95			5	15	10	10	1	1	1	0	2	1	2	0	A	4	3	F	
12/03/10	29	518011.89	6970058.52	50	12	95			5	5	5	5	1	1	1	0	1	0	3	0	A	3	3	G	
12/03/10	30	517972.23	6970208.20	40	12	100				5	5	5	1	1	1	0	2	1	3	0	A	2	3	G	
12/03/10	31	517893.53	6970321.53	50	12	100				5	5	5	1	1	1	0	1	0	3	0	A	3	2	G	
12/03/10	32	517864.42	6970366.46	10	12	100				10	20	25	1	2	2	0	2	1	1	1	P	2	1	P	
12/03/10	33	517808.18	6970373.81	40	12	100				10	10	10	1	1	2	0	3	1	1	0	A	1	1	F	
12/03/10	34	517768.99	6970380.22	30	2	100				15	15	10	1	1	1	1	3	2	0	0	P	1	1	P	
12/03/10	35	518224.44	6969882.12																					B/S	Boundary of clay pan/ salt march and terrestrial (landward)/dead (seaward) mangroves line claypan landward from 39-40 ~4m deep
12/03/10	36	517146.17	6970261.78																					B/S	
12/03/10	37	517150.99	6970274.55																					B/S	
12/03/10	38	517163.64	6970277.93																					B/S	
12/03/10	39	517167.05	6970298.10	20	2	100				5	5	5	1	1	1	0	3	2	0	2	P	1	1	P	
12/03/10	40	517210.57	6970367.57			100																		G	
12/03/10	41	517263.31	6970438.89			100																		G	Isolated AM
12/03/10	42	517276.25	6970474.68			100																		G	
12/03/10	43	517303.64	6970515.41			100																		G	Mangroves line claypan landward
12/03/10	44	517311.90	6970508.74																					B/S	Boundary of clay pan/ salt march and terrestrial (landward)/dead (seaward) mangroves line claypan landward from 39-40 ~4m deep
12/03/10	45	517317.68	6970488.54																					B/S	
12/03/10	46	517324.59	6970486.00																					B/S	
12/03/10	47	517336.51	6970462.75																					B/S	
12/03/10	48	517352.92	6970462.05																					B/S	
12/03/10	49	517360.81	6970466.54																					B/S	
12/03/10	50	517357.57	6970473.70																					B/S	
12/03/10	51	517380.30	6970491.72																					B/S	
12/03/10	52	517379.52	6970495.90																					B/S	
12/03/10	53	517367.59	6970492.34																					B/S	
12/03/10	54	517363.56	6970495.18																					B/S	

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12/03/10	55	517348.95	6970488.63																					B/S	
12/03/10	56	517338.37	6970497.69																					B/S	
12/03/10	57	517352.49	6970513.00																					B/S	
12/03/10	58	517372.16	6970516.61																					B/S	
12/03/10	59	517382.17	6970524.41																					B/S	
12/03/10	60	517399.66	6970498.97																					B/S	
12/03/10	61	517410.92	6970497.76																					B/S	
12/03/10	62	517422.09	6970508.28																					B/S	
12/03/10	63	517416.77	6970508.89																					B/S	
12/03/10	64	517421.07	6970520.64																					B/S	
12/03/10	65	517464.11	6970522.99																					B/S	
12/03/10	66	517438.47	6970515.60																					B/S	
12/03/10	67	517420.95	6970499.98																					B/S	
12/03/10	68	517419.27	6970485.50																					B/S	
12/03/10	69	517428.18	6970495.11																					B/S	
12/03/10	70	517431.05	6970486.30																					B/S	
12/03/10	71	517440.74	6970487.85																					B/S	
12/03/10	72	517437.69	6970481.30																					B/S	
12/03/10	73	517444.28	6970481.42																					B/S	
12/03/10	74	517437.16	6970470.67																					B/S	
12/03/10	75	517393.41	6970480.06																					B/S	
12/03/10	76	517389.96	6970472.79																					B/S	
12/03/10	77	517398.44	6970465.63																					B/S	
12/03/10	78	517374.21	6970468.62																					B/S	
12/03/10	79	517356.61	6970449.74																					B/S	
12/03/10	80	517346.33	6970444.18																					B/S	
12/03/10	81	517345.22	6970396.16																					B/S	
12/03/10	82	517362.43	6970387.78																					B/S	
12/03/10	83	517363.88	6970393.04																					B/S	
12/03/10	84	517365.39	6970426.77																					B/S	
12/03/10	85	517372.24	6970428.44																					B/S	
12/03/10	86	517369.42	6970414.67																					B/S	
12/03/10	87	517371.39	6970397.05																					B/S	
12/03/10	88	517379.46	6970373.57																					B/S	
12/03/10	89	517370.22	6970367.21																					B/S	
12/03/10	90	517380.11	6970355.18																					B/S	
12/03/10	91	517392.85	6970351.82																					B/S	
12/03/10	92	517394.08	6970345.22																					B/S	
12/03/10	93	517380.76	6970351.09																					B/S	
12/03/10	94	517393.79	6970332.68																					B/S	
12/03/10	95	517404.22	6970341.03																					B/S	
12/03/10	96	517406.52	6970353.68																					B/S	
12/03/10	97	517393.91	6970371.10																					B/S	
12/03/10	98	517406.65	6970378.57																					B/S	
12/03/10	99	517412.25	6970409.24																					B/S	
12/03/10	100	517399.02	6970396.62																					B/S	
12/03/10	101	517380.33	6970396.62																					B/S	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	102	517380.94	6970408.88																					B/S	
12/03/10	103	517395.80	6970407.26																					B/S	
12/03/10	104	517405.96	6970416.61																					B/S	
12/03/10	105	517400.97	6970439.25																					B/S	
12/03/10	106	517409.24	6970461.93																					B/S	
12/03/10	107	517426.05	6970446.83																					B/S	
12/03/10	108	517422.91	6970432.26																					B/S	
12/03/10	109	517429.13	6970430.02																					B/S	
12/03/10	110	517448.29	6970433.17																					B/S	
12/03/10	111	517449.22	6970419.29																					B/S	
12/03/10	112	517460.09	6970428.68																					B/S	
12/03/10	113	517465.91	6970468.98																					B/S	
12/03/10	114	517472.01	6970467.90																					B/S	
12/03/10	115	517481.03	6970448.94																					B/S	
12/03/10	116	517484.18	6970441.43																					B/S	
12/03/10	117	517492.56	6970436.89																					B/S	
12/03/10	118	517478.60	6970419.72																					B/S	
12/03/10	119	517469.62	6970428.47																					B/S	
12/03/10	120	517456.95	6970420.20																					B/S	
12/03/10	121	517459.84	6970410.03																					B/S	
12/03/10	122	517489.32	6970387.32																					B/S	
12/03/10	123	517509.25	6970379.31																					B/S	
12/03/10	124	517509.36	6970373.45																					B/S	
12/03/10	125	517515.26	6970357.97	15	2	100				40	10	10	1	2	1	0	1	1	1	2	P	0	1	P	N of 125 ~300m long, ~10m Thin, patch of mangroves surrounded by dead mangroves
12/03/10	126	517525.66	6970344.57																					B/S	Boundary of clay pan/ salt march and terrestrial (landward)/dead (seaward) mangroves line claypan landward from 39-40 ~4m deep
12/03/10	127	517519.95	6970320.44																					B/S	
12/03/10	128	517580.79	6970322.95																					B/S	
12/03/10	129	517574.17	6970305.66																					B/S	
12/03/10	130	517527.44	6970288.68																					B/S	
12/03/10	131	517536.26	6970269.48																					B/S	
12/03/10	132	517498.77	6970224.50																					B/S	
12/03/10	133	517491.01	6970220.38																					B/S	
12/03/10	134	517459.65	6970223.67																					B/S	
12/03/10	135	517492.36	6970249.43																					B/S	
12/03/10	136	517495.42	6970264.21																					B/S	
12/03/10	137	517477.25	6970277.45																					B/S	
12/03/10	138	517442.07	6970266.68																					B/S	
12/03/10	139	517402.37	6970302.21																					B/S	
12/03/10	140	517359.58	6970319.93																					B/S	
12/03/10	141	517366.79	6970300.42																					B/S	
12/03/10	142	517406.94	6970214.50																					B/S	
12/03/10	143	517405.63	6970155.58																					B/S	
12/03/10	144	517351.09	6970117.27																					B/S	
12/03/10	145	517343.25	6970100.22																					B/S	
12/03/10	146	517322.87	6970087.96																					B/S	
12/03/10	147	517322.09	6970087.89																					B/S	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	148	517329.19	6970102.11																					B/S	
12/03/10	149	517330.06	6970127.21																					B/S	
12/03/10	150	517291.19	6970140.50																					B/S	
12/03/10	151	517295.64	6970155.70																					B/S	
12/03/10	152	517312.71	6970167.84																					B/S	
12/03/10	153	517312.03	6970200.25																					B/S	
12/03/10	154	517281.65	6970232.17																					B/S	
12/03/10	155	517255.95	6970213.73																					B/S	
12/03/10	156	517246.74	6970247.70																					B/S	
12/03/10	157	517216.82	6970291.79																					B/S	
12/03/10	158	517198.90	6970292.32																					B/S	
12/03/10	159	517189.73	6970270.83																					B/S	
12/03/10	160	517186.94	6970244.42																					B/S	
12/03/10	161	517173.53	6970242.36																					B/S	
12/03/10	162	517159.89	6970232.71																					B/S	
12/03/10	163	517152.51	6970234.58																					B/S	
12/03/10	164	517158.02	6970239.36																					B/S	
12/03/10	165	517149.96	6970249.16																					B/S	
12/03/10	166	517133.01	6970244.22																					D/P	
12/03/10	167	517118.50	6970234.66																					D/P	
12/03/10	168	517123.99	6970201.21																					D/P	
12/03/10	169	517135.84	6970223.64																					D/P	
12/03/10	170	517142.19	6970205.90																					D/P	
12/03/10	171	517167.07	6970205.46																					D/P	
12/03/10	172	517168.83	6970183.92																					D/P	
12/03/10	173	517109.77	6970210.41																					D/P	
12/03/10	174	517091.58	6970210.24																					D/P	
12/03/10	175	517083.18	6970175.69																					D/P	Boundary of dead and poor health
12/03/10	176	517112.93	6970169.21																					D/P	
12/03/10	177	517088.86	6970158.59																					D/P	
12/03/10	178	517124.13	6970108.68																					D/P	
12/03/10	179	517181.88	6970081.08																					D/P	
12/03/10	180	517180.81	6970057.96																					D/P	
12/03/10	181	517214.95	6970049.13																					D/P	
12/03/10	182	517204.70	6970031.29																					D/P	
12/03/10	183	517235.38	6970010.09																					D/P	
12/03/10	184	517222.76	6969964.26																					D/P	
12/03/10	185	517184.57	6969965.82																					D/BS	
12/03/10	186	517221.36	6969917.13																					D/BS	
12/03/10	187	517219.91	6969929.37																					D/BS	
12/03/10	188	517233.83	6969945.59																					D/BS	Boundary of saltmarsh and fair health
12/03/10	189	517244.11	6969952.13																					D/BS	
12/03/10	190	517272.43	6969957.46																					D/BS	
12/03/10	191	517288.53	6969954.18																					D/BS	
12/03/10	192	517318.47	6969964.73																					BS/P	Boundary of saltmarsh and poor health
12/03/10	193	517322.86	6969974.07																					BS/P	
12/03/10	194	517310.43	6970008.07																					BS/P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	195	517322.78	6970021.56																					BS/P	
12/03/10	196	517309.94	6970027.08																					BS/P	
12/03/10	197	517288.09	6970000.32																					BS/P	
12/03/10	198	517263.06	6970003.61																					BS/P	
12/03/10	199	517245.85	6970015.73																					BS/P	
12/03/10	200	517252.54	6970037.56																					BS/P	
12/03/10	201	517274.67	6970056.51																					BS/P	Boundary of saltmarsh and poor health
12/03/10	202	517243.35	6970058.94																					BS/P	
12/03/10	203	517209.99	6970069.02																					D/P	
12/03/10	204	517231.38	6970079.80																					D/P	Boundary of dead and poor health
12/03/10	205	517294.65	6970090.00																					D/P	
12/03/10	206	517362.92	6970065.56																					D/P	
12/03/10	207	517349.21	6970096.25	10	2	100				50	20	10	1	2	2	1	3	2	0	1	P	0	1	P	Small patch of P to the south of this path surrounded by dead
12/03/10	208	517417.25	6970161.25																					D/P	
12/03/10	209	517417.97	6970209.67																					D/P	
12/03/10	210	517438.06	6970163.39																					D/P	
12/03/10	211	517429.54	6970141.67																					D/P	
12/03/10	212	517428.44	6970093.92																					D/P	Boundary of dead and poor health
12/03/10	213	517404.64	6970083.91																					D/P	
12/03/10	214	517373.98	6970084.23																					D/P	
12/03/10	215	517399.16	6970075.43																					D/P	
12/03/10	216	517411.65	6970041.71																					D/P	
12/03/10	217	517395.76	6970033.72																					D/P	
12/03/10	218	517463.02	6969990.85	30	1	100				35	30	10	2	1	1	1	3	3	0	1	P	0	1	P	
12/03/10	219	517471.94	6970030.42																					D/P	
12/03/10	220	517490.62	6970025.23																					D/P	
12/03/10	221	517471.73	6970040.87																					D/P	Boundary of dead and poor health
12/03/10	222	517527.87	6970022.15	25	5	100				20	40	30	1	2	1	0	4	3	0	2	P	1	1	P	
12/03/10	223	517535.42	6970052.40																					D/P	
12/03/10	224	517521.53	6970073.61																					D/P	Interesting Ob through area - saltmarsh dead/poor in areas of more recent death but dense and diverse saltmarsh that appears to be spreading in long dead areas - suggests not even saltmarsh can survive this conditions!!! (possibly too few due to sedi subsidence
12/03/10	225	517563.73	6970102.07																					D/P	Boundary of dead and poor health
12/03/10	226	517593.27	6970100.80																					D/P	
12/03/10	227	517614.22	6970146.21																					D/P	
12/03/10	228	517499.63	6970188.31																					D/P	Water birds common throughout dead area e.q whimbrel and white egret
12/03/10	229	517437.49	6970193.52																					D/P	Boundary of dead and poor health
12/03/10	230	517431.28	6970214.42																					D/P	
12/03/10	231	517493.24	6970219.49																					D/P	

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12/03/10	232	517500.04	6970241.77																					D/P	
12/03/10	233	517536.51	6970261.71																					D/P	
12/03/10	234	517562.13	6970261.15																					D/P	
12/03/10	235	517585.06	6970297.29																					D/P	
12/03/10	236	517573.41	6970304.97																					D/P	
12/03/10	237	517586.76	6970317.46																					D/P	
12/03/10	238	517555.80	6970328.95																					D/P	
12/03/10	239	517548.81	6970356.23																					D/P	
12/03/10	240	517574.61	6970332.30																					D/P	
12/03/10	241	517586.10	6970333.21																					D/P	
12/03/10	242	517527.13	6970387.86																					D/P	
12/03/10	243	517511.72	6970444.51																					D/P	
12/03/10	244	517585.16	6970348.26																					D/P	
12/03/10	245	517608.88	6970307.30																					D/P	
12/03/10	246	517577.80	6970255.15																					D/P	Old walkway supports??
12/03/10	247	517551.08	6970240.95																					D/P	
12/03/10	248	517519.82	6970246.64																					D/P	
12/03/10	249	517521.39	6970206.66																					D/P	
12/03/10	250	517665.68	6970242.48																					D/P	Boundary of dead and poor
12/03/10	251	517648.17	6970263.82																					D/P	health
12/03/10	252	517630.99	6970264.20																					D/P	
12/03/10	253	517660.69	6970326.90																					D/P	
12/03/10	254	517615.47	6970446.78																					D/P	
12/03/10	255	517665.41	6970452.92	15	6	100				50	20	10	1	2	1	1	4	2	0	2	P	0	1	P	Seawards appears to be recently dead 2008 but recovered to poor to 2010
12/03/10	256	517656.62	6970504.51																					D/P	Boundary of dead and poor health
12/03/10	257	517674.40	6970521.34																					D/P	
12/03/10	258	517643.85	6970562.20																					D/P	
12/03/10	259	517603.28	6970568.78																					D/P	
12/03/10	260	517566.70	6970615.59																					D/P	
12/03/10	261	517533.50	6970654.15																					D/P	
12/03/10	262	517539.23	6970606.24																					D/P	
12/03/10	263	517481.44	6970659.35																					D/P	
12/03/10	264	517459.18	6970645.40																					D/P	
12/03/10	265	517437.24	6970665.00																					D/P	
12/03/10	266	517385.88	6970636.19																					D/P	
12/03/10	267	517342.75	6970571.47																					P	Thin strip of poor mangroves along landward margin
12/03/10	268	517313.38	6970535.60																					P	
12/03/10	269	517628.58	6970613.27																					P	
12/03/10	270	517626.44	6970595.82	0	0					100										1	P		1	D	Patch 10x20m surrounded by poor health forest
12/03/10	271	517691.46	6970594.28	0	0					100										1	P		1	O	Patch 10x10m surrounded by poor health forest
12/03/10	272	517735.82	6970603.29	0						100										1	P	0	1	D	Patch 30x60m2 surrounded by pool
12/03/10	273	517741.59	6970578.20	40	8					30	40	30	1	2	1	1	3	2	0	1	P	0	1	P	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	273	517741.59	6970578.20	60	12					20	20	15	1	1	1	0	2	1	1	0	A	3	2	F	
12/03/10	273	517741.59	6970578.20																					P/F	Boundary of poor (landward) and fair (seaward)
12/03/10	274	517747.56	6970555.05																					P/F	
12/03/10	275	517760.57	6970535.60																					P/F	
12/03/10	276	517770.38	6970516.29																					P/F	
12/03/10	277	517773.27	6970487.51																					P/F	
12/03/10	278	517805.57	6970468.87																					P/F	
12/03/10	279	517795.14	6970428.25																					S	Dead patch (10m2) towards claypan and good seaward with very thin strip of poor
12/03/10	280	517777.56	6970416.75																					P/F	Boundary of poor (landward) and fair (seaward)
12/03/10	281	517780.70	6970394.30																					P/F	
12/03/10	282	517778.92	6970369.29																					P/F	
12/03/10	283	517785.90	6970347.21																					P/F	
12/03/10	284	517784.40	6970319.09																					P/F	
12/03/10	285	517784.68	6970303.86																					P/F	
12/03/10	286	517784.92	6970289.53																					P/F	
12/03/10	287	517799.40	6970270.16																					P/F	
12/03/10	288	517806.95	6970233.21																					P/F	
12/03/10	289	517814.98	6970220.71																					P/F	
12/03/10	290	517818.14	6970203.46																					P/F	
12/03/10	291	517827.58	6970182.87																					P/F	
12/03/10	292	517821.21	6970155.78																					P/F	
12/03/10	293	517813.68	6970142.05																					P/F	
12/03/10	294	517806.55	6970131.17																					P/F	
12/03/10	295	517771.12	6970116.03																					P/F	
12/03/10	296	517748.52	6970113.14																					D/P	Boundary of dead and poor
12/03/10	297	517717.52	6970101.16																					D/P	
12/03/10	298	517681.08	6970089.39																					D/P	
12/03/10	299	517646.04	6970068.86																					D/P	
12/03/10	300	517632.68	6970045.64																					D/P	
12/03/10	301	517622.34	6970063.24																					D/P	
12/03/10	302	517630.91	6970071.38																					D/P	
12/03/10	303	517631.59	6970076.55																					D/P	
12/03/10	304	517646.08	6970086.85																					D/P	
12/03/10	305	517678.48	6970101.21																					D/P	
12/03/10	306	517682.83	6970112.62																					D/P	
12/03/10	307	517706.01	6970119.68																					D/P	
12/03/10	308	517712.50	6970137.21																					D/P	
12/03/10	309	517712.08	6970155.68																					D/P	
12/03/10	310	517734.05	6970160.97																					D/P	

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12/03/10	311	517762.82	6970167.86																					D/P	
12/03/10	312	517764.02	6970229.80																					D/P	Seedlings coming up along edge of dead/poor(in saltmarsh mostly but some on bare mud) but not enough to map as regrowth
12/03/10	313	517741.28	6970329.10																					D/P	Boundary of dead and poor
12/03/10	314	517746.54	6970375.79																					D/P	
12/03/10	315	517726.18	6970411.54																					D/P	
12/03/10	316	517736.66	6970432.74																					D/P	
12/03/10	317	517755.62	6970424.34																					D/P	
12/03/10	318	517752.66	6970373.23																					D/P	
12/03/10	319	517756.41	6970329.24																					D/P	
12/03/10	320	517761.78	6970306.38																					D/P	
12/03/10	321	517765.26	6970278.52																					D/P	
12/03/10	322	517781.60	6970247.42																					D/P	
12/03/10	323	517800.06	6970204.72																					D/P	
12/03/10	324	517793.89	6970178.08																					D/P	
12/03/10	325	517808.57	6970161.54																					D/P	
12/03/10	326	517836.11	6970095.67																					D/P	
12/03/10	327	517888.03	6970044.40																					P/F	Boundary of poor (toward claypan) and fair (seaward)
12/03/10	328	517868.47	6970046.43																					P/F	
12/03/10	329	517851.82	6970059.11																					P/F	
12/03/10	330	517820.75	6970081.24																					P/F	
12/03/10	331	517799.16	6970103.80																					P/F	
12/03/10	332	517770.07	6970095.38																					P/F	
12/03/10	333	517745.16	6970088.17																					P/F	
12/03/10	334	517729.41	6970078.22																					P/F	
12/03/10	335	517711.11	6970062.66																					P/F	
12/03/10	336	517691.99	6970053.29																					P/F	
12/03/10	337	517684.79	6970032.96																					P/F	
12/03/10	338	517658.81	6970008.53																					P/F	
12/03/10	339	517640.48	6969979.90																					P/F	
12/03/10	340	517614.42	6969996.18																					D	Small dead patch towards claypan 10x50m (see aerial)
12/03/10	340	517614.42	6969996.18	70	10	90	10			5	10	10	1	1	2	1	2	2	1	0	A	3	1	F	
12/03/10	341	517602.39	6969999.43																					P/F	Boundary of poor (toward claypan) and fair (seaward)
12/03/10	342	517581.02	6969991.12																					P/F	
12/03/10	343	517540.95	6969948.66	5	1	100				60	10	10	2	2	2	1	3	2	0	1	P	1	1	P	
12/03/10	344	517513.14	6969919.79																					P/F	Boundary of poor (toward claypan) and fair (seaward)
12/03/10	345	517483.78	6969918.80																					P/F	
12/03/10	346	517452.35	6969878.83																					P/F	
12/03/10	347	517416.43	6969864.61																					P/F	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	348	517424.18	6969830.76																					P/F	
12/03/10	349	517440.21	6969822.86																					P/F	
12/03/10	350	517441.30	6969798.18																					P/F	
12/03/10	351	517413.67	6969805.02																					P/F	
12/03/10	352	517418.62	6969794.55																					P	patch of poor health (dead ceriops with ceriops + aricennia under story) landward ? Regrowth
12/03/10	353	517374.17	6969882.51	70	10	5	20	75		20	10	10	1	1	1	0	0	1	0	0	A	1	3	F/P	
12/03/10	354	517386.41	6969899.56																					D/P	boundary of dead and poor. Appears to have shrunk with low AM along margins and scattered throughout? Regrowth/poor surrounding dead
12/03/10	355	517374.26	6969900.87																					D/P	
12/03/10	356	517361.03	6969897.66																					D/P	
12/03/10	357	517356.91	6969888.69																					D/P	
12/03/10	358	517367.62	6969857.57																					D/P	
12/03/10	359	517345.36	6969828.99																					D/P	
12/03/10	360	517331.67	6969835.21																						Fisherman islands north cntd from the thin strop of poor along landward margin and northern margin
12/03/10	361	517322.45	6969859.44																						
12/03/10	362	517277.74	6969857.54																						
12/03/10	363	517257.71	6969840.57																						
12/03/10	364	517220.31	6969852.41																						
12/03/10	365	517179.53	6969864.40																						
12/03/10	366	518171.79	6971874.68																						
12/03/10	367	518194.76	6971840.34	25	6					15	20	20	1	2	2	1	3	2	0	0	P	1	1	P	
12/03/10	368	518127.59	6971786.99	60	10					5	5	5	1	2	1	0	1	1	0	0	P	2	1	P/F	
12/03/10	369	517948.55	6971448.23	0																0	P	0	0	D	Small patch 10x15m
12/03/10	370	517833.11	6971288.80	70	12					5	5	5	1	1	2	1	0	0	2	0	A	1	2	G	
12/03/10	371	517727.48	6971251.20	50	8					5	5	5	1	1	1	1	1	0	1	0	A	1	3	G	
12/03/10	372	517682.69	6971215.94	15	8					5	10	10	1	2	2	0	1	3	1	0	P	1	1	P	Patch 10x15m
12/03/10	373	517636.63	6971153.97	30	8					10	10	15	1	2	2	1	2	2	1	0	P	2	1	P	Patches
12/03/10	374	517547.36	6971023.07	20	10					50	40	50	1	2	2	1	3	2	1	0	A	3	2	P	Previously dead
12/03/10	375	517538.47	6970980.46	0																3	P	0	0	D	Dead patch 50m2
12/03/10	376	517595.60	6970919.91	0																3	P	0	0	D	Dead patch 30m2
12/03/10	377	517695.22	6971060.76	60	10	100				5	5	5	1	1	2	0	1	0	2	0	A	4	2	G	FI pore water control
12/03/10	378	517669.31	6971122.15	60	10	100				5	5	5	1	1	1	0	1	1	3	0	A	3	3	G	Channels of mud
12/03/10	379	518012.92	6971569.45	20	10	100				30	20	30	1	2	2	1	3	2	0	0	P	2	1	P	In mud channel/ hole of death
12/03/10	380	518049.06	6971612.52	0																0	A	0	1	D	Thin patch 5x30m
12/03/10	381	518121.70	6971785.53	20	8	90		10		20	30	20	2	2	2	1	3	3	0	0	A	1	2	P	
12/03/10	382	518144.68	6971789.47	0																0	A	0	1	D	Dry death patch
12/03/10	383	518163.27	6971648.16	30	8	100				20	20	10	1	2	2	1	3	2	0	0	A	1	2	P2	More typical
12/03/10	384	517471.04	6970707.87	50	10	100				10	15	10	1	1	2	0	2	1	1	0	A	3	2	F	
12/03/10	385	517517.62	6970713.33	50	10	100				20	15	15	1	2	2	1	1	2	0	0	A	1	1	F	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	386	517510.81	6970772.54	20	8	100				50	30	20	1	2	2	1	2	3	0	0	A	0	0	P	Pneumatophores
12/03/10	387	517537.85	6970860.52	5	1	100				70	10	5	1	2	2	0	0	2	0	0	A	1	2	P	
12/03/10	388	517494.24	6970864.88	60	4	100				5	15	10	1	1	1	0	1	0	2	0	A	2	2	F	
12/03/10	389	517646.56	6970783.04	15	2	100				40	20	15	1	2	3	0	3	2	0	0	P	1	2	P	Previously dead
12/03/10	390	517807.15	6970628.06	70	12	100				10	10	10	1	1	1	0	1	1	3	0	A	2	1	G	
12/03/10	391	517790.48	6970657.93	60	15	95			5	5	10	10	1	1	1	0	1	0	3	0	A	3	2	G	Same distance from shore!!
12/03/10	392	517716.59	6970675.04	30	12	95			5	30	30	20	1	2	2	0	1	1	1	0	A	1	1	P	Same distance from shore!!
12/03/10	393	517687.06	6970649.26	50	12	95			5	10	10	10	1	1	2	1	1	1	1	0	A	2	1	F	
12/03/10	394	517676.61	6970622.57	40	2	100				10	15	15	1	2	2	0	2	3	0	0	A	0	1	P2	
12/03/10	395	517652.29	6970588.52	5	2	100				80	20	30	1	1	2	1	3	3	0	1	P	0	1	D	2 samples - adjacent stump - saltmarsh
12/03/10	396	517637.36	6970566.75	40	6	100				20	20	15	1	2	2	1	3	3	0	1	P	0	1	P3	
12/03/10	397	517731.54	6970494.71	0																2	P	0	0	D	3 samples - stump-saltmarsh - pooling water
12/03/10	398	517734.04	6970414.48	0																1	P	0	0	D	small patch 10x40m
12/03/10	399	517701.94	6970423.58	0																0	P	0	0	D	Not pooling (stump)
12/03/10	400	517825.06	6970420.34	20	3	100				40	20	10	1	2	2	1	3	3	0	0	P	0	1	P	
12/03/10	401	517885.29	6970419.26	50	12	100				10	15	10	1	1	2	0	1	1	3	0	A	4	1	F	
12/03/10	402	518126.14	6969992.12	60	12	95				10	5	5	1	1	2	0	1	0	4	0	A	4	1	G	
12/03/10	403	518265.37	6969787.75	60	14	100			5	0	5	10	1	1	2	0	2	1	3	0	A	2	3	G	
12/03/10	404	518234.30	6969739.42	50	15	90			10	5	15	10	1	1	1	0	1	0	3	0	A	4	1	G	
12/03/10	405	518217.57	6969706.44	60	12	100				10	15	15	1	1	2	0	1	1	3	0	A	4	1	F	
12/03/10	406	518191.25	6969684.31	20	6	100				60	50	40	1	1	2	0	2	2	0	0	A	0	0	P	
12/03/10	407	518233.82	6969703.55	0																0	A	0	0	D	Pooling (stump)
12/03/10	408	518301.65	6969619.29	0																0	P	0	0	D2	Not pooling(closest dead to transect)
12/03/10	409	518366.47	6969510.63																					D	branchlets
12/03/10	410	518394.65	6969463.26																						
12/03/10	411	518404.81	6969479.95	0																0	P	1	0	(R) D	Pooling (rd tree)
12/03/10	412	518352.48	6969449.47	60	12	100				10	15	10	1	1	2	0	2	1	1	0	A	3	1	F	
12/03/10	413	518463.80	6969514.22	40	5	100				20	20	20	1	2	2	0	3	3	0	0	P	0	0	P	
12/03/10	414	518421.90	6969424.83	60	14	85			15	10	5	5	1	1	1	0	1	1	3	0	A	3	2	G	
12/03/10	415	518420.82	6969379.14																						
12/03/10	416	518395.70	6969393.98																						
12/03/10	417	518377.21	6969384.25																						
12/03/10	418	518365.44	6969399.70																						
12/03/10	419	518345.37	6969423.03																						
12/03/10	420	518358.75	6969453.50																						
12/03/10	421	518323.95	6969471.13																						
12/03/10	422	518312.26	6969497.82																						
12/03/10	423	518317.51	6969537.45																						
12/03/10	424	518266.70	6969548.61																						
12/03/10	425	518229.86	6969565.88																						
12/03/10	426	518204.30	6969527.32																						
12/03/10	427	518230.00	6969525.27																						
12/03/10	428	518270.23	6969467.96																						
12/03/10	429	518300.53	6969455.92																						

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12/03/10	430	518278.75	6969409.09																						
12/03/10	431	518310.81	6969392.67																						
12/03/10	432	518311.96	6969355.39																						
12/03/10	433	518364.33	6969340.48																						
12/03/10	434	518389.67	6969295.55																						
12/03/10	435	518394.76	6969239.87																						
12/03/10	436	518368.42	6969276.24																						
12/03/10	437	518348.01	6969313.21																						
12/03/10	438	518254.57	6969401.79	0																0	P	0	0	D	
12/03/10	439	518213.73	6969421.18	10	1	100				5	5	5	1	3		0	1	3	0	0	P	0	0	P	
12/03/10	440	518183.62	6969416.47																					RD/P	Boundary RD/Poor with patches of D in wider sections no RD margin 443-467 (dead/pool boundary)
12/03/10	441	518198.68	6969443.29																					F/D	Boundary of Fair/Dead
12/03/10	442	518184.59	6969440.30																					F/D	
12/03/10	443	518164.58	6969442.09																					F/D	
12/03/10	444	518134.74	6969504.98																					F/D	
12/03/10	445	518124.78	6969518.85																					F/D	
12/03/10	446	518118.37	6969534.16																					F/D	Patch of RD to the south 20m2
12/03/10	447	518093.86	6969572.80																					F/D	Boundary of Fair/Dead
12/03/10	448	518074.67	6969588.22																					F/D	Strip of RC to the NE 70mx10m
12/03/10	449	518044.83	6969591.33																					F/D	Boundary of Fair/Dead
12/03/10	450	518040.02	6969608.59																					F/D	Patch of RD to the South 10x5m
12/03/10	451	518029.99	6969604.90																					F/D	Boundary of Fair/Dead
12/03/10	452	518018.21	6969586.18																					F/D	
12/03/10	453	518002.31	6969588.02																					F/D	
12/03/10	454	517880.28	6969513.96																					F/D	
12/03/10	455	517825.73	6969524.28																					F/D	
12/03/10	456	517866.90	6969571.86																					F/D	
12/03/10	457	517897.91	6969575.66																					F/D	Boundary Poor/Dead
12/03/10	458	517943.60	6969596.24																					F/D	
12/03/10	459	518005.81	6969623.47																					F/D	
12/03/10	460	518004.58	6969652.44																					F/D	
12/03/10	461	518009.73	6969626.33																					F/D	
12/03/10	462	518032.32	6969632.18																					F/D	
12/03/10	463	518043.50	6969610.59																					F/D	
12/03/10	464	518059.13	6969619.52																					F/D	
12/03/10	465	518063.53	6969599.89																					F/D	
12/03/10	466	518105.97	6969603.43																					F/D	
12/03/10	467	518161.19	6969584.29																					F/D	
12/03/10	468	518179.59	6969595.20																					RD/P	Strip of poor to the centre 20x100m
12/03/10	469	518178.53	6969569.88																					RD/P	Boundary RD/poor joins JP data
12/03/10	470	518192.97	6969564.75	30	2	100				30	40	30	2	1	2	1	3	2	0	1	P	0	0	D	Strip
12/03/10	471	518214.05	6969560.25	0																0	P	0	1	RD	
12/03/10	472	518209.98	6969525.99	50	1	100				20	20	10	2	1	2	1	2	3	0	0	P	0	1	P	Small Patch 10x20M

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12/03/10	473	518201.00	6969509.73	50	2	100				30	20	20	2	1	2	1	2	3	0	0	P	1	1	P	Edge of large central patch
12/03/10	474	518150.53	6969393.66																						
12/03/10	475	518121.30	6969369.28	15	6	100				40	50	30	2	1	1	2	3	3	0	1	P	1	1	P	
12/03/10	476	518020.27	6969374.27	40	10	90		10		20	15	10	1	1	2	1	2	1	1	0	P	4	3	F	
12/03/10	477	517984.93	6969421.95	30	12	95			5	30	30	30	1	1	1	2	2	2	3	0	A	2	4	F	Erosion
12/03/10	478	517984.93	6969421.95	70	8	10		90		40	20	10	2	2	2	1	1	3	0	0	A	1	4	F	Erosion
GPS 8																									
12/03/10	1	517117.03	6969822.85																						
12/03/10	2	517751.14	6969743.88																						
12/03/10	3	517781.28	6969764.89																						
12/03/10	4	517942.83	6969422.79	90	5			100		100		5	1	1	2	1	1	2	1	0	2	1	4	F	Erosion heavy
12/03/10	5	518147.67	6969422.08	40	5				5		5	15	3	2	1	0	2	2	0	0	A	2	1	F	Dead inland creek
12/03/10	6	518206.17	6969512.26																						Dead
12/03/10	7	518216.79	6969525.16																						
12/03/10	8	518218.10	6969525.17																						
12/03/10	9	518230.00	6969528.17																						
12/03/10	10	518233.70	6969527.28																						
12/03/10	11	518238.94	6969515.08																						
12/03/10	12	518232.14	6969496.55																						
12/03/10	13	518241.46	6969488.02																						
12/03/10	14	518249.86	6969471.57																						
12/03/10	15	518234.36	6969488.37																						
12/03/10	16	518218.55	6969489.91																						
12/03/10	17	518225.27	6969881.16																						
12/03/10	18	525327.64	6958395.26																						
12/03/10	19	525419.16	6958478.01																						
12/03/10	20	694152.53	7405121.55																						
12/03/10	21	688388.78	7400267.92																						
12/03/10	22																								
12/03/10	23	693523.31	7411039.45																						
12/03/10	24	692085.08	7400452.13																						
12/03/10	25	516077.72	6970166.91																						
12/03/10	26	515809.95	6969393.08	50	12	70			30		30	10	1	0	1	0	1	1	3	0	A	1	1	G	
12/03/10	27	515800.87	6969391.16																						Bare/saltmarsh - dominated by sueada
12/03/10	28	515793.30	6969390.94																						Different saltmarsh plant
12/03/10	29	515790.59	6969385.70																						Bare/saltmarsh - dominated by sueada
12/03/10	30	515789.66	6969385.33																						
12/03/10	31	515787.53	6969385.21																						
12/03/10	32	515786.33	6969385.28																						
12/03/10	33	515785.02	6969386.48																						
12/03/10	34	515783.93	6969386.69																						
12/03/10	35	515781.75	6969387.31																						
12/03/10	36	515780.69	6969387.36																						
12/03/10	37	515779.21	6969381.79																						
12/03/10	38	515778.87	6969381.49																						

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12/03/10	39	515778.63	6969379.65																						
12/03/10	40	515777.86	6969378.13																						
12/03/10	41	515779.76	6969374.88																						
12/03/10	42	515780.45	6969374.37																						
12/03/10	43	515781.07	6969375.70																						
12/03/10	44	515781.24	6969375.42																						
12/03/10	45	515781.43	6969376.42																						
12/03/10	46	515782.91	6969375.38																						
12/03/10	47	515783.68	6969374.97																						
12/03/10	48	515784.38	6969375.15																						
12/03/10	49	515784.05	6969378.59																						
12/03/10	50	515785.79	6969379.79																						
12/03/10	51	515770.20	6969375.72																						
12/03/10	52	515764.41	6969374.36																						
12/03/10	53	515755.25	6969378.77																						
12/03/10	54	515747.53	6969377.90																						
12/03/10	55	515737.09	6969379.22																						More ceriops
12/03/10	56	515733.08	6969377.49																						ceriops to foreshore
12/03/10	57	515722.89	6969382.22																						
12/03/10	58	515717.16	6969384.65																						
12/03/10	59	515717.38	6969383.67																						
12/03/10	60	515713.99	6969382.46																						
12/03/10	61	515704.53	6969387.48																						
12/03/10	62	515700.97	6969388.21																						
12/03/10	63	515697.04	6969390.69																						
12/03/10	64	515697.19	6969391.21																						
12/03/10	65	515695.97	6969392.31																						
12/03/10	66	515693.75	6969392.99																						
12/03/10	67	515689.39	6969396.90																						
12/03/10	68	515685.82	6969395.43																						
12/03/10	69	515677.24	6969397.65																						
12/03/10	70	515672.01	6969412.74																						
12/03/10	71	515671.39	6969415.87																						
12/03/10	72	515672.64	6969420.32																						
12/03/10	73	515668.03	6969447.99																						
12/03/10	74	515665.46	6969473.41																						
12/03/10	75	515668.12	6969476.30																						
12/03/10	76	515641.95	6969397.22																					G	Good
12/03/10	77	515644.14	6969399.46																					G	
12/03/10	78	515645.46	6969412.26																						
12/03/10	79	515638.25	6969427.80																						
12/03/10	80	515639.31	6969432.35																						
12/03/10	81	515635.30	6969441.00																						
12/03/10	82	515636.66	6969444.08																						
12/03/10	83	515636.65	6969446.38																						
12/03/10	84	515639.03	6969447.07																						
12/03/10	85	515639.84	6969448.17																						

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	86	515640.31	6969447.73																						
12/03/10	87	515643.04	6969447.31																						
12/03/10	88	515648.10	6969450.86																						
12/03/10	89	515646.60	6969453.90																						
12/03/10	90	515647.75	6969458.02																						
12/03/10	91	515653.87	6969462.95																						
12/03/10	92	515656.01	6969469.00																						
12/03/10	93	515657.31	6969472.92																						
12/03/10	94	515663.62	6969487.44																						
12/03/10	95	515665.07	6969490.07																						
12/03/10	96	515654.34	6969506.68																					P	On waters edge is poor, inland up to 6m saltmarsh
12/03/10	97	515651.69	6969508.62									20	2	2	2	0	2	1	0	0	A	0		P	Poor area
12/03/10	98	515649.73	6969511.10									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	99	515648.54	6969512.57									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	100	515653.74	6969517.49									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	101	515653.76	6969519.60									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	102	515653.82	6969524.18									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	103	515654.12	6969528.38									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	104	515653.91	6969532.62									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	105	515654.63	6969535.33									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	106	515655.43	6969538.69									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	107	515657.52	6969540.52									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	108	515659.17	6969544.32									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	109	515660.50	6969545.86									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	110	515662.93	6969559.41									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	111	515667.58	6969561.96									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	112	515668.75	6969565.82									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	113	515668.19	6969569.86									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	114	515669.82	6969572.31									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	115	515670.68	6969576.49									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	116	515671.27	6969581.08									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	117	515671.84	6969586.01									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	118	515672.88	6969589.53									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	119	515673.40	6969593.44									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	120	515673.80	6969597.48									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	121	515653.39	6969517.17									20	2	2	2	0	2	1	0	0	A	0		P	
12/03/10	122	515681.00	6969490.79	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	123	515678.89	6969490.56	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	124	515678.78	6969491.17	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	125	515679.95	6969490.85	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	126	515680.84	6969490.52	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	127	515682.44	6969490.21	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	128	515684.12	6969488.97	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	129	515685.11	6969484.90	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	130	515685.68	6969479.04	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	131	515686.75	6969475.48	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	132	515684.38	6969473.11	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	

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12/03/10	133	515681.82	6969470.92	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	134	515680.11	6969470.86	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	135	515678.52	6969473.31	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	136	515675.30	6969476.48	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	137	515674.29	6969480.22	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	138	515674.57	6969482.05	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	139	515674.01	6969484.62	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	140	515674.97	6969487.26	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	141	515675.97	6969488.82	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	142	515676.04	6969491.03	40	25	60		40		40		10	1	1	1	0	2	1	1	0	A	1	2	F	
12/03/10	143	515698.22	6969497.15																						
12/03/10	144	515703.50	6969497.25																						
12/03/10	145	515713.51	6969499.65																						
12/03/10	146	515723.21	6969504.40																						
12/03/10	147	515726.28	6969505.84																						
12/03/10	148	515736.63	6969511.83																						
12/03/10	149	515758.47	6969563.51	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	150	515758.43	6969564.21	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	151	515758.75	6969563.74	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	152	515758.91	6969563.73	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	153	515759.31	6969562.67	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	154	515762.29	6969562.53	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	155	515764.06	6969561.92	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	156	515767.99	6969559.95	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	157	515772.26	6969555.13	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	158	515773.64	6969552.79	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	159	515774.57	6969551.47	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	160	515774.01	6969550.33	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	161	515772.55	6969549.09	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	162	515771.27	6969549.51	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	163	515770.49	6969551.13	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	164	515768.14	6969554.85	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	165	515762.35	6969556.86	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	166	515761.11	6969560.55	30	25	80		20		20		40	1	1	2	0	1	0	2	0	A	1	2	P	
12/03/10	167	515757.69	6969563.83		1																				
12/03/10	168	515768.95	6969600.30	0	0																			D	Dead
12/03/10	169	515768.73	6969599.88	0	0																			D	
12/03/10	170	515768.52	6969599.72	0	0																			D	
12/03/10	171	515768.31	6969600.74	0	0																			D	
12/03/10	172	515762.02	6969600.02	0	0																			D	
12/03/10	173	515756.64	6969601.15	0	0																			D	
12/03/10	174	515756.46	6969602.05	0	0																			D	
12/03/10	175	515757.02	6969602.56	0	0																			D	
12/03/10	176	515757.33	6969602.92	0	0																			D	
12/03/10	177	515758.65	6969603.60	0	0																			D	
12/03/10	178	515758.96	6969603.01	0	0																			D	
12/03/10	179	515759.09	6969602.89	0	0																			D	

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12/03/10	180	515763.93	6969603.58	0	0																			D	
12/03/10	181	515766.19	6969603.78	0	0																			D	
12/03/10	182	515770.53	6969603.27	0	0																			D	
12/03/10	183	515769.93	6969603.18	0	0																			D	
12/03/10	184	515720.84	6969672.49																					BS	Saltmarsh transect line
12/03/10	185	515717.71	6969677.01																					BS	
12/03/10	186	515712.66	6969681.41																					BS	
12/03/10	187	515710.29	6969682.87																					BS	
12/03/10	188	515705.56	6969685.29																					BS	
12/03/10	189	515704.64	6969688.55																					BS	
12/03/10	190	515704.15	6969691.65																					BS	
12/03/10	191	515705.46	6969694.45																					BS	
12/03/10	192	515705.27	6969698.79																					BS	
12/03/10	193	515705.14	6969703.99																					BS	
12/03/10	194	515710.30	6969707.46																					D/BS	Dead w/ saltmarsh Previous regrowth now good
12/03/10	195	515711.95	6969709.92																					D/BS	
12/03/10	196	515712.22	6969713.64																					D/BS	
12/03/10	197	515713.61	6969716.75																					D/BS	
12/03/10	198	515711.33	6969719.64																					D/BS	
12/03/10	199	515706.61	6969721.95																					D/BS	
12/03/10	200	515701.80	6969719.00																					D/BS	
12/03/10	201	515697.84	6969717.75																					D/BS	
12/03/10	202	515692.91	6969711.64																					D/BS	
12/03/10	203	515694.26	6969706.76																					D/BS	
12/03/10	204	515696.95	6969704.15																					D/BS	
12/03/10	205	515700.03	6969701.82																					D/BS	
12/03/10	206	517947.55	6971553.14	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	207	517950.07	6971554.49	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	208	517951.17	6971555.25	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	209	517952.78	6971554.20	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	210	517952.33	6971552.98	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	211	517952.23	6971549.94	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	212	517951.88	6971548.80	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	213	517945.83	6971551.08	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	214	517944.00	6971548.72	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	215	517940.40	6971544.41	60	6	100						2	2	1	1	0	0	0	0	0	A	2	0	R	
12/03/10	216	517649.86	6971208.00	50	10	100						10	1	1	1	0	0	0	0	0	A	2	1	G	
12/03/10	217	517655.98	6971210.10																						Dead area/single hole no pneumatophores
12/03/10	218	517927.95	6971525.65																						
12/03/10	219	518012.47	6971667.19																						Less sinkholes, more coverage
12/03/10	220	518154.98	6971883.35	60	5	100						5	2	1	2	0	1	1	0	0	A	1	1	G	
12/03/10	221	518191.03	6971905.03	60	5	100																			sueda ground cover
12/03/10	222	518215.51	6971894.54	60	4	100						10										0	0	F	
12/03/10	223	518239.06	6971883.97	80	6	100						5	2	2	2	0	1	0	0	0	A	1	1	G	
12/03/10	224	518249.38	6971874.74	60	6	100						20	2	1	1	0	0	0	0	0	A	1	1	R	

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12/03/10	225	518266.25	6971866.12	60	6	100						5	1	1	1	0	0	0	0	0	A	1	1	G	
12/03/10	226	518287.71	6971853.54	70	6	100						5	1	1	1	0	0	0	0	0	A	1	1	G	
12/03/10	227	518323.24	6971834.86	70	3	100						5	1	1	1	0	0	0	0	0	A	1	1	G	Flood debris
GPS 10																									
12/03/10	449	516592.28	6970056.65	60	4	100				10	15		1	1	1	0	1	1	1	0	0	1	1	G	AM good
12/03/10	450	516714.90	6970075.03																						
12/03/10	451	516707.97	6970061.63																					F	Fair CT
12/03/10	452	516742.38	6970062.08																					P	Poor CT and AM
12/03/10	453	516743.65	6970061.88																					P	
12/03/10	454	516755.03	6970056.53																					P	
12/03/10	455	516758.04	6970057.85																					P	
12/03/10	456	516759.94	6970060.15																					P	
12/03/10	457	516775.26	6970077.04																					P	
12/03/10	458	516777.91	6970077.40																					F/P	Edge of poor and fair
12/03/10	459	516778.44	6970076.72																					D	Dead CT
12/03/10	460	516793.52	6970071.87																					D	
12/03/10	461	516793.46	6970071.57																					D	
12/03/10	462	516795.51	6970074.57																					D	
12/03/10	463	516804.09	6970076.54																					D	
12/03/10	464	516818.54	6970067.17																					D	
12/03/10	465	516817.30	6970063.03																					D	
12/03/10	466	516820.11	6970052.94																					D	
12/03/10	467	516814.62	6970052.79																					D	
12/03/10	468	516809.67	6970050.83																					D	
12/03/10	469	516808.69	6970050.46																					P	Poor CT and AM
12/03/10	470	516792.92	6970041.22																						
12/03/10	471	516787.82	6970025.76																						
12/03/10	472	516795.92	6970021.14																						
12/03/10	473	516795.63	6970016.78																						
12/03/10	474	516792.40	6970006.12																						
12/03/10	475	516786.92	6969997.76																						
12/03/10	476	516800.65	6969990.03																						
12/03/10	477	516815.22	6969992.05																						
12/03/10	478	516821.51	6969995.66																						
12/03/10	479	516777.00	6970016.05																						
12/03/10	480	516760.74	6970017.35																						
12/03/10	481	516738.64	6970023.48																						
12/03/10	482	516729.92	6970052.76																						
12/03/10	483	516709.55	6970044.33																					F	Fair CT
12/03/10	484	516696.41	6970038.18																					G/F	Edge of fair and good
12/03/10	485	516692.73	6970037.37																					G	Good
12/03/10	486	516713.50	6970009.48																					G	
12/03/10	487	516746.69	6969981.55																					G	
12/03/10	488	516764.39	6970019.19																					G/F	Edge of fair and good
12/03/10	489	516759.91	6970020.48																					P	sml patch of poor CF (10m + 10m)
12/03/10	490	516800.32	6970028.28																					RD	Recently dead CT
12/03/10	491	516801.54	6970023.96																					RD	

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	492	516810.48	6970023.91																					RD	
12/03/10	493	516813.88	6970030.71																					RD	
12/03/10	494	516822.03	6970031.55																					RD	
12/03/10	495	516827.39	6970035.64																					B	Bare saltmarsh
12/03/10	496	516844.27	6969991.70																					P	Patch of poor CT
12/03/10	497	516832.31	6969959.39																					G/F	Edge of fair and good
12/03/10	498	516874.99	6969927.85																					G	Good
12/03/10	499	516876.65	6969918.51																					RG	sml patch of AM regrowth (5m x 2m) parallel to shore
12/03/10	500	516966.15	6969905.78																						Patch of salt marsh (10m x 2m) along CK line
12/03/10	501	517611.67	6969731.25																					G	Good
12/03/10	502	517631.44	6969771.45	50	5				100	5	10		1	1	1	0	0	0	2	0	0	1	2	G	Good RS (photo 237)
12/03/10	503	517828.86	6969719.48																					G	Good
12/03/10	504	518027.22	6969686.34																					F	Fair AM
12/03/10	505	518073.72	6969690.58																						
12/03/10	506	518197.12	6969694.91																					D/RD	Edge b/w dead and recently dead
12/03/10	507	518192.02	6969663.02																					D/RD	
12/03/10	508	518199.21	6969630.05																					D/RD	
12/03/10	509	518184.73	6969605.66																					D/RD	
12/03/10	510	518141.75	6969584.24																					D/RD	
12/03/10	511	518138.34	6969572.19																					P	Patch of poor - 10m x 2m
12/03/10	512	518138.20	6969584.04																					P/D	Edge of D and P
12/03/10	513	518144.81	6969615.99																					P/D	
12/03/10	514	518129.31	6969663.45																					P/D	
12/03/10	515	518114.17	6969674.95																					P/D	
12/03/10	516	518122.05	6969678.83																					RD	Patch of RD
12/03/10	517	518110.00	6969680.37																					P/D	Edge of D and P
12/03/10	518	518080.36	6969680.08																					P/D	
12/03/10	519	518079.10	6969696.85																					P/D	
12/03/10	520	518161.35	6969710.55																					P/D	
12/03/10	521	518204.74	6969709.81																					P/D	
12/03/10	522	518203.00	6969672.21																					P/D	
12/03/10	523	518262.15	6969492.29																					P	Poor AM
12/03/10	524	518261.17	6969482.02																					RD	RD AM
12/03/10	525	518248.83	6969452.23																					RD	
12/03/10	526	518250.59	6969446.23																						
12/03/10	527	518256.95	6969428.26																						
12/03/10	528	518237.04	6969412.63																						
12/03/10	529	518291.90	6969366.00																						
12/03/10	530	518296.10	6969369.67																						Salt marsh
12/03/10	531	518314.76	6969340.06																						
12/03/10	532	518324.36	6969333.71																					P/D	Edge of D and P
12/03/10	533	518358.98	6969286.76																					P/D	
12/03/10	534	518398.30	6969236.80																					P/D	
12/03/10	535	518402.23	6969225.24																					P/D	
12/03/10	536	518403.86	6969220.44																					P	Poor AM

Date	Waypoint	Easting	Northing	% Cover	Height	AM	AC	Ct	Rs	% Dead Trees	% Live Trees	% Dead branches	Colour	Leaf Size	Insect Damage	Adv. Roots	Epic. Shoots	Pneum. Deform	Epi. Algae	Float Algae	BMA (P/A)	Seedling density	Macro Fauna	Health	Comments
12/03/10	537	518397.37	6969207.12																					F/P	Edge of P and F, AM
12/03/10	538	518364.97	6969177.60																					F	Fair
12/03/10	539	518351.26	6969127.33																					F	
12/03/10	540	518356.14	6969109.31	50	8	20			80	10	20		1	1	2	0	1	1	2	0	0	2	2	G	Edge of G and F (good dominated by RS)
12/03/10	541	518405.43	6969051.52	50	8	20			80	10	20		1	1	2	0	1	1	2	0	0	2	2	G	
12/03/10	542	518491.50	6969095.87																					P	Patch of poor (10m x 10m)
12/03/10	543	518462.43	6969095.17																						
12/03/10	544	518431.51	6969140.89																					F	Fair AM
12/03/10	545	518376.21	6969184.02																					F	
12/03/10	546	518328.15	6969256.39																					G/F	Edge of fair and good
12/03/10	547	518365.85	6969320.97																					D	Edge of dead with strip (2m) of RD to east
12/03/10	548	518382.60	6969350.40																					P	Poor AM
12/03/10	549	518372.46	6969359.38																					P	Edge P
12/03/10	550	518332.00	6969382.45																					P	Poor AM
12/03/10	551	518294.19	6969381.52																					P	Patch of poor AM in middle of dead (5m wide)
12/03/10	552	518266.33	6969397.24																					P	
12/03/10	553	518204.66	6969406.69																					P	Poor AM
12/03/10	554	518138.69	6969382.69																					F/P	Edge of P and F, AM
12/03/10	555	518111.98	6969427.93																					F/P	
12/03/10	556	518094.30	6969467.59																					F	Fair
12/03/10	557	518074.64	6969530.60																					P	Poor AM
12/03/10	558	518067.22	6969547.31																					F/P	Edge of P and F, AM
12/03/10	559	518060.03	6969578.17																					D	
12/03/10	560	518034.09	6969583.16																					D	
12/03/10	561	517996.43	6969583.61																					D	
12/03/10	562	517888.08	6969519.93																					D	
12/03/10	563	517860.18	6969506.46																					D	
12/03/10	564	517818.45	6969528.66																					D	
12/03/10	565	517795.46	6969538.26																					P	Poor AM
12/03/10	566	517755.25	6969628.46																						
12/03/10	567	517748.15	6969700.48																					G	AM
12/03/10	568	517788.33	6969737.32																					G	
12/03/10	569	517703.80	6969735.26																						Edge of Am and RS
12/03/10	570	516838.22	6969914.87																					G	
12/03/10	571	516796.69	6969935.53																					G	AM
12/03/10	572	516775.92	6969952.61																					G	

Appendix E Potential Causes of Mangrove Dieback

Contents

List of Figures

1 Introduction

1.1 Historical Context

Potential causes of the mangrove dieback observed at Fisherman and Whyte Island are discussed in detail in the 2006 survey report (frc environmental 2007a).

In a historical context, the major damage to the mangroves of Fisherman Island and Whyte Island has been direct reclamation, and the impacts of unconfined dredge material spreading out over mangrove communities. However, some decades since reclamation in these areas has ceased, large areas of mangroves continue to decline in health. While this may in part be due to the forests reaching a new equilibrium with the newly created morphology and hydrology, there are likely to be other factors involved.

The majority of trees that have died on Fisherman Islands and Whyte Island were *Avicennia marina*, the dominant species in the area. However, *Ceriops tagal* trees have also died in some areas of Fisherman Islands.

A number of interacting factors impact mangrove health in the vicinity of the Port of Brisbane. Some areas of dieback have been predominantly impacted by erosion, sediment accretion and wind. These areas are relatively small, and typically include characteristics such as undermining of roots, sediment deposition on roots, and circular holes in the canopy. Of more concern is the continuing, larger scale dieback in the middle of large areas of Fisherman and Whyte islands, including in the middle of the eastern section of Fisherman Islands. The cause of dieback in these larger areas is less readily identified, and is likely to be a combination of factors, including changes to climate, including wet and dry cycles in rainfall; changes to hydrology and morphology in the area; sediment pore water salinity levels; the historical distribution and health of these communities; and increased nutrient supply. While other factors, such as contaminants, may also be involved, testing to date does not support this.

Our assessment of impacts likely to be causing mangrove dieback focuses on the larger areas of dieback at Fisherman and Whyte islands.

1.2 Summary of Mangrove Health in 2010

Overall, mangrove health in 2010 was generally similar to 2008. While the total area of dead mangroves was similar, the total area and proportion of recently dead mangroves within each dieback area had decreased substantially since 2008 (from 1.6 ha and 6% of the total dead area to 0.8 ha and 3% at Fisherman Islands; and 0.92 ha and 3% to 0.10 ha and 0.03% at Whyte Island). That is, the total area of mangroves dying in 2010 was less than 2008.

In 2010, the only substantial increase in the area of dead mangroves was in the dieback area in the eastern section of Fisherman Islands. In 2008, there was a relatively large area of recently dead mangroves that are now mostly dead, and there is a new 'front' of recently dead mangroves. This area is the furthest away, and presumably least exposed, to any land-based anthropogenic impacts such as port activities.

In contrast, in the western section of Fisherman Islands, mangroves that were classed as recently dead in 2008 had regrown (i.e. there has been extensive epicormic shooting) and were in similar condition to the adjacent forest in poor health.

At Whyte Island, most of the mangroves that were classed as recently dead in 2008 were dead in 2010.

In 2010, there were new areas of mangrove regrowth at Fisherman and Whyte islands, and most of the regrowth recorded in 2008 had matured into mature forest in poor health.

There has been extensive recent colonisation by saltmarsh on the edges of the dieback bare areas on Fisherman Islands, with dense mangrove seedlings common in these areas.

2 Possible Causes of Dieback

2.1 Salinity

Increased salinity levels associated with low rainfall have been implicated as the causal agent of dieback of *Avicennia marina* mangrove communities in many cases, including: the Embley estuary in far north Queensland, an area remote from human intervention (Conacher et al. 1996); the arid Pilbara coast of Western Australia (Gordon 1987); and commonly in West African mangrove ecosystems (Marius & Lucas 1991). High salinity levels are associated with reduced leaf photosynthesis (Sobrado 1999; Li et al. 2008), reduced leaf ion concentration and hydraulic conductivity (Lovelock et al. 2007), reduced mangrove growth (Cintron et al. 1978; Ball 1988; Kahn & Aziz 2001; Naidoo 2006; Yan et al. 2007; Li et al. 2008), and mangrove death (Perdomo et al. 1998).

In 2008 and 2010, sediment pore water salinity was generally higher in dieback areas than from forests in good health. However, pore water salinities of mangroves in good health at Mooroondu Point were similar to areas of dieback at Fisherman islands, suggesting that pore water salinity alone is not responsible for mangrove death at the Port of Brisbane.

2.2 Rainfall

Between 1955 and 1998, the Moreton Bay region saw a net expansion of mangroves in the intertidal zone (frc environmental 2001). It has been suggested that this was due to wetter conditions in the region and increased sedimentation over this period (Duke et al. 2003a). Mangroves that colonised over this period would not need to adapt to high salt concentrations in the sediment. With decreasing rainfall, pore water salinity would rise, and these mangroves would have been under increasing stress. In contrast, stunted mangroves that developed in highly saline areas may have been able to survive.

Similarly, the landward expansion of mangroves in south east Queensland has been correlated with rainfall, with more rapid expansion in wetter years, and large gaps appearing in mangroves in dryer periods (Eslami-Andargoli et al 2009)

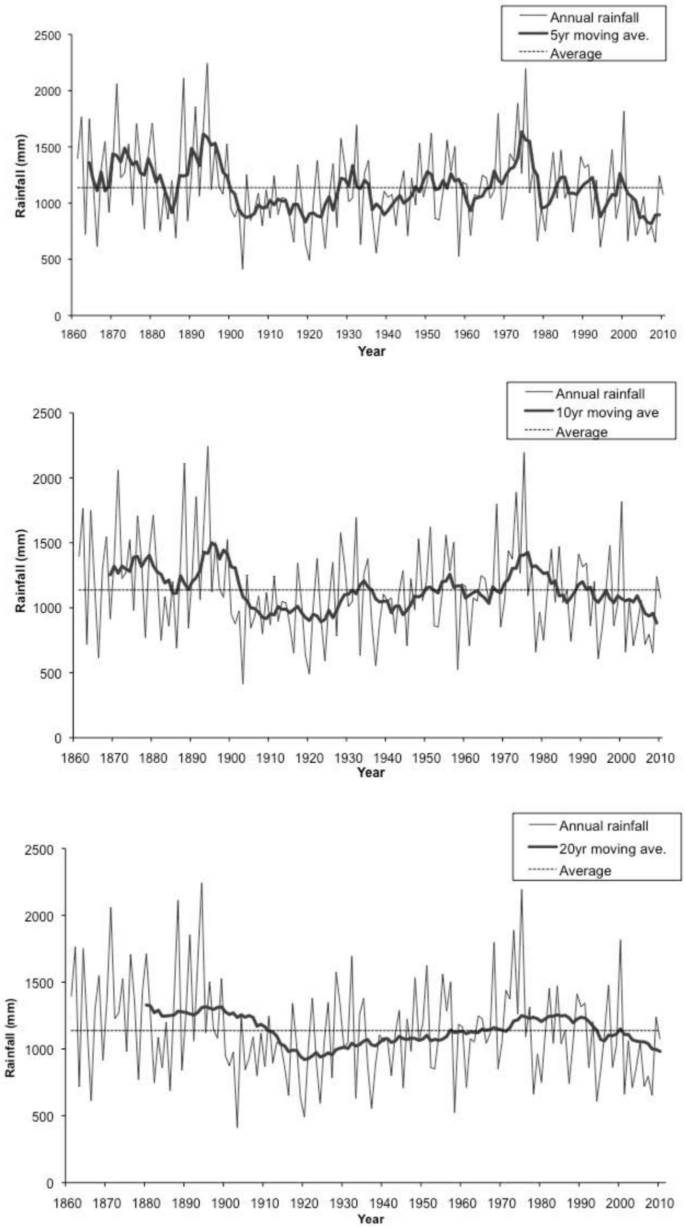
In 1999, rainfall was above average, but decreased again in 2000, and was below average from 2000 to 2007 (Figure 2.1). It is likely that this increased soil salinity, particularly in marginal mangrove habitats, and increased physiological stress on the mangroves. Over this time, a number of areas of mangrove dieback were recorded in

Moreton Bay, including Whyte Island, Fisherman Islands, Luggage Point, the Caboolture River, Boondall Wetlands, (Pedersen 2002; frc environmental 2007b), Cobby Cobby Island, Coombabah Lake, and Hayes Inlet.

In 2008 and 2009, there was an increase in annual rainfall, with rainfall in 2008 above the long term annual average (Figure 2.1). Rainfall in December 2009, and from January to March 2010 was also above the long term monthly average (Bureau of Meteorology 2010). Evaporation rates were also lower than average from January to March 2010 (Bureau of Meteorology 2010).

Higher rainfall and low evaporation rates may have resulted in decreases in the salinity of surface and pore waters, and also a decrease in evapotranspiration, particularly in the hotter summer months. This may have allowed colonisation by saltmarsh in the areas that had been dead for some time, the regrowth of mangrove areas that were dieing in 2008, and may have decreased the rate of dieback[1].

[1] Soil pore water salinity was collected in transects across mangrove health categories from good to recently dead, but was not collected in the older dead areas that are currently being colonised by saltmarsh. Further, samples were collected from the same categories of mangrove health along each transect as in 2008, not from the same sites.



frc environmental
deep thinking. science.

Port of Brisbane: Mangrove Health Assessment 2010.

Figure 2.1 Average annual rainfall between 1860 and 2009, showing 5, 10 and 20 year moving (rolling) averages (updated from Duke et al. 2003b).

June 2010

2.3 Potential Contaminants

Nutrients

Sediments at Fisherman and Whyte Islands have been tested for contaminants including nutrients, TPH, BTEX and Organochlorides and heavy metals. Of these only nutrients were above expected concentrations for contaminated areas, however there were no clear trends between nutrient concentration and mangrove health.

2.4 The Interaction of Pore Water Salinity and Nutrients

Lovelock et al. (2009) recently reported that increasing nutrient concentrations introduce instability, and lower environmental resilience, in mangrove forests when associated with high pore water salinity. This is because nutrients stimulate shoot growth relative to root growth (thereby increasing productivity) during favourable conditions, but these new shoots potentially increase water stress during drought (due to water demand by the new shoots). Water stress can cause mangrove death when pore water salinity is high by limiting water uptake by roots. Furthermore, low atmospheric humidity increases water loss from shoots during periods of drought. That is, high nutrient concentrations can cause death when mangroves are subject to high pore water salinity. The combination of high nutrient levels and salinity stress may have significantly contributed to mangrove death at Fisherman and Whyte Island.

2.5 Ponding of Water

Recent dieback at both Fisherman Islands and Whyte Island was often associated with the ponding of water. Similar dieback associated with the ponding of water has also been recorded in other areas of Moreton Bay, in particular Nudgee, Nundah and Burpengary Creeks (frc environmental 2007b; 2008).

After mangrove death, the sediment level drops to create a basin, increasing the impoundment of water and exacerbating stressful conditions associated with hypersalinity and waterlogging. After particularly high tides (over approximately 2.0 m above lowest astronomical tide, LAT), water is retained in many of the areas of dead and poor health mangroves. Water in ponded mangrove dieback areas in Nundah and Nudgee Creeks was typically high in total ammonia and dissolved organic nitrogen, low in nitrate, highly saline (up to twice that of seawater), relatively warm, alkaline (pH of about 8.4) and super saturated with oxygen during the day, and hypoxic at night (Oxbow 2009). These water quality conditions were conducive to the growth of algal mats which further reduced water quality, can smother mangrove pneumatophores, and can block drainage lines, further impeding water movement (pers. obs.).

Further, anoxic sediments with low redox potentials can favour chemical transformations of a number of essential elements, in some cases improving their availability and in some cases restricting it. Extreme anaerobiosis can lead to the production of hydrogen sulphide (H_2S) and other compounds that are toxic to plants (Clough 1992).

Given these poor water quality conditions, and the decrease in sediment level, resulting in the ponding of water, mangroves are unlikely to recolonise these areas.

Factors contributing to the ponding of water may include:

- loss of biomass (roots) in the sediment
- physicochemical changes to the sediment structure causing the sediment to sink
- the formation of temporary bunds of seagrass and algal wrack, which can be washed into the mangroves during high tides (particularly following strong winds) and block drainage lines
- growth of mangrove forests, in particular pneumatophore density, altering tidal inundation, and trapping water in back swamp areas (Knight et al. 2007)
- mangroves on the outer edges accreting sediment, accretion rates from mangrove areas are variable, but commonly approach 0.5 cm/y (Saenger 2002), and
- sea level rise causing more frequent or severe inundation.

In addition at Fisherman Island, the unconfined deposition of sediment during construction works may have altered drainage patterns and exacerbated ponding.

We hypothesise that colonisation and greater mangrove density in wet years changes the drainage patterns within existing mangrove forests, e.g. 1955 to 1998 in the Moreton Bay region. In dryer years these areas become hypersaline and mangroves adapted to fresher conditions die, e.g. 2005 to 2007 in Moreton Bay. Through a combination of root mass loss and changes to soil processes, the sediment level decreases. Water then ponds in these depressions after spring tides, and gradually evaporates, further increasing salinity levels. Mat forming algae bloom in the ponded water, and are likely to contribute to low dissolved oxygen levels, particularly at night. The high salinity levels, poor water quality, and prolonged high water levels of ponded areas are unsuitable for either mangrove growth or recolonisation. This process may be exacerbated by anthropogenic changes to drainage patterns and nutrient concentrations.

3 Conclusions and Recommendations

Long term changes in rainfall and climate appear to have an over-riding influence on patterns of mangrove dieback and recolonisation in Moreton Bay. However, this may be exacerbated by a number of other factors, including an increase in nutrient concentrations, with mangroves in areas of high salinity and sediment nutrient concentration possibly the most vulnerable communities.

Changes to mangrove communities as a result of growth and dieback also appear to have a feedback mechanism: prolific growth, particularly of pneumatophores can change tidal inundation patterns, while dieback can result in a decrease in sediment levels, resulting in the ponding of water, making an area unsuitable for mangrove growth.

Continued monitoring is recommended, and could be enhanced by further investigations such as:

- ongoing measurement of pore water salinity in sediment from dieback and healthier areas, including the comparative transects and old dieback areas being colonised by saltmarsh, with the same sites sampled each year
- investigation of nutrient levels in sediment along the pore water transects, particularly in the eastern section of Fisherman Islands
- deployment of water depth loggers to confirm the period and frequency of ponding
- a dye run to establish which way the water flows out of the dieback areas, particularly in the new dieback area on Fisherman Islands
- laser survey or similar of dieback areas, to establish benchmark for sediment height, and
- measurement of nutrients, salinity and dissolved oxygen levels in ponded areas.

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Appendix D Pore Water Salinity

Contents

List of Tables

List of Figures

1 Introduction

Worldwide studies of pore water salinity and *Avicennia marina* indicate stunted *A. marina* (that is mature plants under approximately 2.5 m high) are often associated with sediments that have a high pore water salinity (up to 115 PSU), whilst taller forests are associated with lower pore water salinities (Lovelock, Adame & Amir [University of Queensland School of Integrative Biology] pers. comm. 2007, Naidoo 2006). That is, stunting of *A. marina* is likely to be a response to high sediment pore water salinity.

Previous work on Whyte Island indicated that sediment pore water salinity was higher in areas of mangrove dieback, and in areas of poor health, than in healthy tall forest. Salinities were higher again in scrub forests and highest in the central areas with no mangroves and algal mats, i.e. claypan (Lovelock, Adame & Amir [University of Queensland School of Integrative Biology] pers. comm. 2007).

The growth of saltmarsh species, which are more tolerant of high salinities, in areas of dieback also suggests that soil salinities in these areas may have increased.

In this study we further investigated sediment poor water salinity and mangrove health.

2 Methods

2.1 Sample Collection

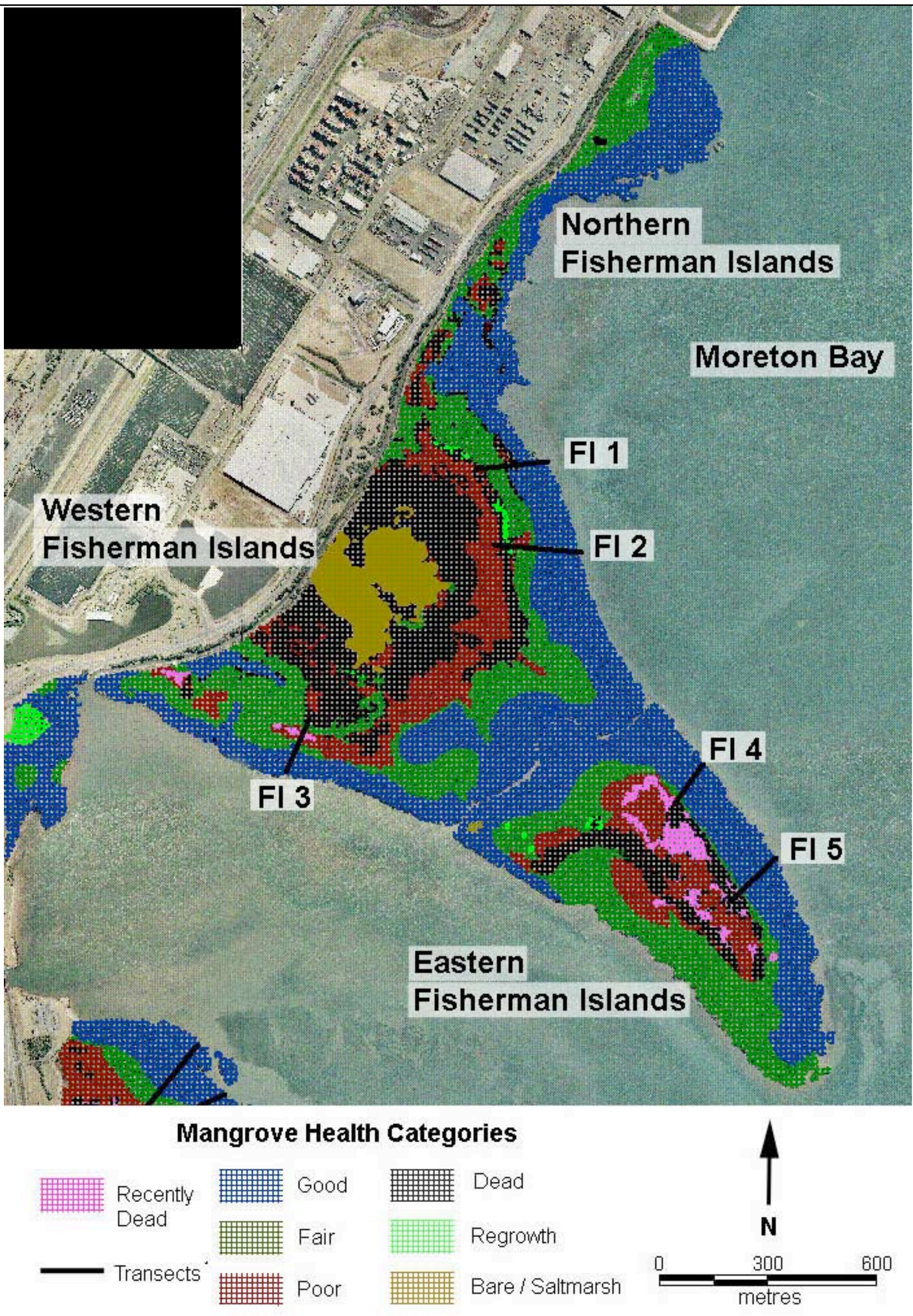
Pore water samples were collected from the sediment of dead mangroves, and from the sediment of forests in poor, fair and good condition, on Fisherman and Whyte islands. At least four samples were collected from each of the five transects on Fisherman Islands (Figure 2.2) and each of the five transects on Whyte Island (Figure 2.3) (Table 2.1). A total of 55 samples were collected.

Comparative pore water samples were collected from forests without large dieback areas, to control for the effect of distance from the seaward margin. Two transects were surveyed at Wellington Point (Figure 2.4) and one transect was surveyed at Mooroondu Point, Thorneside (Figure 2.5). Five samples were collected from a total of three transects, with a total of 15 comparative samples collected.

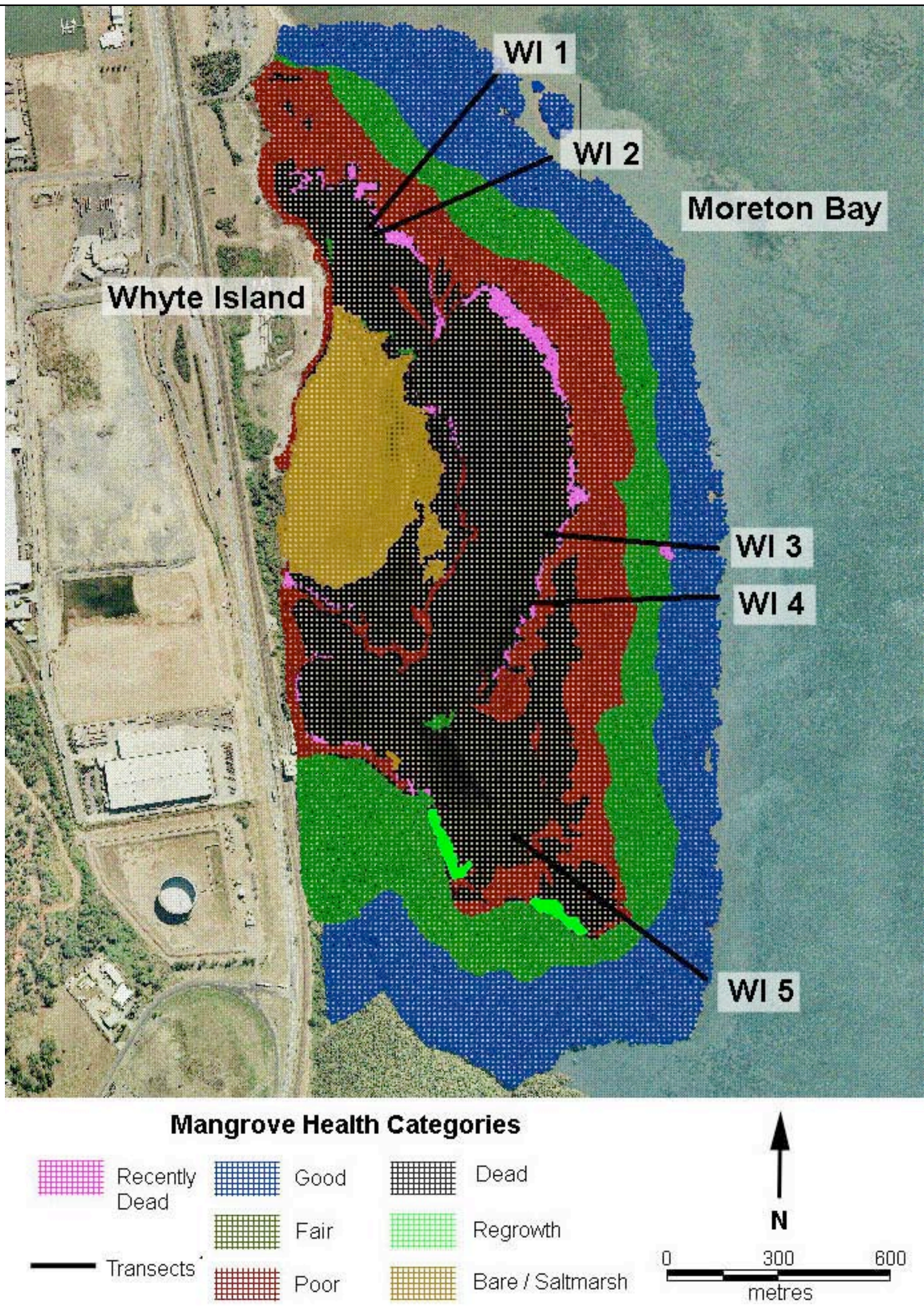
Pore water samples were collected using an apparatus based on McKee et al. (1988). The apparatus consisted of an outer rigid plastic tube (15 mm diameter and sealed at the lower end) and an inner plastic tube (5 mm diameter), both of which were perforated by small holes and connected to a 50 mL syringe (Figure 2.1). The plastic tube was inserted into the sediment, adjacent to mangrove roots, to a depth of approximately 20 cm. The perforated section of the outer tube was buried at least 3 cm below the sediment surface to prevent surface water entering the apparatus. Suction was applied using the syringe.

Figure 2.1

The pore water sampling apparatus in use, March 2010.



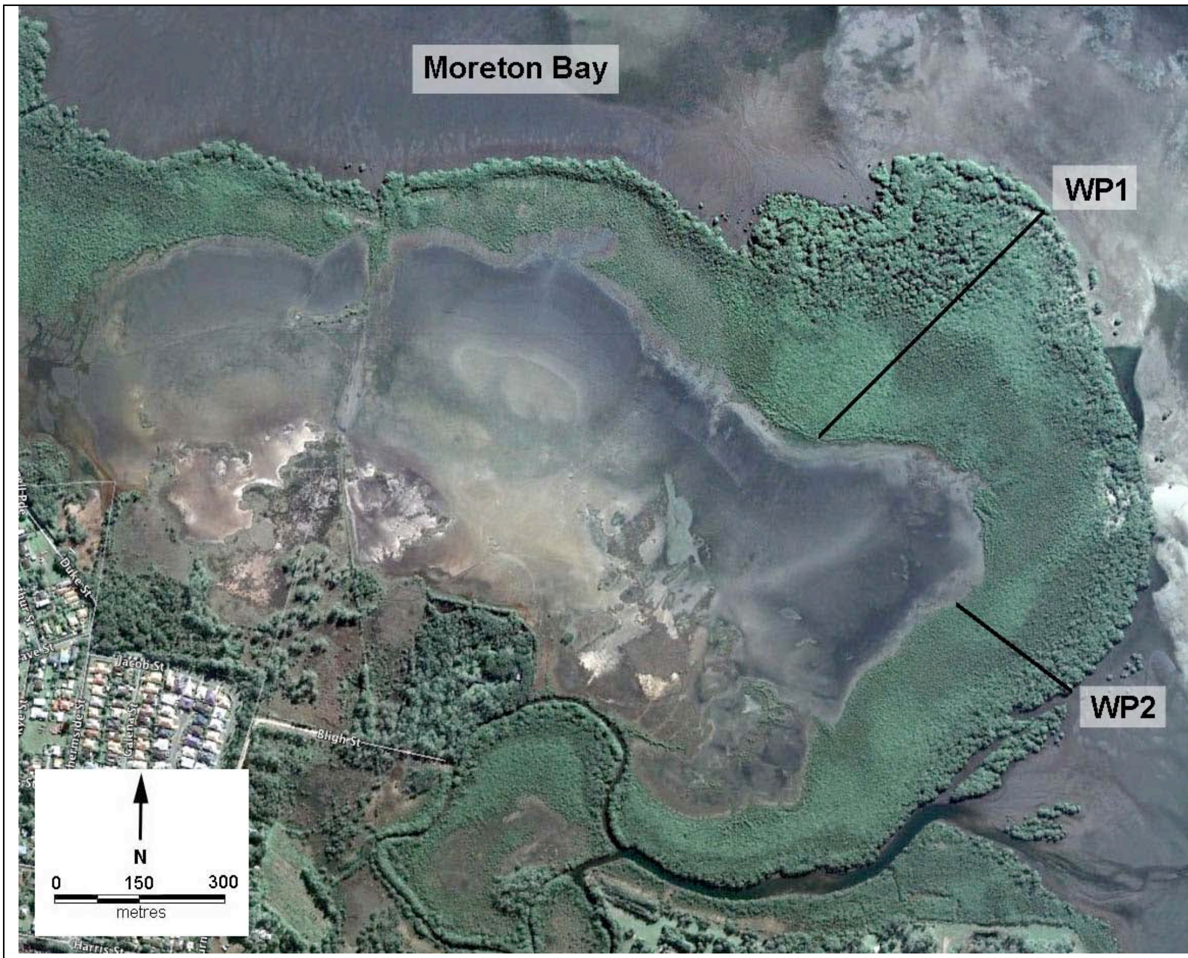
frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 2.2 Location of pore water salinity transects on Fisherman Islands.	
		June 2010



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 2.3 Location of pore water salinity transects on Whyte Island.	
		June 2010

Table 2.1 Position of pore water salinity transects (AGD84 Zone 56J)

Site	Start of Transect		End of Transect	
	Easting	**Northing**	**Easting**	**Northing**
Coal Loader				
No transects surveyed				
Fisherman Islands				
FI 1	517601	6970465	517729	6970476
FI 2	517669	6970246	517777	6970229
FI 3	517085	6969755	517027	6969603
FI 4	518115	6969515	518181	6969604
FI 5	518278	6969244	518374	6969328
Whyte Island				
WI 1	516587	6968611	516741	6968859
WI 2	516677	6968551	516846	6968690
WI 3	516886	6968181	517099	6968155
WI 4	516949	6967990	517101	6967997
WI 5	516912	6967512	517084	6967396
Wellington Point				
WP 1	525201	6959707	525536	6960030
WP 2	525473	6959426	525657	6959273
Mooroondu Point				
MP 1	519865	6960981	520014	6961130



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 2.4 Location of comparative pore water salinity transects at Wellington Point.
	June 2010

frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 2.5 Location of comparative pore water salinity transects at Mooroondu Point.	
		June 2010

2.2 Data Analysis

The salinity of each pore water sample was measured in practical salinity units (PSU) using a Quanta Hydrolab water quality meter, in the frc environmental laboratory.

A nested ANOVA (analysis of variance) test was used to test for differences in pore water salinity between health categories and locations, with health categories nested in location. Pairwise comparisons were undertaken using Tukey's HSD ($p = 0.05$) to distinguish differences between health categories at each location over time.

The distribution and homogeneity of variance was checked using Cochran's Test, and data was log (x+1) transformed due to non-conformance.

3 Results

In 2010, mean pore water salinity was significantly higher in the sediment of the dieback areas of Fisherman and Whyte islands, than in the sediment of mangroves in good health at Fisherman Islands, Whyte Island and Wellington Point (Figure 3.1). This was also the case in 2008.

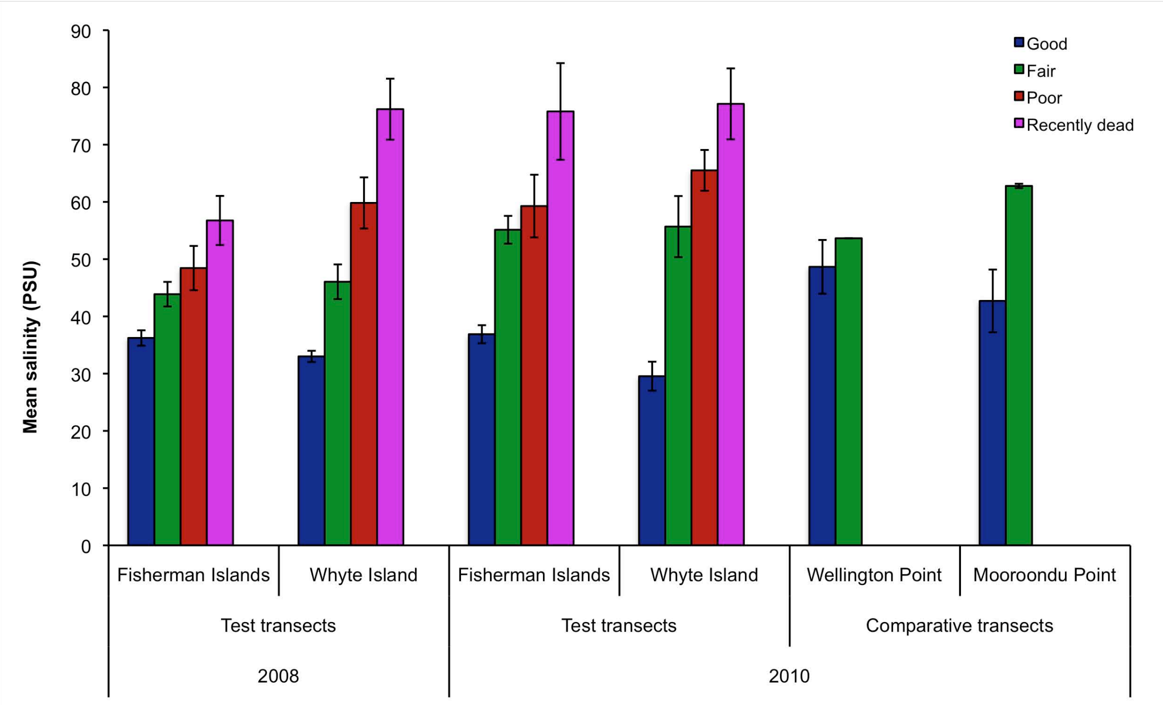


Figure 3.1 Mean pore water salinity at each area surveyed in 2008 and 2010 (vertical bars denote standard error).

At the Whyte Island dieback area, pore water salinity was also significantly higher than in the sediment of mangroves in good health at Mooroondu Point (Tukey HSD test $p < 0.05$) (Table 3.1). Pore water salinity in the sediment of the dieback areas was similar to that of forests in poor and fair health.

Table 3.1 Mean squares and p values for nested ANOVA of pore water salinity in 2010 (mangroves health categories nested in location).

	DF	Mean Squares	p Values
Location	3	0.0075	0.93
Health (Location)	8	0.5143	**0.00**
Error	48	0.0516	

Mean pore water salinity was similar at all four locations in 2010, despite the lack of dieback areas at Wellington and Mooroondu points (Table 3.1). In 2008, mean pore water salinity was significantly higher at Whyte Island than Fisherman Islands (Table 3.2); this was not the case in 2010. Mean pore water was significantly higher in the recently dead mangroves of Fisherman Islands in 2010 than in 2008.

Table 3.2 Mean squares and p values for nested ANOVA of pore water salinity in 2008 (mangroves health categories nested in location).

	DF	Mean Squares	p Values
Location	1	0.1482	**0.02**
Health (Location)	6	0.4767	**0.00**
Error	42	0.0230	

3.1 Fisherman Islands

In 2010, pore water salinity in the dieback areas at Fisherman Islands was similar to that in the sediment of (Tukey HSD test $p < 0.05$):

- the dieback area at Whyte Island
- mangroves in poor health at Fisherman and Whyte islands
- mangroves in fair health at all four survey areas, and
- mangroves in good health at Mooroondu Point.

3.2 Whyte Island

Pore water salinity in the dieback area at Whyte Island was similar to that in the sediment of (Tukey HSD test $p < 0.05$):

- the dieback area at Fisherman Islands
- mangroves in poor health at Fisherman and Whyte islands, and
- mangroves in fair health at all four survey areas.

3.3 Wellington and Mooroondu Points

Mean pore water salinity in the sediment of mangroves in fair and good health at Mooroondu Point, and fair health at Wellington Point, was similar to that of the Whyte Island and / or Fisherman Island dieback area (Tukey HSD test $p < 0.05$). There were no dieback areas at Wellington or Mooroondu points.

Mean pore water salinity was similar at all sampling points along the Wellington Point and Mooroondu Point transects (Tukey HSD test $p < 0.05$). That is, there was no significant difference in pore water salinity with distance from the seaward margin.

4 Discussion and Recommendations

Sediment pore water salinity was generally higher in sediment from dieback areas than from forests in good health. However similar pore water salinity in the dieback areas and forests in fair health in all four survey areas, and forests in good health at Mooroondu Points compared to Fisherman islands (but not Whyte Island), suggests that pore water salinity is not the only factor contributing to the mangrove death at the Port of Brisbane.

We recommend continuation of pore water salinity measurements in future mangrove health assessments, including the comparative transects, to further our understanding of the relationship between pore water salinity and mangrove death. We recommend increasing the number of samples and / or transects to reduce variability, particularly in the dieback areas where variability is highest. In addition we recommend collecting pore water data from the areas that have been dead for some time, and from areas where saltmarsh is colonising.

5 References

McKee, K., Mendelssohn, I. & Hester, M., 1988, 'Reexamination of pore water sulfide concentrations and redox potentials near the aerial roots of Rhizophora mangle and Avicennia germinans', *American Journal of Botany*: 1352-1359.

Appendix C Sediment Quality

Contents

List of Tables

List of Figures

1 Methods

Sediment sampling sites were established and sampled at Fisherman Islands in 1999/2000 (WBM Oceanics Australia 2000) and resampled in 2002 (WBM Oceanics 2002), 2004 (frc environmental 2004), 2006 (frc environmental 2007a) and 2008 (frc environmental 2008). Sediment sampling sites were established at Whyte Island in 2002 (WBM Oceanics Australia 2002), and resampled in 2004, 2006 and 2008. In this 2010 survey, sediments were resampled from these sites (Figure 1.1 – Figure 1.3) and analysed for heavy metals, total petroleum hydrocarbons (TPH), BTEX (benzene, toluene, ethylene & xylene), organochlorine pesticides and nutrients. As in the previous surveys, samples were collected from the surface sediments (up to 10 cm deep).

frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 1.1 Sediment sampling sites in the Coal Loader area of Fisherman Islands.
	June 2010

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deep thinking. science.

Fisherman Islands and Whyte Island

Mangrove Health Assessment 2010

Figure 1.2 Sediment sampling sites, Fisherman Islands.

June 2010

frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 1.3 Sediment sampling sites at Whyte Island.
	June 2010

Sediment samples were collected from 9 to 12 March 2010.

Samples were refrigerated and forwarded to Advanced Analytical laboratories within one week of collection, and analysed for:

- heavy metals (Cu, Pb, Zn, Cr, Cd, As, Ni, Hg)
- total petroleum hydrocarbons (TPH)
- BTEX (benzene, toluene, ethylene & xylene)
- organochlorine pesticides (total chlordane, oxychlordane, dieldrin, aldrin, heptachlor, heptachlor epoxide, methoxychlor, endrin, DDD, DDE, DDT, alpha and beta BHC, lindane, endosulfan (total alpha, beta and sulfate) and hexachlorobenzene), and
- nutrients (nitrogen oxides, total Kjeldahl nitrogen, total nitrogen and total phosphorus).

Table 1.1 lists the parameters analysed at each site.

In all calculations, any results less than the laboratory detection limit and / or Practical Quantification Limit (PQL) were entered as half the value (Environment Australia 2002).

Table 1.1 Sediment analysis schedule for Fisherman and Whyte islands in 2010.

Site	Moisture Content	Nutrients	Heavy Metals	TPH & BTEX	OC Pesticides
Fisherman Islands					
FI 1	✓	✓	✓	✓	–
FI 2	✓	–	–	✓	–
FI 3	✓	✓	✓	✓	–
FI 4	✓	–	–	✓	–
FI 6	✓	✓	✓	✓	–
FI 7	✓	–	–	✓	–
FI 9	✓	✓	✓	✓	✓
FI 11	✓	✓	✓	✓	–
FI 13	✓	✓	✓	✓	–
FI 15	✓	✓	✓	✓	–
FI 17	✓	✓	✓	✓	–
FI 18	✓	✓	✓	✓	–
FI 19	✓	✓	✓	✓	✓
FI 22	✓	–	–	✓	–
FI 23	✓	✓	✓	✓	✓
Whyte Island					
WI 1	✓	✓	✓	✓	✓
WI 2	✓	✓	✓	✓	✓
WI 3	✓	✓	✓	✓	✓

2 Results and Discussion

2.1 Nutrients

Fisherman Islands

In 2010, total nitrogen concentrations in the sediment at Fisherman Islands ranged from 460 mg/kg at site 1 to 9 450 mg/kg at site 23 (Table 2.1). Concentrations in 2010 were substantially lower than in 2008 at sites 1, 6, 13, 15, 18 and 23; and substantially higher than in 2008 at sites 3 and 9 (Table 2.1, Table 2.2).

Total nitrogen concentrations in the sediment of mangroves in good health (sites 3, 6, 11, 17, 18 and 23) was variable, ranging from relatively low concentrations of ≤1 800 mg/kg at sites 11, 17 and 18, to 7 970 mg/kg at site 6 and 9 450 mg/kg at site 23. In areas of fair health (sites 1, 9 and 23) concentrations were highly variable ranging from 460 mg/kg at site 1 to 9 450 mg/kg at site 23. In the poor (site 15) and dead areas (sites 13 and 19) total nitrogen concentrations were relatively low (≤1 430 mg/kg). There were no clear trends linking total nitrogen concentrations to mangrove health, as a single contaminant.

Phosphorous concentrations at Fisherman Islands in 2010 ranged from 300 mg/kg at site 17 to 1 200 mg/kg at site 6 (Table 2.1). Concentrations in 2010 were generally similar to those in 2008 and 2006 at most sites, but higher than those of 2002 and 1999 (Table 2.1 – Table 2.5). At site 6, the concentration was higher than other sites in 2010 and most other sites in most previous surveys.

Total phosphorus concentrations in the sediment of mangroves in good health (sites 3, 6, 11, 17, 18 and 23) was variable, ranging from relatively low concentrations of ≤730 mg/kg at sites 11, 17, 18 and 23, to 960 mg/kg at site 3 and 1 200 mg/kg at site 6. In areas of fair health (sites 1, 9 and 23) concentrations were relatively low ranging from 400 mg/kg at site 1 to 860 mg/kg at site 23. In the poor (site 15) and dead areas (sites 13 and 19) total nitrogen concentrations were relatively low (≤810 mg/kg). There were no clear trends linking total phosphorus concentrations to mangrove health, as a single contaminant.

Whyte Island

Total nitrogen concentrations in the sediment at Whyte Island ranged from 7 600 mg/kg at site 3 to 23 200 mg/kg at site 2 (Table 2.6). Concentrations at sites 1 and 2 had substantially increased since 2002, particularly from 2006 to 2008. The total nitrogen concentration at site 2 in 2010 was the highest recorded at Whyte or Fisherman islands since the survey began in 1999. At site 3, concentrations in 2010 (and 2008) were lower than in 2006.

Total phosphorous concentrations in sediment at Whyte Island ranged between 490 mg/kg at site 1 to 3 200 mg/kg at site 3 (Table 2.6). Concentrations at sites 2 and 3 have progressively increased since 2002, however the concentration at site 1 has dropped to levels lower than in 2006 and 2008.

There were no clear trends linking total nitrogen and phosphorus concentrations in sediments to mangrove health at Whyte Island, although the extremely high levels are in an area of dieback.

Wynnum WWTP discharges into Moreton Bay via a discharge pipe into Crabbe Creek, which is near site 3. Total nitrogen and phosphorus discharge has decreased since 2004. Total nitrogen discharge was 64 000 kg in 2004 – 5, 58 000 kg in 2005 – 6, and 57 700 kg in 2006 – 7 (National Pollutant Inventory 2008). Total phosphorus discharge was 24 800 kg in 2004 – 5, 23 100 kg in 2005 – 6 and 22 500 kg in 2006 – 7 (National Pollutant Inventory 2008).

In September 2007 the Wynnum WWTP was upgraded to include a water reclamation plant (WRP), and biological nutrient removal technology. The main aim of the upgrade was to improve the quality of the treated wastewater, and in particular to remove nitrogen (Brisbane Water Enviro Alliance 2008). More recently, a micro filtration reverse osmosis (MF/RO) was built, which is expected to reduce the volume of effluent by 80%. While nitrogen concentrations have decreased at site 3, the site nearest to the discharge, phosphorous concentrations have increased since 2006.

Regional Perspective

Concentrations of total extractable nitrogen in mangrove sediments vary with sediment type, with higher levels in finer sediments (Alongi et al. 1982). Total nitrogen concentrations in mangrove sediment usually range from 600 to 2 000 mg/kg (Clough et al. 1983) and total phosphorous from 100 to 1 600 mg/kg (Table 2.7) (Alongi et al. 1982). In Queensland, a range of concentrations have been recorded with relatively high values recorded near the Luggage Point Wastewater Treatment Plant (WWTP) (WBM Oceanics Australia 2000).

Table 2.1 Nutrient concentrations (mg/kg) in sediments from Fisherman Islands in 2010.

	Site										
Nutrient	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Phosphorus	400	960	1 200	860	730	650	720	300	310	810	650
Total Kjeldahl Nitrogen	460	5 420	7 970	2 820	1 580	1 430	1 230	1 800	1 550	1 360	9 450
Nitrate – N	2	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrite – N	0.4	0.4	0.3	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.2	0.1
Total Nitrogen	460	5 420	7 970	2 820	1 580	1 430	1 230	1 800	1 550	1 360	9 450

Table 2.2 Nutrient concentrations (mg/kg) in sediments from Fisherman Islands in 2008.

	Site										
Nutrient	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Phosphorus	490	1 100	690	780	670	690	780	350	420	690	930
Total Kjeldahl Nitrogen	700	4 100	9 200	1 900	1 500	3 100	10 000	1 600	3 000	1 100	13 000
Nitrate & Nitrite – N	0.1	0.1	0.2	0.1	0.1	0.5	0.6	0.2	0.1	0.1	0.5
Total Nitrogen	700	4 100	9 200	1 900	1 500	3 100	10 000	1 600	3 000	1 100	13 000

Table 2.3 Nutrient concentrations (mg/kg) in sediments from Fisherman Islands in 2006.

	Site										
Nutrient	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Phosphorus	460	930	770	660	980	460	580	690	470	690	650
Total Kjeldahl Nitrogen	700	5 070	8 900	6 400	1 440	1 130	580	8 780	2 180	5 180	8 960
Nitrate – N	1.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5
Nitrite – N	<0.5	<0.5	0.5	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Nitrogen	700	5 070	8 900	6 400	1 440	1 130	580	8 780	2 180	5 180	8 960

Table 2.4 Nutrient concentrations (mg/kg) in sediments from Fisherman Islands in 2002 (WBM Oceanics 2002).

	Site										
Nutrient	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Phosphorus	494	555	348	223	338	526	449	219	87	444	139
Total Kjeldahl Nitrogen	993	2 320	2 490	1 890	1 310	1 320	573	1 020	635	772	1 670
Nitrite and Nitrate – N	2.2	4.7	0.4	9.1	0.2	0.6	0.8	0.2	<0.2	0.3	0.4
Total Nitrogen	995	2 320	2 490	1 890	1 310	1 320	573	1 020	635	772	1 670

Table 2.5 Nutrient concentrations (mg/kg) in sediments from Fisherman Islands in 1999 (WBM Oceanics Australia 2000).

	Site / Year										
Nutrient	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Phosphorus	410	460	170	150	430	360	400	290	380	500	230
Total Kjeldahl Nitrogen	600	1 800	260	430	1 890	1 570	540	1 110	1 580	740	2 540
Nitrite and Nitrate – N	0.15	0.5	0.15	<0.05	0.2	1.2	<0.05	0.1	0.3	0.35	0.15
Total Nitrogen	600	1 800	260	430	1 900	1 570	540	1 110	1 580	740	2 540

Table 2.6 Nutrient concentrations (mg/kg) recorded in sediments from Whyte Island in 2002, 2006, 2008 and 2010.

	Site / Year											
	1				**2**				**3**			
Nutrient	**2002**	**2006**	**2008**	**2010**	**2002**	**2006**	**2008**	**2010**	**2002**	**2006**	**2008**	**2010**
Phosphorus	216	920	780	490	134	610	1 000	1 100	1 080	1 200	2 700	3 200
Total Kjeldahl Nitrogen	3 230	4 520	10 000	9 450	2 520	7 050	18 000	23 200	2 590	11 900	7 400	7 600
Nitrate – N	2*	<0.5	0.2*	<0.1	2.8*	8.5	0.7*	<0.1	6.1*	<0.5	0.7*	<0.1
Nitrite – N		<0.5		0.2		<0.5		0.2		<0.5		<0.1
Total Nitrogen	3 320	4 520	10 000	9 450	2 520	7 060	18 000	23 200	2 590	11 900	7 400	7 600

* Nitrate and nitrite N

Table 2.7 Nutrient concentrations (mg/kg) recorded in mangrove sediments in Queensland.

	Luggage Pt*[1]	Wellington Pt[1]	Wellington Pt[2]	Victoria Pt[1]	Deception Bay[1]	Clontarf[3]	Weinam Creek[4]	Qld Estuaries[5]	North Qld[6]
Phosphorus	1 367	656	538	526	250	228	619	100 – 700	50 – 450
Total Nitrogen	8 606	2 566	1 770	3 000	1 043	1 148	NA	200 – 4 000	1 000 – 4 000

* Near sewage discharge
1 Average of 3 values (WBM Oceanics Australia 2000)
2 Average of 6 samples (frc environmental 2007b)
3 Average of 6 samples (frc environmental 2006)
4 Average of 6 samples (frc environmental 2009)
5 Alongi et al. 1992
6 Average of 15 values from 9 sites (Kaly et al. 1997)

In 2010, nutrient concentrations at Fisherman Islands were generally similar to those at other Queensland sites, excluding Luggage Point (which is near a discharge from a waste water treatment plant, Table 2.7). In 2010, total nitrogen concentrations at sites 3 and 6 exceeded those at other Queensland sites, excluding Luggage Point; and concentrations at site 23 exceeded those recorded from Luggage Point. These sites were all in good health. In 2010, total phosphorus concentrations at sites 3, 6, 9 11, 15 and 19 exceeded Queensland sites, excluding Luggage Point; mangroves at these sites were of good health, poor health and dead. Total phosphorus concentrations did not exceed concentrations recorded from Luggage Point.

In 2010, nutrient concentrations at Whyte Island were often higher than those recorded at other Queensland sites (Table 2.7). Nitrogen and phosphorus concentrations in 2010 at sites 2 and 3, were substantially higher than those at Luggage Point (almost three-times higher for both sites). Site 2 was in the dieback area, whereas site 3 was in forest of good health.

Nutrient concentrations were generally higher at Whyte Island than Fisherman Islands. This is likely to be associated with the discharge from the Wynnum WWTP.

2.2 Petroleum Hydrocarbons and BTEX

Petroleum hydrocarbons are assessed in fractions: petrol is in the C6 – C9 fraction, kerosene in the C10 – C18 fraction, diesel in C12 – C18 and lubricating oils above C18 (DPIW&E 2002). Naturally occurring hydrocarbons are also detected in the analyses, for example sequiturpenoids in mangrove leaves and roots are in the C10 – C28 fraction. The National Assessment Guidelines for Dredging (NAGD) Screening Level for total petroleum hydrocarbons (TPH) is 550mg/kg (DEWHA 2009).

BTEX (benzene, toluene, ethylene and xylene) are aromatic hydrocarbons, which are commonly highly toxic to aquatic organisms (Connell 1995). There are no NADG (DEWHA 2009) or ANZECC & ARMCANZ (2000) trigger levels for BTEX in sediments.

Fisherman Islands

In 2010, TPH concentrations at Fisherman Islands were below the Screening Level at most sites (Table 2.8). Concentrations exceeded the Screening Level at sites 6 and 23. Concentrations of fractions C15 – C28 and C29 – C36 were generally higher in 2010 than 2008, but 2010 concentrations were generally similar of lower than those recorded in 2006 (Table 2.9 – Table 2.12).

In 2010, BTEX concentrations at Fisherman Islands were below the laboratory detection limits at all sites (Table 2.8).

There were no clear trends linking TPH or BTEX concentrations in sediments to mangrove health at Fisherman Islands.

Whyte Island

In 2010, TPH concentrations at Whyte Island were below the Screening Level at site 1 only, which is located in a dieback area. THP concentrations in 2010 were higher than in 2008, for most fractions at most sites, but similar to those recorded in earlier surveys (Table 2.13).

In 2010, BTEX concentrations at Whyte Island were below the laboratory detection limits at all sites.

There were no clear trends linking TPH or BTEX concentrations in sediments to mangrove health at Whyte Island.

Table 2.8 TPH and BTEX concentrations (mg/kg) in sediments from Fisherman Islands in 2010.[1]

	Site														
	1	2	3	4	6	7	9	11	13	15	17	18	19	22	23
Total Petroleum Hydrocarbon (TPH) Fractions															
C6 – C9	<10	<10	<20	<10	<40	<10	<10	<10	<10	<10	<10	<10	<10	<40	<40
C10 – C14	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C15 – C28	<50	200	160	170	540	<50	110	88	<50	<50	82	76	<50	210	240
C29 – C36	<50	250	220	180	690	<50	150	120	<50	56	110	99	58	130	600
TPH[2]	<120	460	395	360	1255	<120	270	218	<120	91	202	185	93	365	865
BTEX															
Benzene	<0.20	<0.20	<0.40	<0.20	<0.80	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.80	<0.80
Toluene	<0.20	<0.20	<0.40	<0.20	<0.80	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.80	<0.80
Ethyl Benzene	<0.20	<0.20	<0.40	<0.20	<0.80	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.80	<0.80
m+p xylenes	<0.40	<0.40	<0.80	<0.40	<1.6	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<1.6	<1.6
o-xylene	<0.20	<0.20	<0.40	<0.20	<0.80	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.80	<0.80
Total BTEX	<1.2	<1.2	<2.4	<1.2	<4.8	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<4.8	<4.8

[1] Laboratory detection limits vary between sites due to the high moisture content of some samples (Laboratory Certificates page 31).

[2] Determined by adding the concentration of each fraction. Where site results included values less than the laboratory detection limit, those values less than the laboratory detection limit were halved (Environment Australia 2002). Where all results were less than the laboratory detection limit they were added (not halved).

Table 2.9 TPH and BTEX concentrations (mg/kg) in sediments from Fisherman Islands in 2008.

	Site														
	1	**2**	**3**	**4**	**6**	**7**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**22**	**23**
Total Petroleum Hydrocarbons[1]															
C6 – C9	<1	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
C10 – C14	<5	<5	<5	<5	<5	<5	<2	<2	<2	<2	<5	<5	<2	<2	<2
C15 – C28	<10	<10	<10	<10	<10	<10	<4	<4	<4	<4	<10	<10	<4	<4	<4
C29 – C36	<5	<5	<5	<5	<5	<5	<2	<2	<2	<2	<5	<5	<2	<2	<2
BTEX															
Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0019
Toluene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethyl Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
m+p xylenes	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-xylene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total BTEX	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.004

[1] Sites 9, 11, 13, 15, 19, 22 and 23 had lower laboratory detection limits for the TPH fractions C10 – C14, C15 – C28 and C29 – C36 than the remaining samples because the analytical laboratory refined their technique after processing some of the samples (T. Lawlor [Simmonds & Bristow] 2008, pers. comm., 11th of July); the 2008 detection limits are much lower than those of previous surveys and the 2010 survey.

Table 2.10 TPH and BTEX concentrations (mg/kg) in sediments from Fisherman Islands in 2006.

	Site														
	1	**2**	**3**	**4**	**6**	**7**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**22**	**23**
Total Petroleum Hydrocarbons															
C6 – C9	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10 – C14	<10	<10	13	<10	54	<10	12	<10	<10	<10	15	<10	<10	<10	22
C15 – C28	58	330	280	100	160	62	150	80	<50	<50	420	100	50	52	120
C29 – C36	65	440	250	110	220	91	150	50	<50	<50	400	130	99	68	230
BTEX															
Benzene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Toluene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethyl Benzene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
m+p xylenes	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
o-xylene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Total BTEX	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2

Table 2.11 TPH and BTEX concentrations (mg/kg) sediments from Fisherman Islands in 2002 (WBM Oceanics 2002).

	Site														
	1	**2**	**3**	**4**	**6**	**7**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**22**	**23**
Total Petroleum Hydrocarbons															
C6 – C9	<2	<4	<4	<4	<4	<2	<4	<2	<2	<2	<4	<4	<2	<4	<4
C10 – C14	<50	<100	<100	<100	<100	<50	<100	<50	<50	<50	<100	<100	<50	<100	<100
C15 – C28	<100	<200	<200	<200	<200	<100	<200	<100	<100	<100	<200	<200	<100	<200	<200
C29 – C36	<100	<200	<200	<200	<200	<100	<200	<100	<100	<100	<200	<200	<100	<200	<200
BTEX															
Benzene	<0.2	<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.2	<0.2	<0.4	<0.4	<0.2	<0.4	<0.4
Toluene	<0.2	<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.2	<0.2	<0.4	<0.4	<0.2	<0.4	<0.4
Ethyl Benzene	<0.2	<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.2	<0.2	<0.4	<0.4	<0.2	<0.4	<0.4
m+p xylenes	<0.2	<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.2	<0.2	<0.4	<0.4	<0.2	<0.4	<0.4
o-xylene	<0.2	<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.2	<0.2	<0.4	<0.4	<0.2	<0.4	<0.4

Table 2.12 TPH and BTEX concentrations (mg/kg) sediments from Fisherman Islands in 1999 (WBM Oceanics Australia 2000).

	Site														
	1	**2**	**3**	**4**	**6**	**7**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**22**	**23**
Total Petroleum Hydrocarbons															
C6 – C9	<2	<5	<5	<5	<2	<2	<2	<2	<5	<2	<5	<5	<2	<5	<5
C10 – C14	<50	<125	<125	<125	<50	<50	<50	<50	<125	<50	<125	<125	<50	<125	<125
C15 – C28	<100	<250	<250	<250	<100	<100	<100	<100	<250	<100	<250	<250	<100	<250	435
C29 – C36	<100	<250	<250	<250	<100	<100	<100	<100	<250	<100	<250	<250	<100	<250	565
BTEX															
Benzene	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.5	<0.5	<0.2	<0.5	<0.5
Toluene	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.5	<0.5	<0.2	<0.5	<0.5
Ethyl Benzene	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.5	<0.5	<0.2	<0.5	<0.5
m+p xylenes	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.5	<0.5	<0.2	<0.5	<0.5
o-xylene	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.5	<0.5	<0.2	<0.5	<0.5

Table 2.13 TPH and BTEX concentrations (mg/kg) in sediments from Whyte Island in 2002, 2006, 2008 and 2010.

	Site											
	1				2				3			
	2002	2006	2008	2010	2002	2006	2008	2010	2002	2006	2008	2010
Total Petroleum Hydrocarbon Fractions												
C6 – C9	<4	<10	<1	<20	<4	<10	<1	<40	<4	<10	<1	<20
C10 – C14	<100	14	<5	<10	1 030	24	<5	55	332	15	<5	12
C15 – C28	<200	130	<10	150	2 600	210	<10	570	1 580	320	<10	260
C29 – C36	<200	91	<5	190	3 190	140	<5	740	1 610	210	<5	300
TPH	<504	240	<21	355	6 822	379	<21	1 385	3 524	550	<21	582
BTEX												
Benzene	<0.4	<0.2	<0.001	<0.4	<0.4	<0.2	<0.001	<0.8	<0.4	<0.2	<0.001	<0.4
Toluene	<0.4	<0.2	<0.001	<0.4	<0.4	<0.2	<0.001	<0.8	<0.4	<0.2	<0.001	<0.4
Ethyl Benzene	<0.4	<0.2	<0.001	<0.4	<0.4	<0.2	<0.001	<0.8	<0.4	<0.2	<0.001	<0.4
m+p xylenes	<0.4	<0.4	<0.002	<0.8	<0.4	<0.4	<0.002	<1.6	<0.4	<0.4	<0.002	<0.8
o-xylene	<0.4	<0.2	<0.001	<0.4	<0.4	<0.2	<0.001	<0.8	<0.4	<0.2	<0.001	<0.4
Total BTEX	<1.0	<0.6	<0.003	<2.4	<1.0	<0.6	<0.003	<4.8	<1.0	<0.6	<0.003	<2.4

2.3 Heavy Metals

Concentrations of metals were compared to the ANZECC & ARMCANZ Interim Sediment Quality Guidelines (ISQG) (ANZECC & ARMCANZ 2000) and Queensland Contaminated Land Environmental Investigation Levels (EILs) and Background Levels (DoE 1998) (Table 2.14).

Table 2.14 Guideline and background levels for metal concentrations in sediments.

	ISQG[1]			
Metal	**Low**	**High**	**DoE[2]**	**Background Levels[3]**
Arsenic	20	70	20	0.2 – 30
Cadmium	1.5	10	3	0.04 – 2
Chromium	80	370	50	0.5 – 110
Copper	65	270	60	1 – 190
Mercury	0.15	1	1	0.001 – 0.1
Nickel	21	52	60	2 – 400
Lead	50	220	300	<2 – 200
Zinc	200	410	200	2 - 180

1 Recommended Interim Sediment Quality Guidelines (ISQG) for aquatic ecosystems (ANZECC & ARMCANZ 2000)

2 Department of Environment Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland Environmental Investigation Levels (DoE 1998)

3 DoE guidelines for sediment background levels (DoE 1998)

Fisherman Islands

In 2010, heavy metal concentrations were below the low ISQG level (ANZECC & ARMCANZ 2000) at the Fisherman Islands sites, with the exception of nickel at one site (Table 2.15). The nickel concentration in sediment at site 13 slightly exceeded the low ISQG level, but was within the background range and similar to that recorded in previous surveys (Table 2.16 – Table 2.19).

Concentrations of several metals were higher in 2010 than in 2008 at several sites. Concentrations in 2010 were approximately twice as high as those in 2008 for arsenic at sites 3, 6 and 17; chromium and nickel at sites 1, 3, 6 and 17; lead at sites 3 and 6; and zinc at sites 1, 3 and 6. Mangrove forests at most of these sites with relatively high concentrations were in good health; therefore heavy metals are unlikely to be associated with the large dieback areas at Fisherman Islands.

Whyte Island

In 2010, heavy metal concentrations were below the low ISQG level (ANZECC & ARMCANZ 2000) at all Whyte Island sites (Table 2.20). Heavy metals are unlikely to be associated with the large dieback area at Whyte Island.

Table 2.15 Heavy metal concentrations (mg/kg) in sediments from Fisherman Islands in 2010.

	Site										
Metal	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Arsenic	5.7	7.1	8.3	8.1	14	9	7.3	7.7	3.9	8.2	5.9
Cadmium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.16
Chromium	20	32	28	35	31	46	30	19	16	42	31
Copper	8.75	21	30	19	12	23	14	6.5	5.45	21	17
Mercury	0.03	0.07	0.04	0.04	0.02	0.04	0.05	0.03	0.03	0.05	0.06
Nickel	9.3	14	16	16	15	24	15	9.7	7.3	21	15
Lead	6	17	11	11	7	11	8.5	4.1	3.9	11	15
Zinc	35	59	87	62	46	68	53	32	28	73	49

Table 2.16 Heavy metal concentrations (mg/kg) in sediments from Fisherman Islands in 2008.

	Site										
Metal	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Arsenic	2.8	2.5	2.2	8.5	83	51	58	3.2	3.1	72	40
Cadmium	0.50	0.50	0.50	<0.50	<0.50	<0.50	<0.50	0.50	0.50	<0.50	<0.50
Chromium	8.9	14	10	26	20	36	22	9.4	9.5	37	27
Copper	5.3	11	8.3	25	14	28	13	4.6	4.5	22	20
Mercury	0.060	0.10	0.080	<0.010	0.060	0.030	0.080	0.040	0.050	0.060	<0.010
Nickel	4.7	7.0	5.6	13	9.9	22	13	5.3	5.4	19	14
Lead	4.0	8.6	4.7	11	8.9	14	11	3.0	3.0	15	15
Zinc	20	32	26	44	36	73	52	19	22	66	45

Table 2.17 Heavy metal concentrations (mg/kg) in sediments from Fisherman Islands in 2006.

	Site										
Metal	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Arsenic	5	5.8	6.1	2.8	24	6.4	6.7	9.6	7.7	10	3.6
Cadmium	<0.1	<0.1	0.41	<0.1	0.15	<0.1	<0.1	0.15	<0.1	0.1	<0.1
Chromium	22	37	43	21	36	46	29	34	30	49	34
Copper	11	28	20	13	11	23	12	19	13	27	17
Mercury	0.03	0.05	0.08	0.08	0.04	0.05	0.04	0.05	0.02	0.05	0.04
Nickel	11	18	22	11	16	25	16	19	16	26	17
Lead	8.7	20	15	11	10	11	8.6	13	10	15	18
Zinc	43	76	78	39	54	64	49	72	60	72	52

Table 2.18 Heavy metal concentrations (mg/kg) in sediments from Fisherman Islands in 2002 (WBM Oceanics 2002).

	Site										
Metal	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Arsenic	7.4	7.5	10.1	5.7	11.5	8.4	11.3	17.5	8.6	7.3	5.3
Cadmium	<0.01	<0.2	<0.2	0.3	<0.1	<0.1	<0.1	<0.2	<0.2	<0.1	<0.2
Chromium	25.4	37.8	28.6	20.0	18.5	44.2	33.7	23.1	17.9	43.1	33.9
Copper	12.6	28.3	26.0	14.7	7.4	21.6	12.9	12.2	7.2	20.1	17.7
Mercury	<0.1	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	0.6	0.4	1.1
Nickel	12.3	18.4	16.4	10.0	7.9	25.7	20.9	14.7	10.8	22.5	16.7
Lead	11.9	24.6	15.4	11.2	8.7	14.4	11.5	8.7	6.4	13.3	21.6
Zinc	50.5	83.9	84.7	47.5	27.1	73.7	63.8	47.6	36.0	75.5	50.6

Table 2.19 Heavy metal concentrations (mg/kg) in sediments from Fisherman Islands in 1999 (WBM Oceanics Australia 2000).

	Site										
Metal	**1**	**3**	**6**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**23**
Arsenic	6.8	8.95	3.1	2.8	8.35	9.7	7.65	7.05	6	5.1	4.35
Cadmium	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.1	0.05	0.05	<0.05	0.1
Chromium	57.7	59.8	93.1	86	56.4	44.6	39.4	77	57.9	40.7	43.8
Copper	13.7	24.7	5.65	8.2	13.8	19.6	13.6	13.2	9.65	17.6	20.5
Mercury	0.1	0.15	<0.05	<0.05	0.05	<0.05	0.1	0.05	0.05	<0.05	0.1
Nickel	12.4	16.6	9.65	7	13.6	18.6	17.4	15.4	12.8	23.1	19.9
Lead	11.5	24.2	4.05	5.05	12.3	16.3	11	10.4	8.15	11.7	18.9
Zinc	48.3	68.4	23.8	30.2	48.3	65.3	53.8	52.3	43.3	63.3	58

Table 2.20 Heavy metal concentrations (mg/kg) in sediments from Whyte Island in 2002, 2006, 2008 and 2010.

	Site / Year											
	1				2				3			
Metal	**2002**	**2006**	**2008**	**2010**	**2002**	**2006**	**2008**	**2010**	**2002**	**2006**	**2008**	**2010**
Arsenic	13	10	2.6	0.9	3.1	1.5	3.5	7	9.2	5.3	5.0	8.2
Cadmium	<0.2	<0.1	<0.50	0.13	<0.5	<0.1	<0.50	0.14	0.2	0.11	<0.50	<0.1
Chromium	37.1	43	28	27	15.4	38	24	12	52.1	41	41	42
Copper	21.2	21	31	21	21.8	17	34	39	84.5	84	56	43
Mercury	1.7	0.06	2.7	0.05	1.7	0.07	2.4	0.07	1.2	0.17	<0.010	0.09
Nickel	17.4	20	18	14	10.3	17	15	11	21.2	19	20	20
Lead	17	18	18	9.3	10.5	26	25	9	45.5	31	26	19
Zinc	63.2	68	91	63	29.6	55	76	62	212	120	120	100

2.4 Oganochlorine Pesticides

Concentrations of organochloride pesticides were compared to The National Assessment Guidelines for Dredging (NAGD) Screening Level (DEWHA 2009) (Table 2.21).

Table 2.21 Guideline and background levels (μg/kg) for metal concentrations in sediments.

	Screening Level
Aldrin	–
alpha-BHC	–
beta-BHC	–
gamma-BHC (Lindane)	0.32
delta-BHC	–
cis-Chlordane	–
trans-Chlordane	–
p,p'-DDD	2.00
p,p'-DDE	2.20
p,p'-DDT	–
Dieldrin	0.02
alpha-Endosulfan	–
beta-Endosulfan	–
Endosulfan Sulphate	–
Endrin	0.02
Endrin ketone	–
Endrin aldehyde	–
Heptachlor	–
Heptachlor epoxide	–
Hexachlorobenzene	–
Methoxychlor	–
Oxychlordane	–

As in previous surveys, all organochlorine pesticides concentrations at Fisherman and Whyte islands sites were below laboratory detection limits (Table 2.22 – Table 2.24). Organochlorides are unlikely to be associated with the large dieback areas.

Table 2.22 Organochlorine concentrations (μg/kg) in sediments from Fisherman Islands in 2010 and 2008.

	Site / Year					
	9		19		23	
Organochlorine	**2010**	**2008**	**2010**	**2008**	**2010**	**2008**
Aldrin	<10	<1	<1	<1	<4	<1
alpha-BHC	<10	<1	<1	<1	<4	<1
beta-BHC	<10	<1	<1	<1	<4	<1
gamma-BHC (Lindane)	<10	<1	<1	<1	<4	<1
delta-BHC	<10	<1	<1	<1	<4	<1
cis-Chlordane	<1	<1	<1	<1	<4	<1
trans-Chlordane	<1	<1	<1	<1	<4	<1
p,p'-DDD	<1	<1	<1	<1	<40	<1
p,p'-DDE	<1	<1	<1	<1	<40	<1
p,p'-DDT	<1	<1	<1	<1	<40	<1
Dieldrin	<1	<1	<1	<1	<4	<1
alpha-Endosulfan	<10	<1	<10	<1	<40	<1
beta-Endosulfan	<10	<1	<10	<1	<40	<1
Endosulfan Sulphate	<10	<1	<10	<1	<40	<1
Endrin	<10	<1	<1	<1	<4	<1
Endrin ketone	<10	–	<1	–	<4	–
Endrin aldehyde	<10	–	<1	–	<4	–
Heptachlor	<10	<1	<1	<1	<4	<1
Heptachlor epoxide	<10	<1	<1	<1	<4	<1
Hexachlorobenzene	<10	<1	<1	<1	<4	<1
Methoxychlor	<10	<1	<10	<1	<40	<1
Oxychlordane	<1	–	<1	–	<4	–

Table 2.23 Organochlorine concentrations (µg/kg) in sediments from Fisherman Islands in 1999, 2002 and 2006.

	Site / Year							
	9			19			23	
Organochlorine	**1999**	**2002**	**2006**	**1999**	**2002**	**2006**	**1999**	**2006**
Aldrin	<0.05	<0.05	<1	<0.05	<0.05	<1	<0.1	<1
alpha-BHC	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
beta-BHC	<0.1	<0.5*	<1	<0.1	<0.1*	<1	<0.3	<1
gamma-BHC (Lindane)	<0.1	–	<1	<0.1	–	<1	<0.3	<1
delta-BHC	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
cis-Chlordane	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
trans-Chlordane	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
p,p'-DDD	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
p,p'-DDE	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
p,p'-DDT	<0.2	<1.0	<1	<0.2	<0.2	<1	<0.5	<1
Dieldrin	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
alpha-Endosulfan	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
beta-Endosulfan	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Endosulfan Sulphate	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Endrin	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Endrin ketone	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Endrin aldehyde	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Heptachlor	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Heptachlor epoxide	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Hexachlorobenzene	<0.05	<0.25	<1	<0.05	<0.05	<1	<0.1	<1
Methoxychlor	<0.2	<0.1	<1	<0.2	<0.02	<1	<0.5	<1

Table 2.24 Organochlorine concentrations (μg/kg) in sediments from Whyte Island in 2002, 2006, 2008 and 2010.

	Site / Year											
	1				2				3			
Organochlorine	**2002**	**2006**	**2008**	**2010**	**2002**	**2006**	**2008**	**2010**	**2002**	**2006**	**2008**	**2010**
Aldrin	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
alpha-BHC	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
beta-BHC	<0.5	<1	<1	<1	<0.5	<1	<1	<1	<0.5	<1	<1	<1
gamma-BHC (Lindane)	<0.5	<1	<1	<1	<0.5	<1	<1	<1	<0.5	<1	<1	<1
delta-BHC	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
cis-Chlordane	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
trans-Chlordane	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
p,p'-DDD	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
p,p'-DDE	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
p,p'-DDT	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dieldrin	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
alpha-Endosulfan	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
beta-Endosulfan	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
Endosulfan Sulphate	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
Endrin	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
Endrin ketone	<0.25	<1	–	–	<0.25	<1	–	–	<0.25	<1	–	–
Endrin aldehyde	<0.25	<1	–	–	<0.25	<1	–	–	<0.25	<1	–	–
Heptachlor	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
Heptachlor epoxide	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
Hexachlorobenzene	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1
Methoxychlor	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<0.25	<1	<1	<1	<0.25	<1	<1	<1	<0.25	<1	<1	<1

3 Laboratory Certificates

REPORT OF ANALYSIS

Laboratory Reference: A10/0860

Client:	FRC Environmental 185 Main Rd Wellington Point QLD 4160	**Order No:**	100114KM
		Project:	100114 PoB Mangroves
		Sample Type:	Sediments
		No. of Samples:	18
Contact:	Kylie McPherson	**Date Received:**	15/3/10
		Date Completed:	25/05/2010

Laboratory Contact Details:

Client Services Manager: Lilian Wong
Technical Enquiries: Andrew Bradbury
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Email: brisbane@advancedanalytical.com.au
andrew.bradbury@advancedanalytical.com.au

Attached Results Approved By:

Ian Eckhard
Technical Director

Comments:
All samples tested as submitted by client. All attached results have been checked and approved for release.
This is the Final Report and supersedes any reports previously issued with this batch number.
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NATA Accredited Laboratory
Accreditation No: 15109

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Batch Number: A10/0860
Project Reference: 100114 PoB Mangroves

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/1 FI 1	/2 FI 2	/3 FI 3	/4 FI 4
Moisture Content						
Moisture Content	04-004	%	20.4	52.3	62.1	49.8
Trace Elements						
Arsenic	04-001	mg/kg	5.7	[NA]	7.1	[NA]
Cadmium	04-001	mg/kg	<0.1	[NA]	<0.1	[NA]
Chromium	04-001	mg/kg	20	[NA]	32	[NA]
Copper	04-001	mg/kg	8.8	[NA]	21	[NA]
Mercury	04-002	mg/kg	0.03	[NA]	0.07	[NA]
Nickel	04-001	mg/kg	9.3	[NA]	14	[NA]
Phosphorus	04-001	mg/kg	400	[NA]	960	[NA]
Lead	04-001	mg/kg	6.0	[NA]	17	[NA]
Zinc	04-001	mg/kg	35	[NA]	59	[NA]
BTEX						
Benzene	04-021	mg/kg	<0.20	<0.20	<0.4	<0.20
Toluene	04-021	mg/kg	<0.20	<0.20	<0.4	<0.20
Ethyl Benzene	04-021	mg/kg	<0.20	<0.20	<0.4	<0.20
m+p xylenes	04-021	mg/kg	<0.40	<0.40	<0.8	<0.40
o-xylene	04-021	mg/kg	<0.20	<0.20	<0.4	<0.20
Total BTEX	04-021	mg/kg	<1.2	<1.2	<2.4	<1.2
Surrogate 1 Recovery	04-021	%	97	65	65	70
Surrogate 2 Recovery	04-021	%	88	57	57	65
Surrogate 3 Recovery	04-021	%	89	53	55	63
Date Extracted	04-021	-	16/03/2010	16/03/2010	16/03/2010	16/03/2010
Date Analysed	04-021	-	18/03/2010	18/03/2010	18/03/2010	18/03/2010
Total Petroleum Hydrocarbons						
TPH C6-C9	04-021	mg/kg	<10	<10	<20	<10
TPH C10-14	04-020	mg/kg	<10	<10	<10	<10
TPH C15-28	04-020	mg/kg	<50	200	160	170
TPH C29-36	04-020	mg/kg	<50	250	220	180
Surrogate Recovery	04-020	%	97	113	109	111
Date Extracted	04-020	-	17/03/2010	17/03/2010	17/03/2010	17/03/2010
Date Analysed	04-020	-	19/03/2010	19/03/2010	19/03/2010	19/03/2010

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Batch Number: A10/0860

Project Reference: 100114 PoB Mangroves

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/1 FI 1	/2 FI 2	/3 FI 3	/4 FI 4
Organochlorine Pesticides						
Subcontract Analysis						
Nitrate as N	SUB	mg/kg	2.0	[NA]	<0.1	[NA]
Nitrite as N	SUB	mg/kg	0.4	[NA]	0.4	[NA]
Total Kjeldahl Nitrogen	SUB	mg/kg	460	[NA]	5,420	[NA]
Total Nitrogen	SUB	mg/kg	460	[NA]	5,420	[NA]

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/5 FI 6	/6 FI 7	/7 FI 9	/8 FI 11
Moisture Content						
Moisture Content	04-004	%	81.3	20.8	46.4	38.1
Trace Elements						
Arsenic	04-001	mg/kg	8.3	[NA]	8.1	14
Cadmium	04-001	mg/kg	<0.1	[NA]	<0.1	0.10
Chromium	04-001	mg/kg	28	[NA]	35	31
Copper	04-001	mg/kg	30	[NA]	19	12
Mercury	04-002	mg/kg	0.04	[NA]	0.04	0.02
Nickel	04-001	mg/kg	16	[NA]	16	15
Phosphorus	04-001	mg/kg	1,200	[NA]	860	730
Lead	04-001	mg/kg	11	[NA]	11	7.0
Zinc	04-001	mg/kg	87	[NA]	62	46
BTEX						
Benzene	04-021	mg/kg	<0.8	<0.20	<0.20	<0.20
Toluene	04-021	mg/kg	<0.8	<0.20	<0.20	<0.20
Ethyl Benzene	04-021	mg/kg	<0.8	<0.20	<0.20	<0.20
m+p xylenes	04-021	mg/kg	<1.6	<0.40	<0.40	<0.40
o-xylene	04-021	mg/kg	<0.8	<0.20	<0.20	<0.20
Total BTEX	04-021	mg/kg	<4.8	<1.2	<1.2	<1.2
Surrogate 1 Recovery	04-021	%	57	83	96	82

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/5 FI 6	/6 FI 7	/7 FI 9	/8 FI 11
Surrogate 2 Recovery	04-021	%	48	77	93	81
Surrogate 3 Recovery	04-021	%	45	77	96	84
Date Extracted	04-021	-	16/03/2010	16/03/2010	16/03/2010	16/03/2010
Date Analysed	04-021	-	18/03/2010	18/03/2010	18/03/2010	18/03/2010
Total Petroleum Hydrocarbons						
TPH C6-C9	04-021	mg/kg	<40	<10	<10	<10
TPH C10-14	04-020	mg/kg	35	<10	<10	<10
TPH C15-28	04-020	mg/kg	540	<50	110	88
TPH C29-36	04-020	mg/kg	690	<50	150	120
Surrogate Recovery	04-020	%	111	106	97	103
Date Extracted	04-020	-	17/03/2010	17/03/2010	17/03/2010	17/03/2010
Date Analysed	04-020	-	19/03/2010	19/03/2010	19/03/2010	19/03/2010
Organochlorine Pesticides						
Aldrin	04-023	µg/kg	[NA]	[NA]	<10	[NA]
alpha-BHC	04-023	µg/kg	[NA]	[NA]	<10	[NA]
beta-BHC	04-023	µg/kg	[NA]	[NA]	<10	[NA]
gamma-BHC (Lindane)	04-023	µg/kg	[NA]	[NA]	<10	[NA]
delta-BHC	04-023	µg/kg	[NA]	[NA]	<10	[NA]
cis-Chlordane	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
trans-Chlordane	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
p,p'-DDD	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
p,p'-DDE	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
p,p'-DDT	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
Dieldrin	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
alpha-Endosulfan	04-023	µg/kg	[NA]	[NA]	<10	[NA]
beta-Endosulfan	04-023	µg/kg	[NA]	[NA]	<10	[NA]
Endosulfan Sulphate	04-023	µg/kg	[NA]	[NA]	<10	[NA]
Endrin	04-023	µg/kg	[NA]	[NA]	<10	[NA]
Endrin ketone	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
Endrin aldehyde	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
Heptachlor	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
Heptachlor epoxide	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
Hexachlorobenzene	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]

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Batch Number: A10/0860
Project Reference: 100114 PoB Mangroves

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/5 FI 6	/6 FI 7	/7 FI 9	/8 FI 11
Methoxychlor	04-023	µg/kg	[NA]	[NA]	<10	[NA]
Oxychlordane	04-023	µg/kg	[NA]	[NA]	<1.0	[NA]
Surrogate Recovery	04-023	%	[NA]	[NA]	80	[NA]
Date Extracted	04-023	-	[NA]	[NA]	17/03/2010	[NA]
Date Analysed	04-023	-	[NA]	[NA]	19/03/2010	[NA]
Subcontract Analysis						
Nitrate as N	SUB	mg/kg	<0.1	[NA]	0.2	<0.1
Nitrite as N	SUB	mg/kg	0.3	[NA]	0.1	<0.1
Total Kjeldahl Nitrogen	SUB	mg/kg	7,970	[NA]	2,820	1,580
Total Nitrogen	SUB	mg/kg	7,970	[NA]	2,820	1,580

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/9 FI 13	/10 FI 15	/11 FI 17	/12 FI 18
Moisture Content						
Moisture Content	04-004	%	42.6	37.1	52.7	45.5
Trace Elements						
Arsenic	04-001	mg/kg	9.0	7.3	7.7	3.9
Cadmium	04-001	mg/kg	<0.1	<0.1	<0.1	<0.1
Chromium	04-001	mg/kg	46	30	19	16
Copper	04-001	mg/kg	23	14	6.5	5.4
Mercury	04-002	mg/kg	0.04	0.05	0.03	0.03
Nickel	04-001	mg/kg	24	15	9.7	7.3
Phosphorus	04-001	mg/kg	650	720	300	310
Lead	04-001	mg/kg	11	8.5	4.1	3.9
Zinc	04-001	mg/kg	68	53	32	28
BTEX						
Benzene	04-021	mg/kg	<0.20	<0.20	<0.20	<0.20
Toluene	04-021	mg/kg	<0.20	<0.20	<0.20	<0.20
Ethyl Benzene	04-021	mg/kg	<0.20	<0.20	<0.20	<0.20

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Batch Number: A10/0860
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Laboratory Reference: **Client Reference:** **Date Sampled:** **Analysis Description**	- - - **Method**	- - - **Units**	**/9** **FI 13**	**/10** **FI 15**	**/11** **FI 17**	**/12** **FI 18**
m+p xylenes	04-021	mg/kg	<0.40	<0.40	<0.40	<0.40
o-xylene	04-021	mg/kg	<0.20	<0.20	<0.20	<0.20
Total BTEX	04-021	mg/kg	<1.2	<1.2	<1.2	<1.2
Surrogate 1 Recovery	04-021	%	72	83	61	70
Surrogate 2 Recovery	04-021	%	67	82	60	66
Surrogate 3 Recovery	04-021	%	69	82	59	63
Date Extracted	04-021	-	16/03/2010	16/03/2010	16/03/2010	16/03/2010
Date Analysed	04-021	-	18/03/2010	18/03/2010	18/03/2010	18/03/2010
Total Petroleum Hydrocarbons						
TPH C6-C9	04-021	mg/kg	<10	<10	<10	<10
TPH C10-14	04-020	mg/kg	<10	<10	<10	<10
TPH C15-28	04-020	mg/kg	<50	<50	82	76
TPH C29-36	04-020	mg/kg	<50	56	110	99
Surrogate Recovery	04-020	%	94	98	115	108
Date Extracted	04-020	-	17/03/2010	17/03/2010	17/03/2010	17/03/2010
Date Analysed	04-020	-	19/03/2010	19/03/2010	19/03/2010	19/03/2010
Organochlorine Pesticides						
Subcontract Analysis						
Nitrate as N	SUB	mg/kg	<0.1	<0.1	<0.1	<0.1
Nitrite as N	SUB	mg/kg	<0.1	<0.1	<0.1	0.1
Total Kjeldahl Nitrogen	SUB	mg/kg	1,430	1,230	2,800	1,550
Total Nitrogen	SUB	mg/kg	1,430	1,230	2,800	1,550

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/13 FI 19	/14 FI 22	/15 FI 23	/16 WI 1
Moisture Content						
Moisture Content	04-004	%	52.7	80.3	77.6	71.2
Trace Elements						
Arsenic	04-001	mg/kg	8.2	[NA]	5.9	9.1
Cadmium	04-001	mg/kg	<0.1	[NA]	0.16	0.13
Chromium	04-001	mg/kg	42	[NA]	31	27
Copper	04-001	mg/kg	21	[NA]	17	21
Mercury	04-002	mg/kg	0.05	[NA]	0.06	0.05
Nickel	04-001	mg/kg	21	[NA]	15	14
Phosphorus	04-001	mg/kg	810	[NA]	650	490
Lead	04-001	mg/kg	11	[NA]	15	9.3
Zinc	04-001	mg/kg	73	[NA]	49	63
BTEX						
Benzene	04-021	mg/kg	<0.20	<0.8	<0.8	<0.4
Toluene	04-021	mg/kg	<0.20	<0.8	<0.8	<0.4
Ethyl Benzene	04-021	mg/kg	<0.20	<0.8	<0.8	<0.4
m+p xylenes	04-021	mg/kg	<0.40	<1.6	<1.6	<0.8
o-xylene	04-021	mg/kg	<0.20	<0.8	<0.8	<0.4
Total BTEX	04-021	mg/kg	<1.2	<4.8	<4.8	<2.4
Surrogate 1 Recovery	04-021	%	72	511.00	56	58
Surrogate 2 Recovery	04-021	%	71	48	49	54
Surrogate 3 Recovery	04-021	%	72	45	45	52
Date Extracted	04-021	-	16/03/2010	16/03/2010	16/03/2010	16/03/2010
Date Analysed	04-021	-	18/03/2010	18/03/2010	18/03/2010	18/03/2010
Total Petroleum Hydrocarbons						
TPH C6-C9	04-021	mg/kg	<10	<40	<40	<20
TPH C10-14	04-020	mg/kg	<10	31	32	<10
TPH C15-28	04-020	mg/kg	<50	210	240	150
TPH C29-36	04-020	mg/kg	58	130	600	190
Surrogate Recovery	04-020	%	94	91	132	120
Date Extracted	04-020	-	17/03/2010	17/03/2010	17/03/2010	17/03/2010
Date Analysed	04-020	-	19/03/2010	19/03/2010	19/03/2010	19/03/2010
Organochlorine Pesticides						

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Batch Number: A10/0860
Project Reference: 100114 PoB Mangroves

Laboratory Reference: **Client Reference:** **Date Sampled:** **Analysis Description**	- - - **Method**	- - - **Units**	**/13** **FI 19**	**/14** **FI 22**	**/15** **FI 23**	**/16** **WI 1**
Aldrin	04-023	µg/kg	<1.0	[NA]	<4	<2
alpha-BHC	04-023	µg/kg	<10	[NA]	<40	<20
beta-BHC	04-023	µg/kg	<10	[NA]	<40	<20
gamma-BHC (Lindane)	04-023	µg/kg	<10	[NA]	<40	<20
delta-BHC	04-023	µg/kg	<10	[NA]	<40	<20
cis-Chlordane	04-023	µg/kg	<1.0	[NA]	<4	<2
trans-Chlordane	04-023	µg/kg	<1.0	[NA]	<4	<2
p,p'-DDD	04-023	µg/kg	<1.0	[NA]	<40	<20
p,p'-DDE	04-023	µg/kg	<1.0	[NA]	<40	<20
p,p'-DDT	04-023	µg/kg	<1.0	[NA]	<40	<20
Dieldrin	04-023	µg/kg	<1.0	[NA]	<4	<2
alpha-Endosulfan	04-023	µg/kg	<10	[NA]	<40	<20
beta-Endosulfan	04-023	µg/kg	<10	[NA]	<40	<20
Endosulfan Sulphate	04-023	µg/kg	<10	[NA]	<40	<20
Endrin	04-023	µg/kg	<1.0	[NA]	<4	<2
Endrin ketone	04-023	µg/kg	<1.0	[NA]	<4	<2
Endrin aldehyde	04-023	µg/kg	<1.0	[NA]	<4	<2
Heptachlor	04-023	µg/kg	<1.0	[NA]	<4	<2
Heptachlor epoxide	04-023	µg/kg	<1.0	[NA]	<4	<2
Hexachlorobenzene	04-023	µg/kg	<1.0	[NA]	<4	<2
Methoxychlor	04-023	µg/kg	<10	[NA]	<40	<20
Oxychlordane	04-023	µg/kg	<1.0	[NA]	<4	<2
Surrogate Recovery	04-023	%	75	[NA]	71	70
Date Extracted	04-023	-	17/03/2010	[NA]	17/03/2010	17/03/2010
Date Analysed	04-023	-	19/03/2010	[NA]	19/03/2010	19/03/2010
Subcontract Analysis						
Nitrate as N	SUB	mg/kg	<0.1	[NA]	<0.1	<0.1
Nitrite as N	SUB	mg/kg	0.2	[NA]	0.1	0.2
Total Kjeldahl Nitrogen	SUB	mg/kg	1,360	[NA]	9,450	2,950
Total Nitrogen	SUB	mg/kg	1,360	[NA]	9,450	2,950

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Batch Number: A10/0860
Project Reference: 100114 PoB Mangroves

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	/17 WI 2	/18 WI 3
Moisture Content				
Moisture Content	04-004	%	85.6	67.9
Trace Elements				
Arsenic	04-001	mg/kg	7.0	8.2
Cadmium	04-001	mg/kg	0.14	<0.1
Chromium	04-001	mg/kg	12	42
Copper	04-001	mg/kg	39	43
Mercury	04-002	mg/kg	0.07	0.09
Nickel	04-001	mg/kg	11	20
Phosphorus	04-001	mg/kg	1,100	3,200
Lead	04-001	mg/kg	9.0	19
Zinc	04-001	mg/kg	62	100
BTEX				
Benzene	04-021	mg/kg	<0.8	<0.4
Toluene	04-021	mg/kg	<0.8	<0.4
Ethyl Benzene	04-021	mg/kg	<0.8	<0.4
m+p xylenes	04-021	mg/kg	<1.6	<0.8
o-xylene	04-021	mg/kg	<0.8	<0.4
Total BTEX	04-021	mg/kg	<4.8	<2.4
Surrogate 1 Recovery	04-021	%	52	67
Surrogate 2 Recovery	04-021	%	45	62
Surrogate 3 Recovery	04-021	%	43	61
Date Extracted	04-021	-	16/03/2010	16/03/2010
Date Analysed	04-021	-	18/03/2010	18/03/2010
Total Petroleum Hydrocarbons				
TPH C6-C9	04-021	mg/kg	<40	<20
TPH C10-14	04-020	mg/kg	55	12
TPH C15-28	04-020	mg/kg	570	260
TPH C29-36	04-020	mg/kg	740	300
Surrogate Recovery	04-020	%	116	119
Date Extracted	04-020	-	17/03/2010	17/03/2010
Date Analysed	04-020	-	19/03/2010	19/03/2010
Organochlorine Pesticides				

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Batch Number: A10/0860
Project Reference: 100114 PoB Mangroves

Laboratory Reference: **Client Reference:** **Date Sampled:** **Analysis Description**	- - - **Method**	- - - **Units**	**/17** **WI 2**	**/18** **WI 3**
Aldrin	04-023	µg/kg	<40	<2
alpha-BHC	04-023	µg/kg	<40	<20
beta-BHC	04-023	µg/kg	<40	<20
gamma-BHC (Lindane)	04-023	µg/kg	<40	<20
delta-BHC	04-023	µg/kg	<40	<20
cis-Chlordane	04-023	µg/kg	<4	<2
trans-Chlordane	04-023	µg/kg	<4	<2
p,p'-DDD	04-023	µg/kg	<40	<20
p,p'-DDE	04-023	µg/kg	<40	<20
p,p'-DDT	04-023	µg/kg	<40	<20
Dieldrin	04-023	µg/kg	<4	<2
alpha-Endosulfan	04-023	µg/kg	<40	<20
beta-Endosulfan	04-023	µg/kg	<40	<20
Endosulfan Sulphate	04-023	µg/kg	<40	<20
Endrin	04-023	µg/kg	<4	<2
Endrin ketone	04-023	µg/kg	<4	<2
Endrin aldehyde	04-023	µg/kg	<4	<2
Heptachlor	04-023	µg/kg	<4	<2
Heptachlor epoxide	04-023	µg/kg	<4	<2
Hexachlorobenzene	04-023	µg/kg	<4	<2
Methoxychlor	04-023	µg/kg	<40	<20
Oxychlordane	04-023	µg/kg	<4	<2
Surrogate Recovery	04-023	%	77	84
Date Extracted	04-023	-	17/03/2010	17/03/2010
Date Analysed	04-023	-	19/03/2010	19/03/2010
Subcontract Analysis				
Nitrate as N	SUB	mg/kg	<0.1	<0.1
Nitrite as N	SUB	mg/kg	0.2	<0.1
Total Kjeldahl Nitrogen	SUB	mg/kg	23,200	7,600
Total Nitrogen	SUB	mg/kg	23,200	7,600

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Method	Method Description
04-004	Moisture by gravimetric, %
04-001	Metals by ICP-OES, mg/kg
04-002	Mercury by CVAAS, mg/kg
04-021	TPH C6-9 & BTEX by P&T GCMS, mg/kg
04-020	TPH by GC-FID, mg/kg
04-023	Low level OC Pesticides by GCMS, µg/kg
SUB	Subcontracted Analyses

Result Comments

[<] Less than
[INS] Insufficient sample for this test
[NA] Test not required
Solid sample results are reported on a dry weight basis.

Nutrients analysis was subcontracted to Sydney Analytical Laboratories (NATA Number 1884); reference SAL report number SAL22686.

Limits of reporting for selected samples have be raised for BTEX, TPH, and OC analysis due to high moisture content.
Limits of reporting for selected OC analytes have been raised due to matrix interferences.

Replacement report for A10-0860-[R00]. Copper results included.

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Batch Number: A10/0860
Project Reference: 100114 PoB Mangroves

QUALITY ASSURANCE REPORT

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results
Arsenic	mg/kg	<0.4	A10/0860-1	5.7 || 5.7 || RPD: 0
Cadmium	mg/kg	<0.1	A10/0860-1	<0.1 || <0.1
Chromium	mg/kg	<0.1	A10/0860-1	20 || 20 || RPD: 0
Copper	mg/kg	<0.1	A10/0860-1	8.8 || 8.7 || RPD: 1
Mercury	mg/kg	<0.01	A10/0860-1	0.03 || 0.03 || RPD: 0
Nickel	mg/kg	<0.1	A10/0860-1	9.3 || 9.2 || RPD: 1
Phosphorus	mg/kg	<1	A10/0860-1	400 || 410 || RPD: 2
Lead	mg/kg	<0.5	A10/0860-1	6.0 || 6.1 || RPD: 2
Zinc	mg/kg	<0.5	A10/0860-1	35 || 35 || RPD: 0

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Benzene	mg/kg	<0.20	A10/0860-7	<0.20 || <0.20	External	90%
Toluene	mg/kg	<0.20	A10/0860-7	<0.20 || <0.20	External	94%
Ethyl Benzene	mg/kg	<0.20	A10/0860-7	<0.20 || <0.20	External	93%
m+p xylenes	mg/kg	<0.40	A10/0860-7	<0.40 || <0.40	External	92%
o-xylene	mg/kg	<0.20	A10/0860-7	<0.20 || <0.20	External	91%
Total BTEX	mg/kg	<1.2	A10/0860-7	<1.2 || <1.2	External	N/A
Surrogate 1 Recovery	%	95	A10/0860-7	96 || 71 || RPD: 30	External	95%
Surrogate 2 Recovery	%	93	A10/0860-7	93 || 64 || RPD: 37	External	98%
Surrogate 3 Recovery	%	92	A10/0860-7	96 || 67 || RPD: 36	External	97%

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
TPH C6-C9	mg/kg	<10	A10/0860-7	<10 || <10	External	88%
TPH C10-14	mg/kg	<10	A10/0860-7	<10 || <10	External	84%
TPH C15-28	mg/kg	<50	A10/0860-7	110 || 100 || RPD: 10	External	85%
TPH C29-36	mg/kg	<50	A10/0860-7	150 || 150 || RPD: 0	External	81%
Surrogate Recovery	%	86	A10/0860-7	97 || 99 || RPD: 2	External	90%

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Aldrin	µg/kg	<1.0	A10/0860-7	<10 || <10	External	90%
alpha-BHC	µg/kg	<1.0	A10/0860-7	<10 || <10	External	92%
beta-BHC	µg/kg	<1.0	A10/0860-7	<10 || <10	External	91%
gamma-BHC (Lindane)	µg/kg	<1.0	A10/0860-7	<10 || <10	External	92%
delta-BHC	µg/kg	<1.0	A10/0860-7	<10 || <10	External	87%
cis-Chlordane	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	85%
trans-Chlordane	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	86%

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Batch Number: A10/0860

Project Reference: 100114 PoB Mangroves

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
p,p'-DDD	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	90%
p,p'-DDE	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	86%
p,p'-DDT	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	92%
Dieldrin	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	85%
alpha-Endosulfan	µg/kg	<1.0	A10/0860-7	<10 || <10	External	87%
beta-Endosulfan	µg/kg	<1.0	A10/0860-7	<10 || <10	External	88%
Endosulfan Sulphate	µg/kg	<1.0	A10/0860-7	<10 || <10	External	88%
Endrin	µg/kg	<1.0	A10/0860-7	<10 || <10	External	94%
Endrin ketone	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	88%
Endrin aldehyde	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	55%
Heptachlor	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	93%
Heptachlor epoxide	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	63%
Hexachlorobenzene	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	87%
Methoxychlor	µg/kg	<1.0	A10/0860-7	<10 || <10	External	92%
Oxychlordane	µg/kg	<1.0	A10/0860-7	<1.0 || <1.0	External	N/A
Surrogate Recovery	%	82	A10/0860-7	80 || 80 || RPD: 0	External	83%

TEST	UNITS	Blank
Nitrate as N	mg/kg	<0.1
Nitrite as N	mg/kg	<0.1
Total Kjeldahl Nitrogen	mg/kg	<20
Total Nitrogen	mg/kg	<20

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Arsenic	mg/kg	[NT]	A10/0860-12	3.9 || 3.9 || RPD: 0	A10/0860-1	99%
Cadmium	mg/kg	[NT]	A10/0860-12	<0.1 || <0.1	A10/0860-1	98%
Chromium	mg/kg	[NT]	A10/0860-12	16 || 16 || RPD: 0	A10/0860-1	97%
Copper	mg/kg	[NT]	A10/0860-12	5.4 || 5.5 || RPD: 2	A10/0860-1	97%
Mercury	mg/kg	[NT]	A10/0860-12	0.03 || 0.02 || RPD: 40	A10/0860-1	92%
Nickel	mg/kg	[NT]	A10/0860-12	7.3 || 7.3 || RPD: 0	A10/0860-1	91%
Phosphorus	mg/kg	[NT]	A10/0860-12	310 || 310 || RPD: 0	A10/0860-1	104%
Lead	mg/kg	[NT]	A10/0860-12	3.9 || 3.8 || RPD: 3	A10/0860-1	87%
Zinc	mg/kg	[NT]	A10/0860-12	28 || 29 || RPD: 4	A10/0860-1	90%

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Project Reference: 100114 PoB Mangroves

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Benzene	mg/kg	[NT]	A10/0860-17	<0.8 || <0.8	A10/0860-1	79%
Toluene	mg/kg	[NT]	A10/0860-17	<0.8 || <0.8	A10/0860-1	80%
Ethyl Benzene	mg/kg	[NT]	A10/0860-17	<0.8 || <0.8	A10/0860-1	81%
m+p xylenes	mg/kg	[NT]	A10/0860-17	<1.6 || <1.6	A10/0860-1	81%
o-xylene	mg/kg	[NT]	A10/0860-17	<0.8 || <0.8	A10/0860-1	79%
Total BTEX	mg/kg	[NT]	A10/0860-17	<4.8 || <4.8	A10/0860-1	N/A
Surrogate 1 Recovery	%	[NT]	A10/0860-17	52 || 50 || RPD: 4	A10/0860-1	83%
Surrogate 2 Recovery	%	[NT]	A10/0860-17	45 || 43 || RPD: 5	A10/0860-1	82%
Surrogate 3 Recovery	%	[NT]	A10/0860-17	43 || 39 || RPD: 10	A10/0860-1	83%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
TPH C6-C9	mg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-1	76%
TPH C10-14	mg/kg	[NT]	A10/0860-17	55 || 63 || RPD: 14	A10/0860-1	84%
TPH C15-28	mg/kg	[NT]	A10/0860-17	570 || 550 || RPD: 4	A10/0860-1	86%
TPH C29-36	mg/kg	[NT]	A10/0860-17	740 || 650 || RPD: 13	A10/0860-1	82%
Surrogate Recovery	%	[NT]	A10/0860-17	116 || 113 || RPD: 3	A10/0860-1	92%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Aldrin	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	89%
alpha-BHC	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	95%
beta-BHC	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	97%
gamma-BHC (Lindane)	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	94%
delta-BHC	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	119%
cis-Chlordane	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	81%
trans-Chlordane	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	82%
p,p'-DDD	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	93%
p,p'-DDE	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	82%
p,p'-DDT	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	48%
Dieldrin	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	81%
alpha-Endosulfan	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	81%
beta-Endosulfan	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	90%
Endosulfan Sulphate	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	99%
Endrin	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	92%
Endrin ketone	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	72%
Endrin aldehyde	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	59%
Heptachlor	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	98%
Heptachlor epoxide	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	61%
Hexachlorobenzene	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	91%
Methoxychlor	µg/kg	[NT]	A10/0860-17	<40 || <40	A10/0860-18	42%
Oxychlordane	µg/kg	[NT]	A10/0860-17	<4 || <4	A10/0860-18	N/A
Surrogate Recovery	%	[NT]	A10/0860-17	77 || 77 || RPD: 0	A10/0860-18	79%

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Project Reference: 100114 PoB Mangroves

Comments:

RPD = Relative Percent Deviation
[NT] = Not Tested
[N/A] = Not Applicable
'#' = Spike recovery data could not be calculated due to high levels of contaminants

Acceptable replicate reproducibility limit or RPD:	Results < 10 times LOR: no limits
	Results >10 times LOR: 0% - 50%
Acceptable matrix spike & LCS recovery limits:	Trace elements 70-130%
	Organic analyses 50-150%
	SVOC & speciated phenols 10-140%
	Surrogates 10-140%

When levels outside these limits are obtained, an investigation into the cause of the deviation is performed before the batch is accepted or rejected, and results are released.

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Appendix A Community Composition, Structure and Health of Mangrove Communities

Contents

List of Tables

List of Figures

1 Methods

1.1 Study Sites

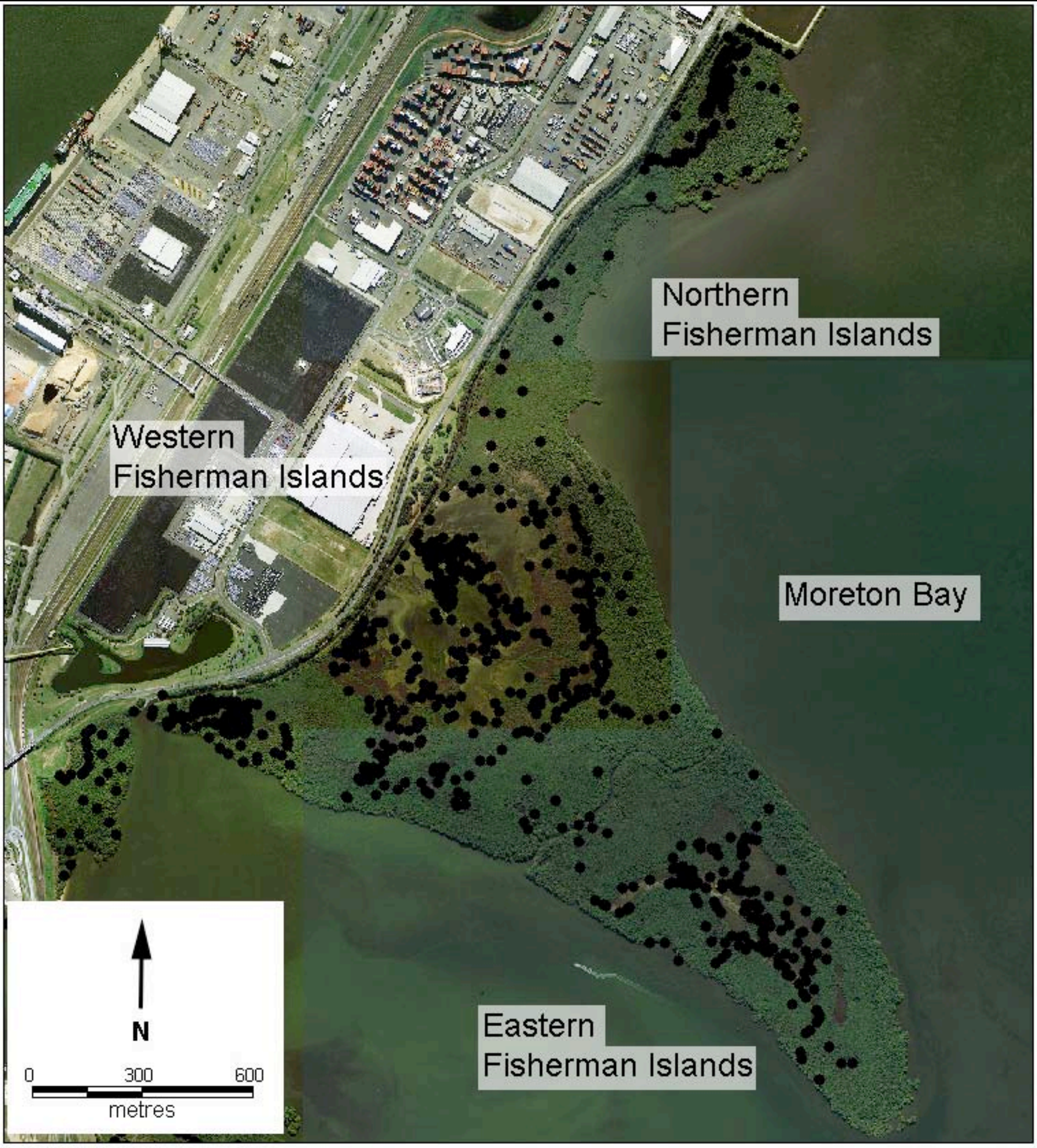
In March 2010 we assessed the community structure, composition and health of mangroves at Fisherman Islands and Whyte Island (Figure 1.1 – Figure 1.4). To facilitate mapping, the mangroves at Fisherman Islands were divided into two areas:

- the 'Coal Loader' area, which is adjacent to the Coal Loader at Fisherman Islands (to both the west and east of Port Drive)
- 'Fisherman Islands', the large area to the east of Lucinda Drive, which was sub-divided into:
  - the western area, which is the large area of mangroves to the south east of the PBC office
  - the eastern area, which is divided from the western area by a channel, and extends to the east in a long peninsula, and
  - the northern area, a smaller strip of mangroves adjacent to the mainland to the north east of the Port of Brisbane Corporation (PBC) office.

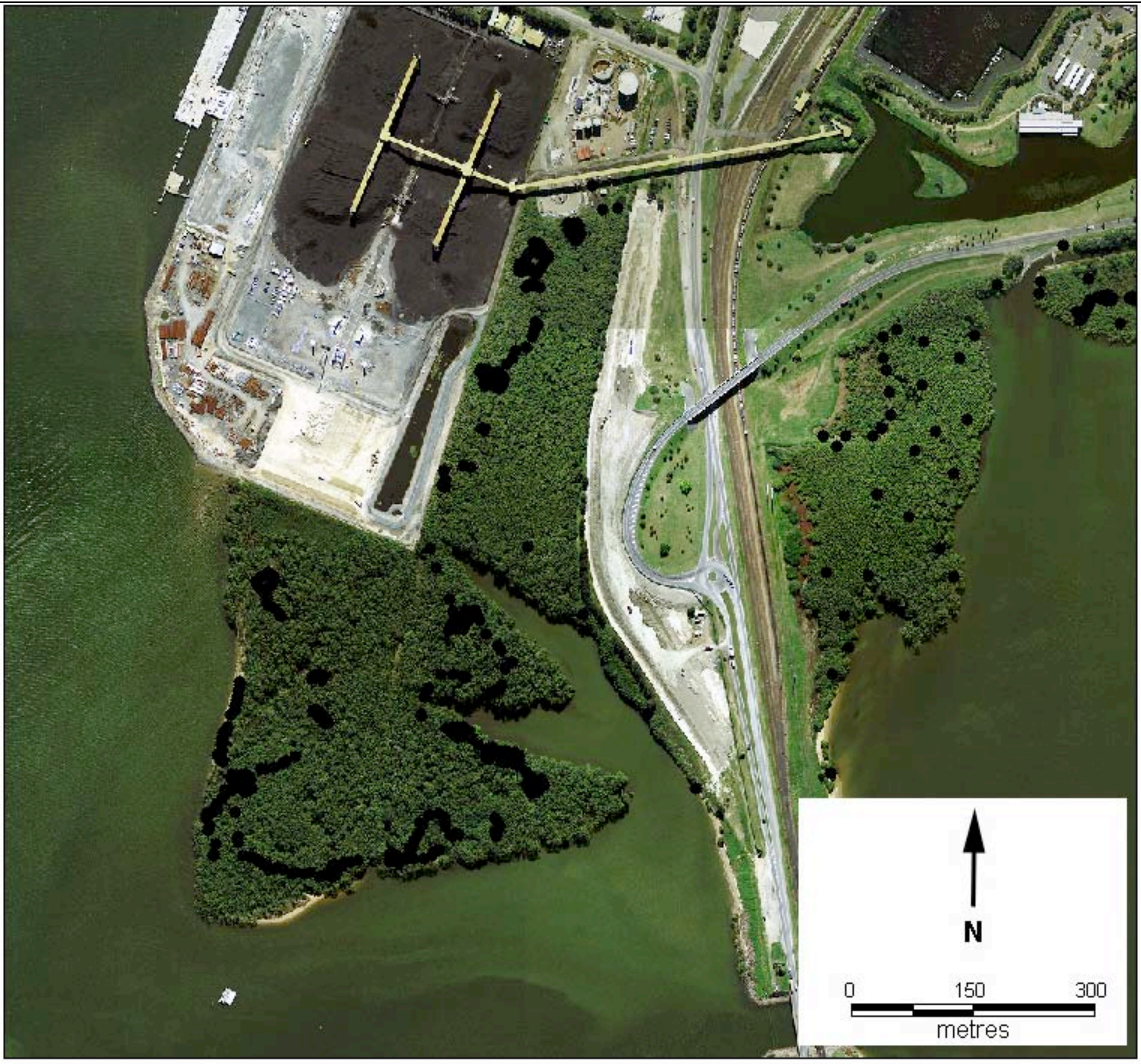
Within each study area, aerial photography, previous monitoring reports, and discussions with the PBC's Senior Environmental Coordinator were used to target specific areas for field assessment. In particular, boundaries between health categories established in previous reports were targeted to see if there had been any substantial change to these areas. In addition, broad transects, usually running landward to seaward, were surveyed to determine the boundaries of health and community composition categories. Survey points were established at regular intervals, or when a change in mangrove community structure or health was noted. The position of each survey point was recorded using GPS (accurate to ±4 m) (Figure 1.3 – Figure 1.4).

At each survey point, we assessed the community composition, structure and health of the mangroves in the immediate vicinity.

frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 1.1 Study areas.	
		June 2010



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 1.2 Survey points at Fisherman Islands in 2010.
	June 2010

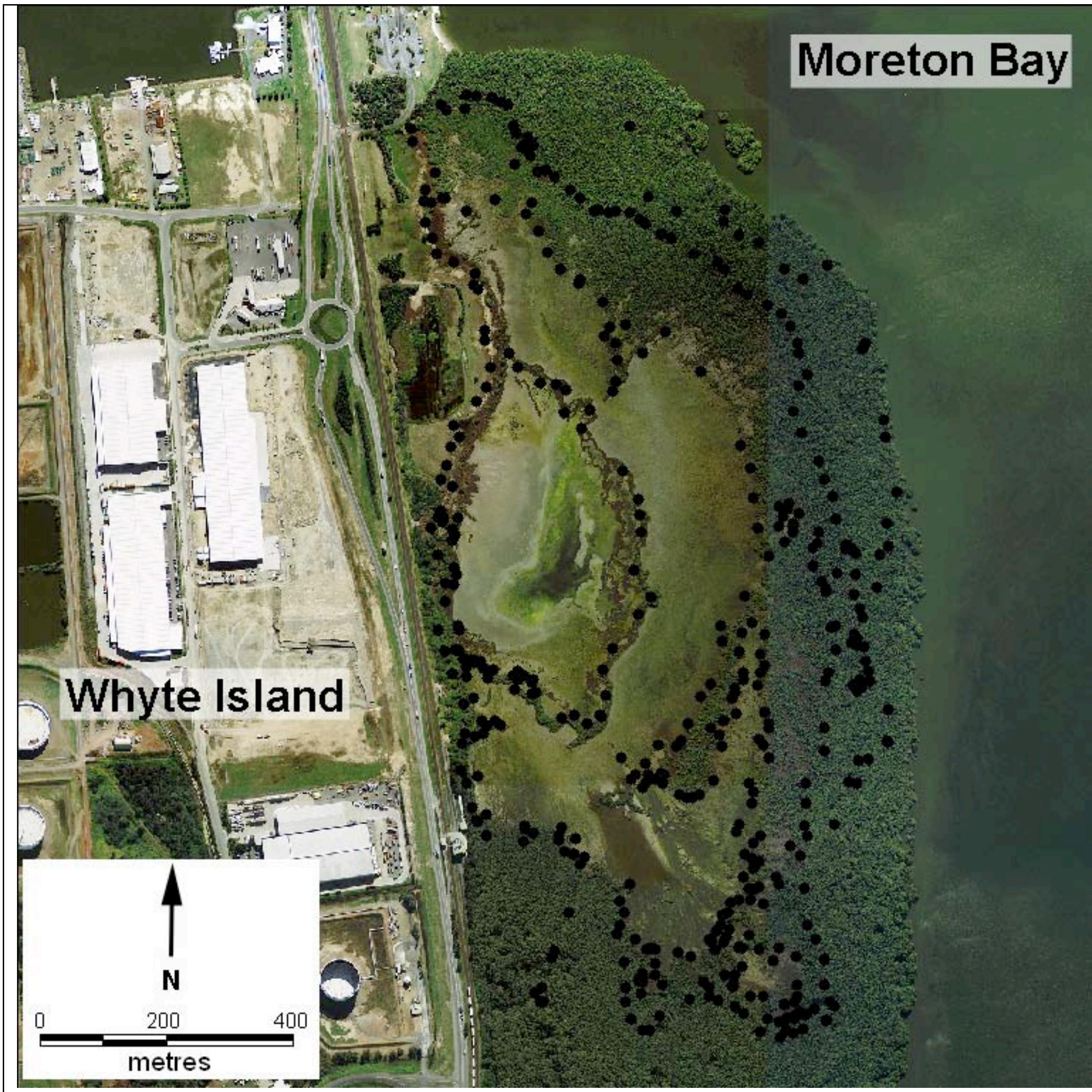


Fisherman Islands and Whyte Island

Mangrove Health Assessment 2010

Figure 1.3 Survey points in the Coal Loader area at Fisherman Islands in 2010.

June 2010



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 1.4 Survey points at Whyte Island in 2010.	
		June 2010

1.2 Description of Community Composition and Structure

At each survey point, species composition (% cover of each species), canopy height (m), canopy cover (%), and the structural formation of the mangroves were recorded.

For structural formation, we followed the classification system used by the Queensland Herbarium (Dowling & Stephens 2001), which is based on the classifications given in Appendix B. Using this methodology, no Tall Forests were identified, as canopy height did not reach 30 m. Therefore, what may have been referred to as Tall Open / Closed Forests in earlier monitoring events (WBM Oceanics Australia 2000; WBM Oceanics 2002; WBM Oceanics Australia 2002) are described as Open or Closed Forests in this study. We have also referred to the yellow mangrove as *Ceriops tagal* as opposed to *Ceriops australis*, as this is the name used for this species by the Queensland Herbarium, and in the Flora of Australia (McCusker 1984; QLD Herbarium pers. comm. 2004; Jessup 2002).

1.3 Description of Mangrove Health

At each survey point, the ecological health of the mangroves was determined using the classification system developed in previous surveys (Table 1.1, Figure 1.5 – Figure 1.10). The ‘recently dead’ and ‘dead’ categories were mapped separately (as per more recent surveys) however, in order to make meaningful comparisons with the dead area from previous years, dead and recently dead areas were graphed together as ‘dead’ mangroves.

Table 1.1 Criteria for visual assessments of mangrove health.

Mangrove Health Category	Criteria
Good	Green leaves with no yellowing, curling etc. and little evidence of damage by insects. No abnormal leaf loss.
Fair	Mainly green leaves with < 20% of the canopy affected by yellowing / curling or damage by insects. Some epicormic growth.
Poor	Many yellowing / curled leaves, reduced canopy cover, high insect damage. Abundant epicormic growth.
Recently Dead	Leaves brown or absent with no new growth, note while these trees appear to be dead, they can sometimes regrow.
Dead	No leaves or twigs, in some cases there are no small branches. Trees have been dead for years.
Regrowth	Canopy cover low but new trees evident, new growth shooting from the base or trunks of older trees. Previous disturbance event sometimes evident.

Figure 1.5

Mangroves in good health at Fisherman Islands.

Figure 1.6

Mangroves in fair health at Fisherman Islands, note there is some epicormic growth.

Figure 1.7

Mangroves in poor health at Fisherman Islands, note numerous dead branches, epicormic growth and yellowing leaves.

Figure 1.8

Recently dead mangroves at eastern Fisherman Islands (right). Mangroves in poor health (left) are showing signs of stress including epicormic growth.

Figure 1.9

Dead mangroves at Fisherman Islands.

Figure 1.10

Regrowth within the Coal Loader area.

We also visually assessed each survey point for signs of disturbance, such as: damage by insects; anthropogenic or natural disturbances such as clearing; the presence of drains or bunds, litter, incursion of exotic weeds; and erosion of the foreshore. The percent cover and depth of any seagrass wrack was also estimated.

The abundance of macroalgae, macrofauna and seedlings were also recorded at each survey point, as they can also be indicative of mangrove health.

Macroalgae

Macroalgae are a common component of mangrove ecosystems. Some species such as *Bostrychia* spp., *Caloglossa leprieurii* and *Catenella nipae* are commonly found on the trunks and exposed roots of mangroves in south east Queensland, and are an important source of primary production in mangrove ecosystems (Karsten et al. 2000). These species are frequently more abundant in well flushed, seaward communities (Karsten et al. 2000), and are consequently an indication of a 'healthy' mangrove environment (Figure 1.11). The abundance of algal epiphytes on pneumatophores was assessed using the methodology developed in earlier surveys (Table 1.2).

Figure 1.11

Epiphytic algae growing on mangrove pneumatophores, in a well flushed area.

Table 1.2 Epiphytic macroalgae abundance categories[1].

Category	Abundance of Epiphytic Macroalgae
Very abundant (4)	> 75% cover of macroalgae on pneumatophores (heavy coating).
Abundant (3)	50 – 75% cover of macroalgae on pneumatophores (easily visible).
Common (2)	10 – 50% cover of macroalgae on pneumatophores (some algae visible).
Rare (1)	< 10% cover of macroalgae on pneumatophores.
Absent (0)	No visible macroalgae on pneumatophores.

[1] Assigning of numerical values to categories were modified in 2010 (i.e. 'very abundant' was assigned a score of 4 in 2010, but a score of 1 in previous surveys) so that all indices were consistent. The Absent (0) category was also added in 2010.

In contrast, other types of algae, such as *Ulva lactuca*, *Microcoleus chthonoplastes*, *Cladophora* and *Enteromorpha intestinalis,* and some cyanobacteria such as *Lyngbya* sp., rapidly respond to increased nutrient availability. In mangrove forests, these species can form mats over the sediment and roots, decreasing oxygen uptake and negatively impacting mangrove condition (Figure 1.12). They are typical of mangrove forests in poor ecological health. The abundance of mat algae was also assessed using the categories in Table 1.3.

Figure 1.12

Mat algae growing in a poorly flushed area.

Table 1.3 Mat-forming algae abundance categories.[1]

Category	Density and Abundance of Macroalgae Mats
Very abundant (4)	> 75% of the sediment covered by macroalgae (heavy coating / carpet).
Abundant (3)	50 – 75% of the sediment covered by macroalgae (easily visible).
Common (2)	10 – 50% of the sediment covered by macroalgae (some algae visible).
Rare (1)	< 10% of the sediment covered by macroalgae.
Absent(0)	No visible macroalgae on sediment.

[1] Assigning of numerical values to categories were modified in 2010 (i.e. 'very abundant' was assigned a score of 4 in 2010, but a score of 1 in previous surveys) so that all indices were consistent. The Absent (0) category was also added in 2010.

Macrofauna

Whilst macrofaunal abundance may not give a good indication of mangrove health *per se*, it can give an indication of the suitability of the mangrove community as a faunal habitat. This can have implications for the importance of the site as a fisheries habitat. Crabs are considered to be a 'keystone' species in the intertidal zone (Saintilan & Mazumder 2004); the abundance of crabs or crab burrows was therefore used as an indicator of the ability of the site to support marine fauna. We also noted the abundance of molluscs and other macrofauna. Macrofaunal abundance was ranked based on the density of crab holes, and the visible abundance of fauna (Table 2.4).

Table 1.4 Macrofauna abundance categories.[1]

Category	Macrofauna Abundance
Very abundant (4)	> 50% of the substrate covered by crab holes.
Abundant (3)	25 – 50% of the substrate covered by crab holes.
Common (2)	< 25% of the substrate covered by crab holes.
Rare (1)	< 10% of the substrate covered by crab holes.
Absent (0)	No macrofauna or crab holes evident.

[1] Assigning of numerical values to categories were modified in 2010 (i.e. 'very abundant' was assigned a score of 4 in 2010, but a score of 1 in previous surveys) so that all indices were consistent. The Absent (0) category was also added in 2010.

Seedling Density

The abundance and species of seedlings were recorded at each site using the classifications given in Table 1.5.

Table 1.5 Seedling abundance categories.[1]

Category	Seedling Abundance
Very abundant (4)	Available space is 100% covered with seedlings, seedlings form a dense carpet with few (if any) gaps.
Abundant (3)	Most of the available space is covered with seedlings, however there are some gaps.
Common (2)	Seedlings are common, but do not form a carpet.
Sparse (1)	Less than 1 seedling per square metre.
Absent (0)	No seedlings present.

[1] Assigning of numerical values to categories were modified in 2010 (i.e. 'very abundant' was assigned a score of 4 in 2010, but a score of 1 in previous surveys) so that all indices were consistent. The Absent (0) category was also added in 2010.

1.4 Mapping and Assessment of Mangrove Health and Community Structure

Field survey data was mapped using GIS software (MapInfo). Data points and field survey data were overlain onto rectified aerial photographs taken in 2010, as provided by the Port of Brisbane. Maps were updated based on field data, and interpretation of the aerial photography. The area of each community and health category was then calculated and compared to previous surveys. Each of the communities was described, based on the field data. Field data was also summarised and compared to previous surveys.

Field data is provided in Appendix F (Fisherman Islands) and G (Whyte Island).

2 Historical Context

In the past 200 years, there have been major changes to coastal landscapes in south east Queensland, including significant changes to wetland communities. Historical changes to mangrove communities at Fisherman and Whyte Island are discussed in a previous report (frc environmental 2007).

Observed changes to wetlands in the area include: direct and intended change, such as reclamation or intentional clearing for roads etc.; direct and unintended change, such as oils spills etc.; indirect and unintended changes such as increases in nutrient runoff and discharges or erosion due to boat wash; and not obviously human related impacts such as storm damage and climate change. Reclamation of tidal wetlands to make way for the construction of the Port of Brisbane began in 1958 (Duke et al. 2003).

Observed long and short term changes to mangrove communities in the vicinity of the Port of Brisbane are likely to be the cumulative response to a number of processes: there have been major changes to mangrove communities in the area resulting from reclamation and construction; nutrient loads have significantly increased; and sediment loads have significantly increased (Neil & Yu 1996 in Duke et al. 2003a). These anthropogenic changes have happened against a background of natural change associated with variations in climate and sea level, which also impact mangrove distribution.

The canopy cover of mangroves in the Coal Loader area, Fisherman Islands and Whyte Island all increased from the 1950s to the early 1970s, with mangroves also colonising new areas over this period.

From 1972 to 1978, mangroves were reclaimed to the west of the road at Fisherman Islands, with subsequent colonisation to the east due to unconfined dredge spoil deposition (WBM Oceanics Australia 2000). Between 1978 and 1987, unconfined spoil on the central saltpan area appeared to have moved north, killing the mangroves along the edge (WBM Oceanics Australia 2000). In 1991, there were dead mangroves in the vicinity of stockpiled dredge material near the access road on the southern end of Fisherman Islands (WBM Oceanics Australia 2000). By 1994, the area of bare mud, and of mangroves in poor health had increased, particularly around the periphery of the central salt pan area.

From 1972 to 2002, mangroves at Whyte Island decreased in area by 73 ha ((WBM Oceanics 2002). Sixty percent of this was due to the intentional and authorised removal of mangroves due to construction of Port Drive in the late 1970s and subsequent development to the west of the road. The remaining loss was unintentional (WBM Oceanics 2002).

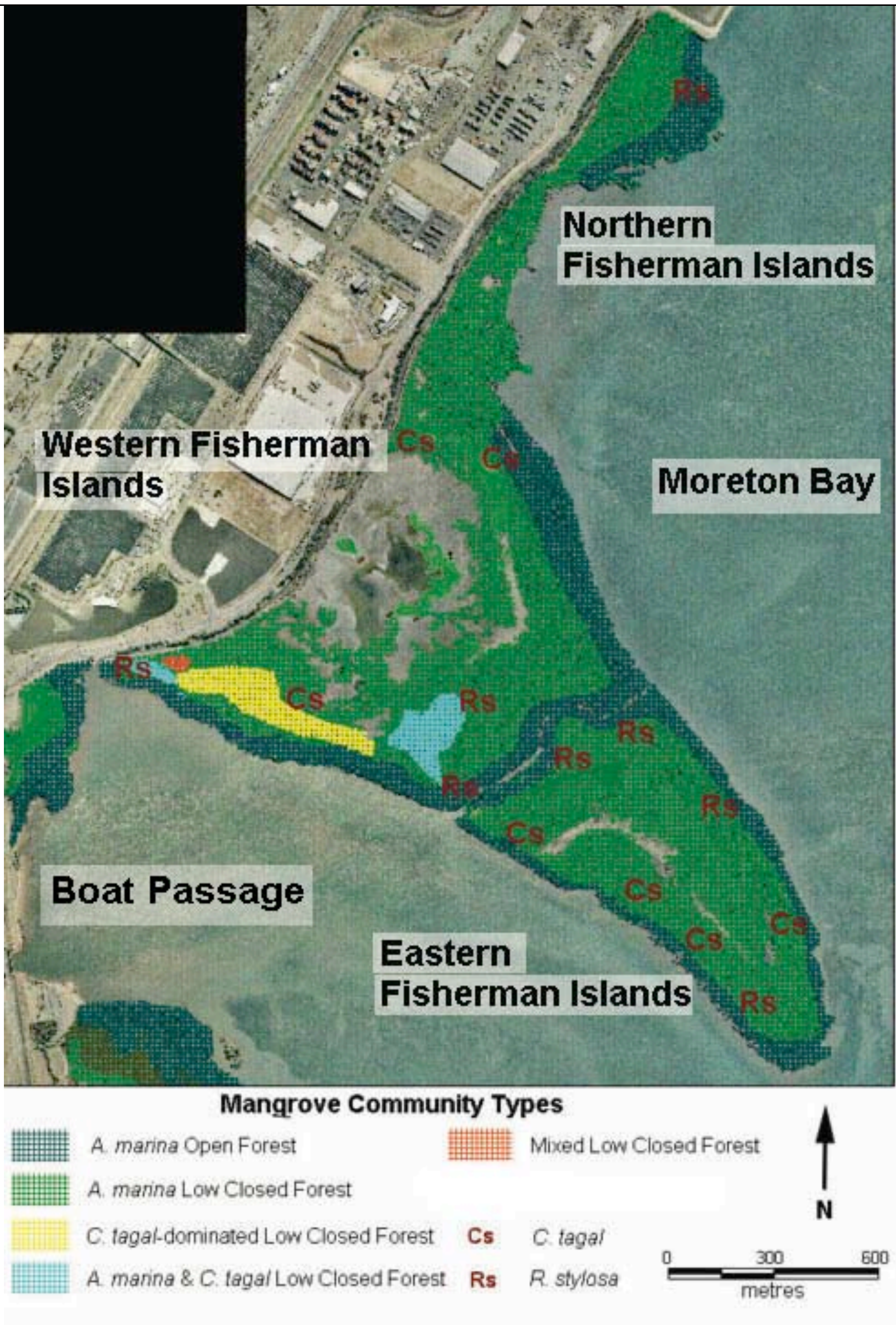
3 Fisherman Islands

3.1 Community Structure

Mangrove community structure at Fisherman Islands was similar to that recorded previously, with the grey mangrove *Avicennia marina* subsp. *australasica* dominating forests (Dowling & Stephens 1999; WBM Oceanics Australia 2000; WBM Oceanics 2002; frc environmental 2004). Other mangroves recorded during the survey included the river mangrove *Aegiceras corniculatum*, the red mangrove *Rhizophora stylosa* and the yellow mangrove *Ceriops tagal*. *C. tagal* was more prevalent in the south western corner of Fisherman Islands (Figure 3.1) and along the southern edge of the peninsula (Figure 3.2), dominating communities in parts of these areas. As in previous years, low closed forests lined the landward and dieback margins, with open forests in more seaward locations.

Figure 3.1

Ceriops tagal is the dominant species in the south western corner of the Fisherman Islands mangrove forest.



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 3.2 Mangrove community structure and species composition, Fisherman Islands 2010.	
		June 2010

Saltmarsh communities on the eastern section of Fisherman Islands were dominated by *Suaeda australis* and *Suaeda arbusculoides* (seablite), *Sarcocornia quinqueflora* (samphire) and *Enchylaena tomentosa* (ruby saltbush). Some other coastal species were also present along the landward margin of the bare / saltmarsh area, these included: *Sesuvium portulacastrum* (sea purslane), *Carpobrotus glaucescens* (coastal pigface) and *Ipomoea pes-caprae* subsp. *brasiliensis* (beach morning glory).

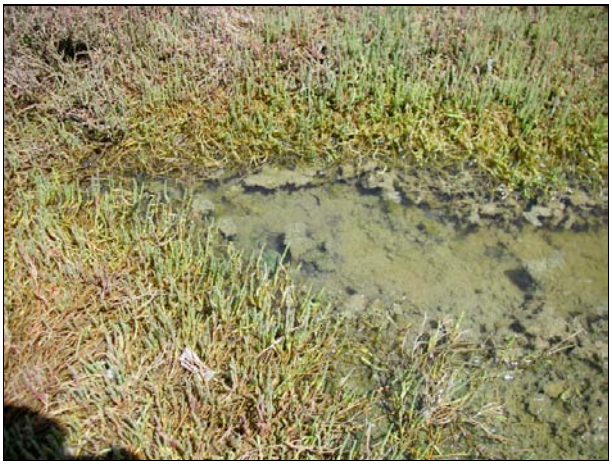
In 2010, the extent of *S. quinqueflora* had substantially increased new growth extending from the areas of dead mangroves to the bare / saltmarsh (Figure 3.3, Figure 3.4).

Figure 3.3

Sarcocornia quinqueflora growing out from the Fisherman Islands dieback area.

Figure 3.4

New growth of *Sarcocornia quinqueflora* at the Fisherman Islands dieback area.



3.2 Mangrove Health

For ease of discussion, we have sub-divided the mangroves of Fisherman Islands into three areas:

- the western area, the large area of mangroves to the south east of the PBC office
- the eastern area, which is divided from the western area by a channel, and extends to the east in a long peninsula, and
- the northern area, a smaller strip of mangroves adjacent to the mainland to the north east of the PBC office.

The health of the mangrove communities from 1999 to 2010 is illustrated in Figure 3.5 to Figure 3.11.

The area of dead / recently dead[1] mangroves has remained relatively similar since 1999 (Figure 3.5). The total area and proportion of recently dead mangroves decreased from 1.6 ha in 2008 (6% of the total dead area) to 0.8 ha in 2010 (3% of the total dead area). Sometimes areas classified as dead in earlier surveys are now classed as bare or saltmarsh, as the dead trucks and branches have rotted away.

The total area of regrowth has steadily decreased since 1999, from 4.3 to 0.3 ha, as these areas reach maturity, or died off (Figure 3.5).

The area of mangroves in poor health was relatively stable between 1999 (43 ha) and 2002 (42 ha) before falling to 14 ha in 2004, then rising to 18 ha in 2006, 24 ha in 2008, and 26 ha in 2010. The area of mangroves in fair health increased between 1999 and 2004 (from 20.5 to 58.3 ha) and then decreased from 2004 to 2006 (45 ha); the total area of mangroves in fair health has not changed since 2006.

[1] The 2008 report quoted incorrect totals; these figures have been corrected.

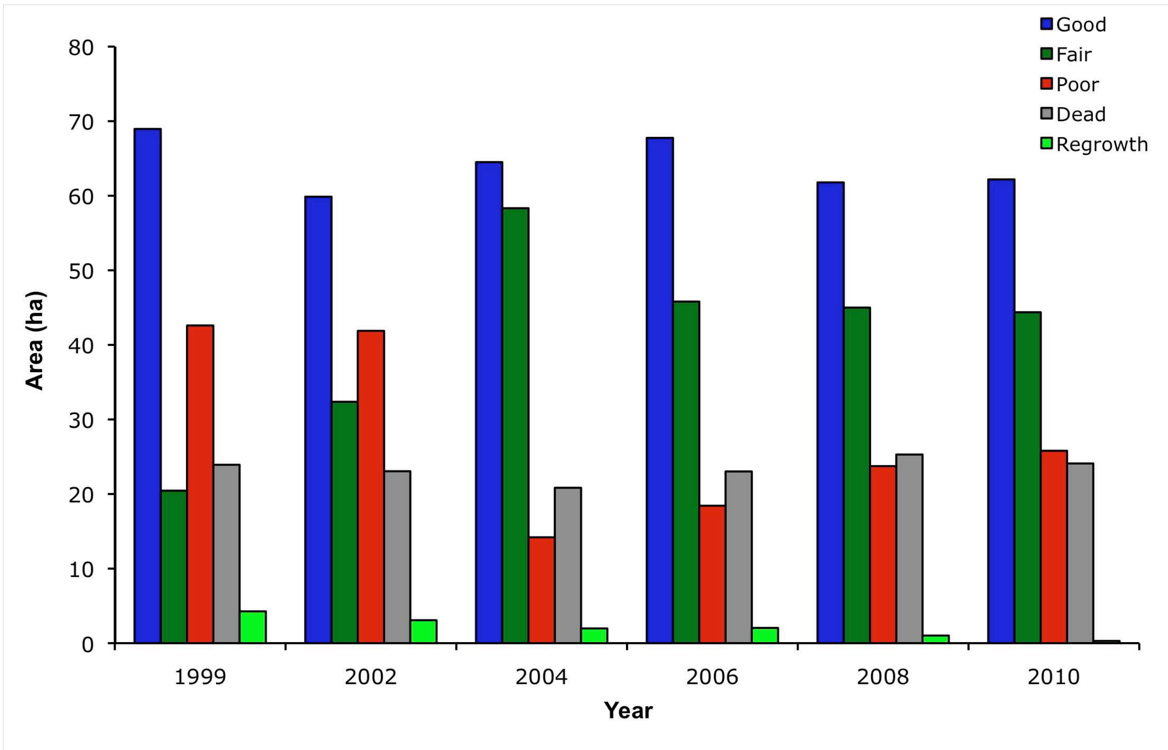


Figure 3.5 Area of mangroves in each health category at Fisherman Islands (excluding the Coal Loader area) 1999 to 2010.

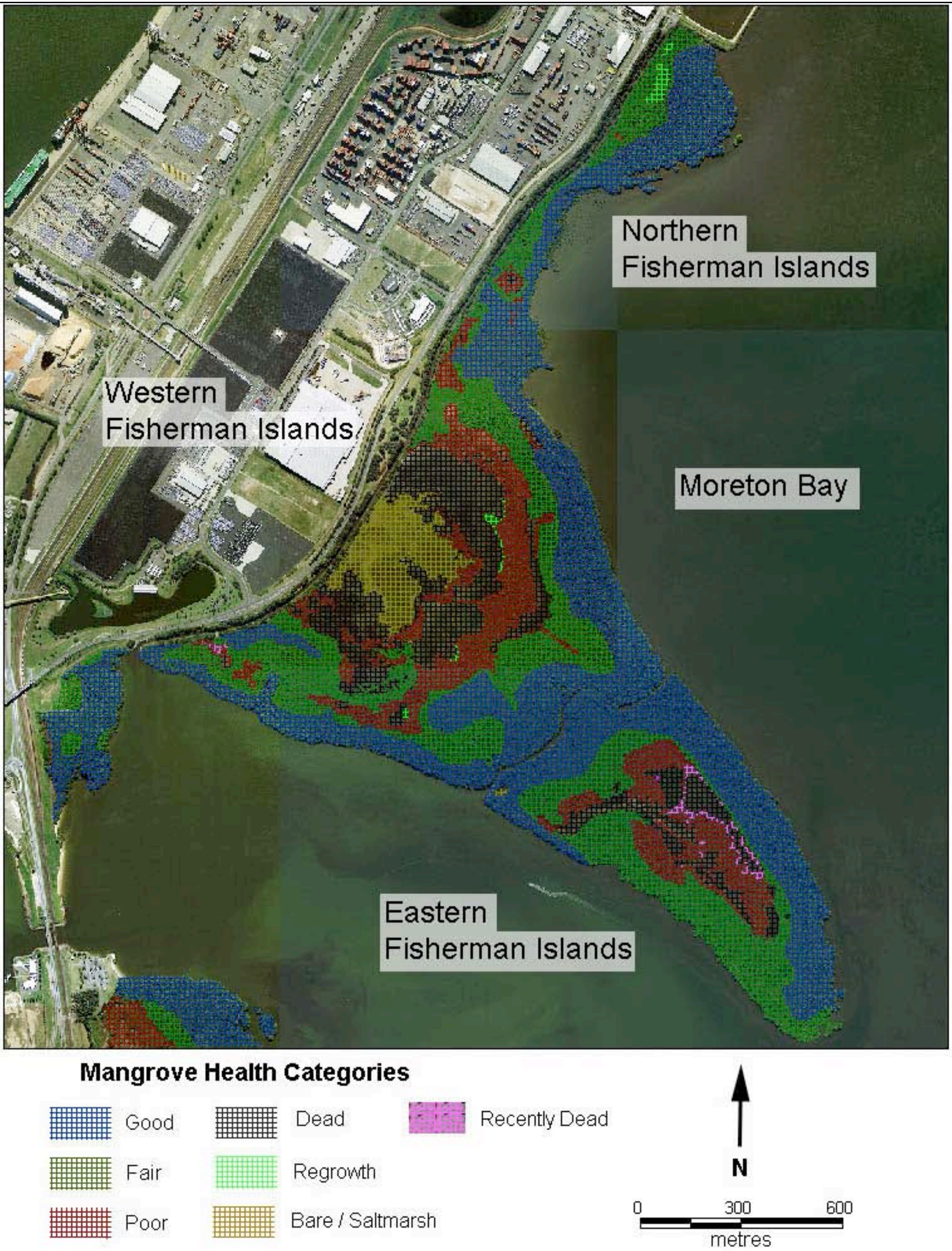


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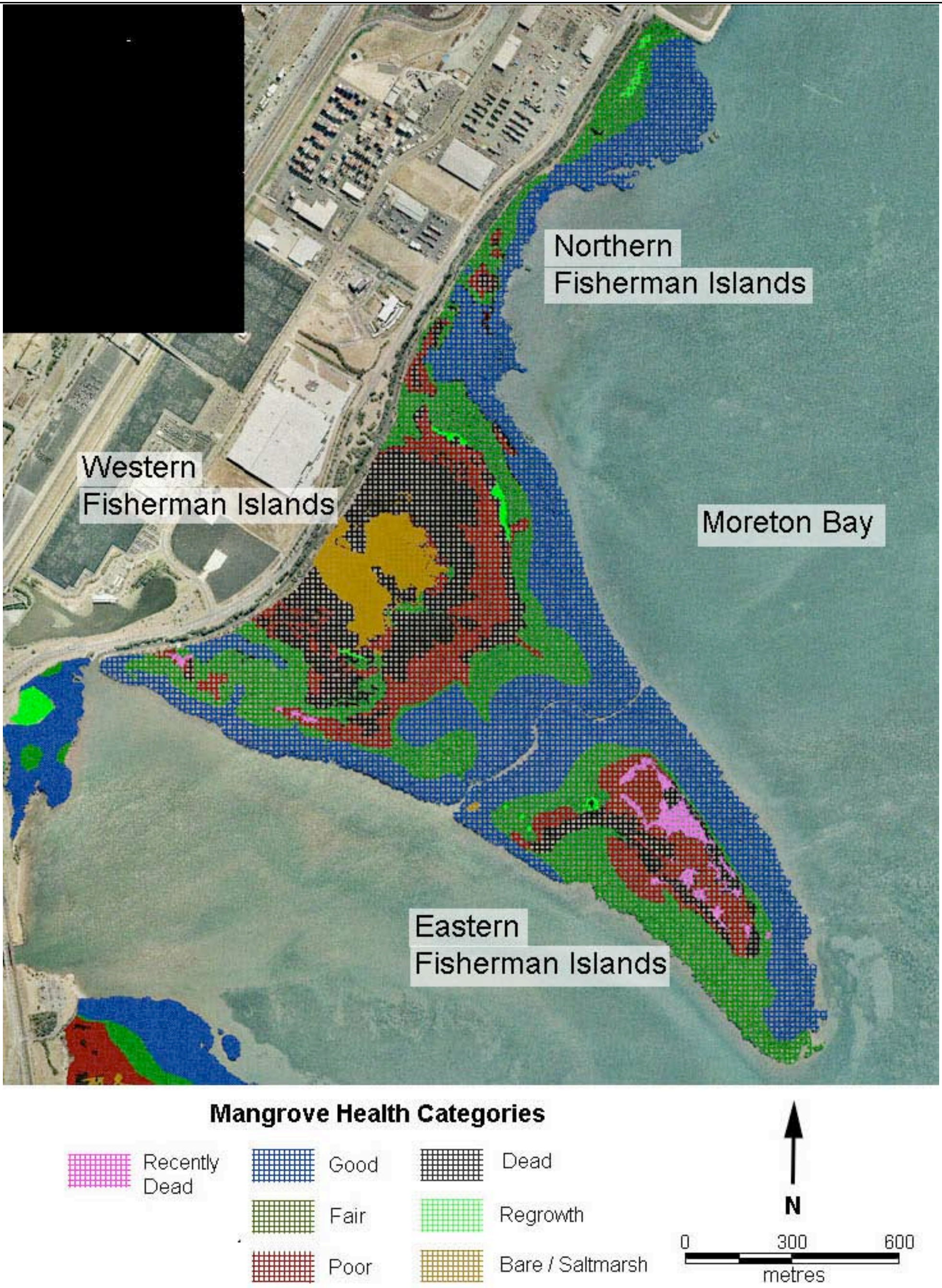
Figure 3.6 Mangrove health Fisherman Islands, 2010.

June 2010



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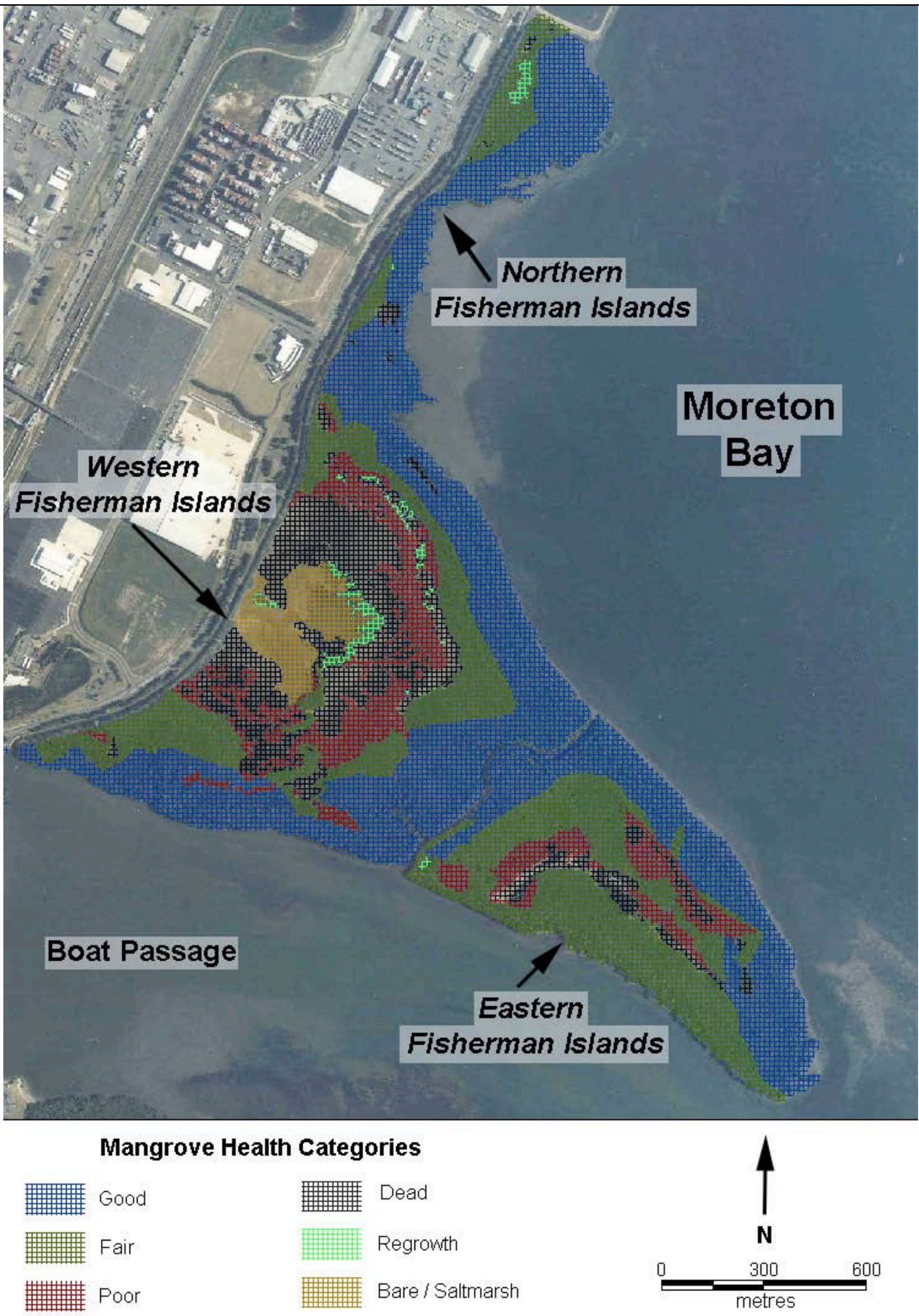
Mangrove Health Assessment 2010

Figure 3.7 Mangrove health Fisherman Islands, 2008.

June 2010



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 3.8 Mangrove health Fisherman Islands, 2006.	
		June 2010

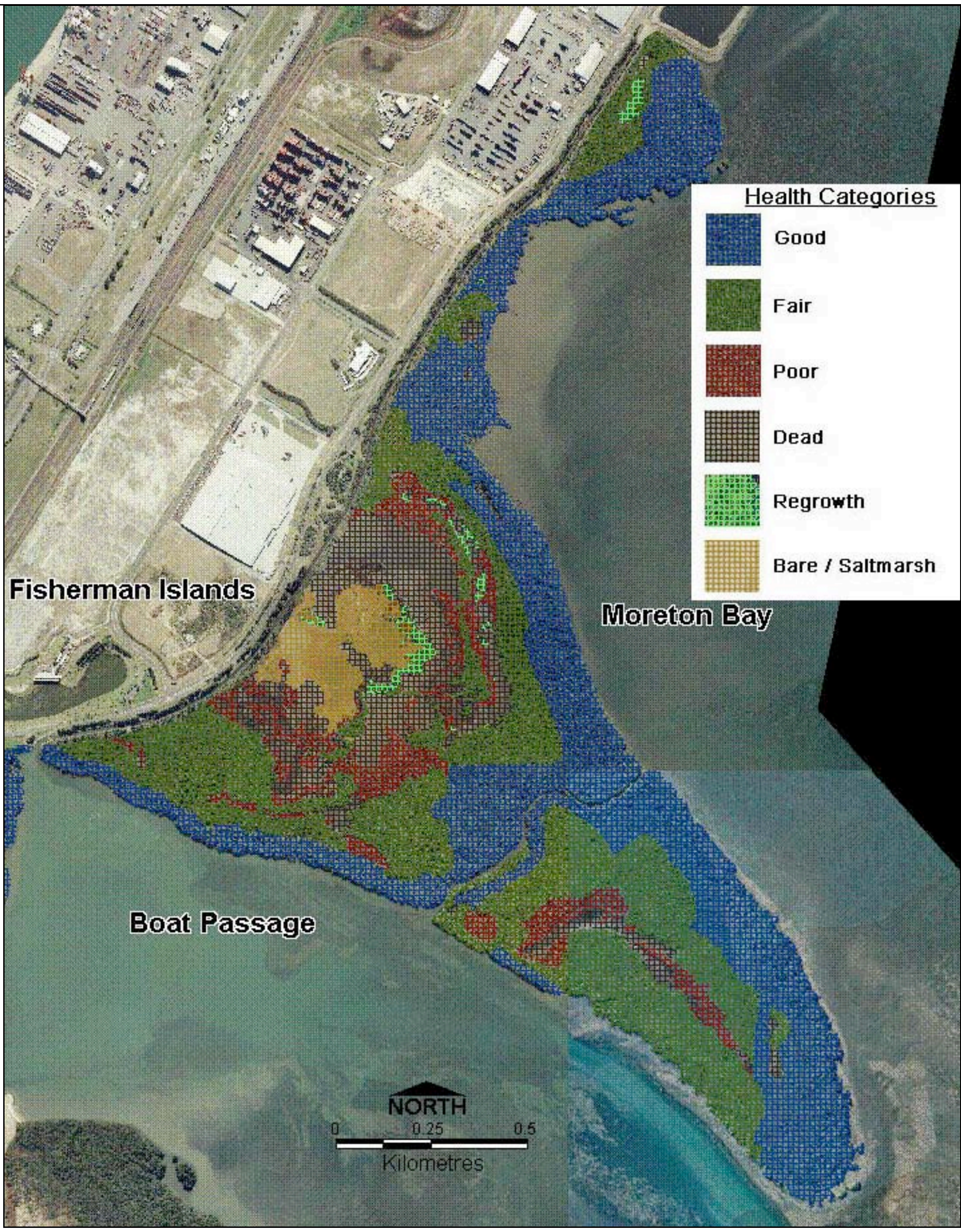


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Figure 3.9 Mangrove health Fisherman Islands, 2004.

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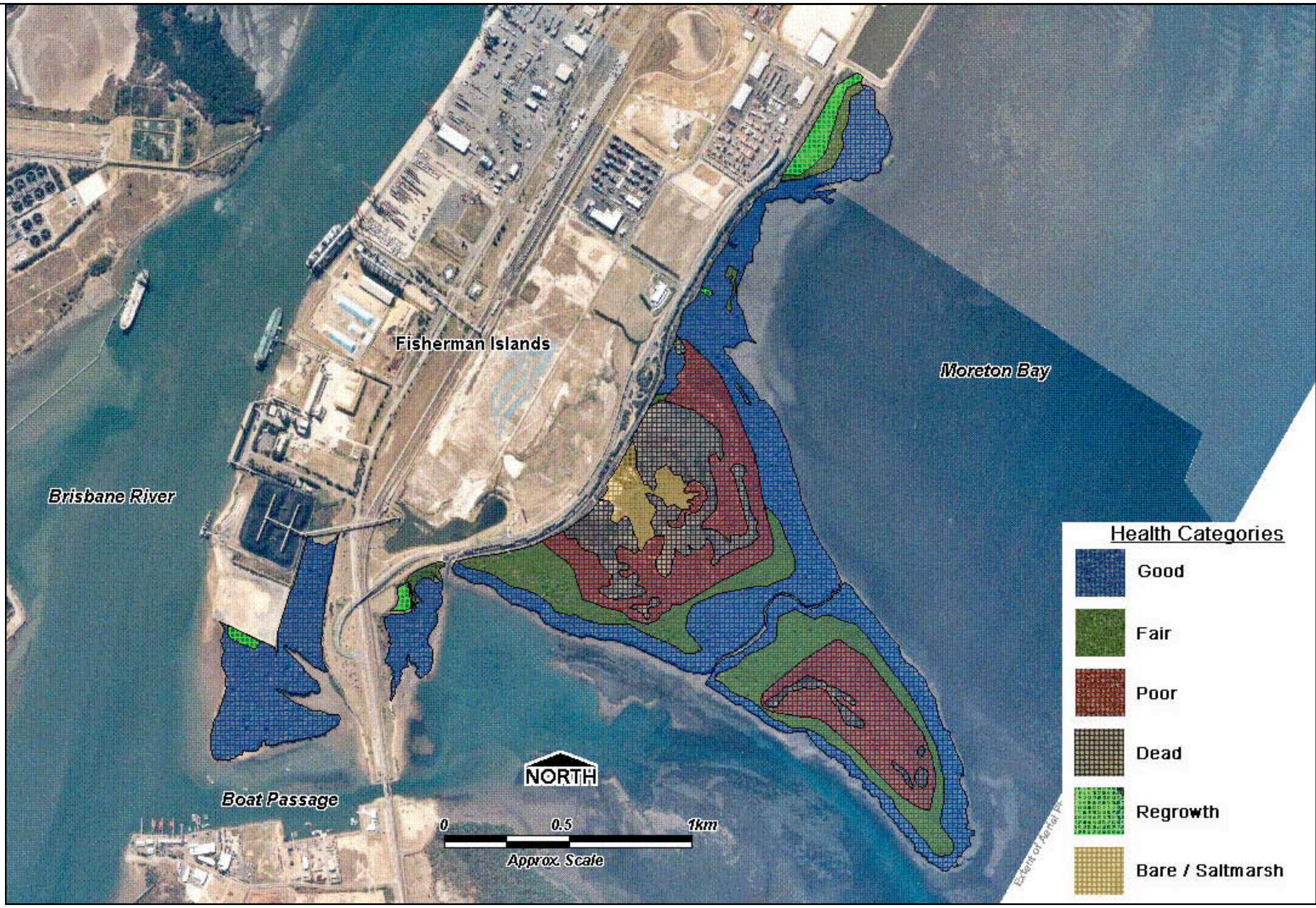

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Figure 3.10 Mangrove health at Fisherman Islands, including the Coal Loader area in 2002 (WBM Oceanics Australia 2002).

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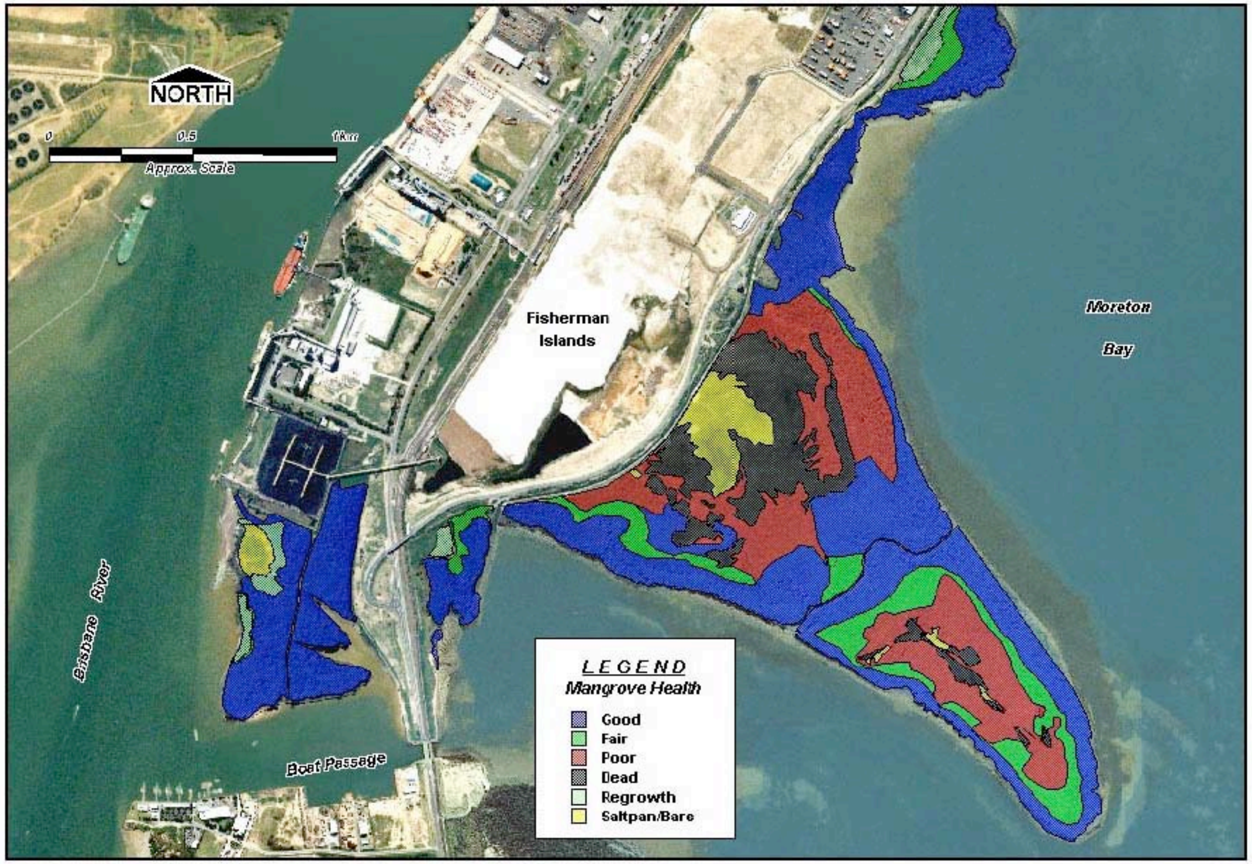

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Figure 3.11 Mangrove health at Fisherman Islands , including the Coal Loader area in 1999 (WBM Oceanics Australia 2000).

June 2010

Western Area

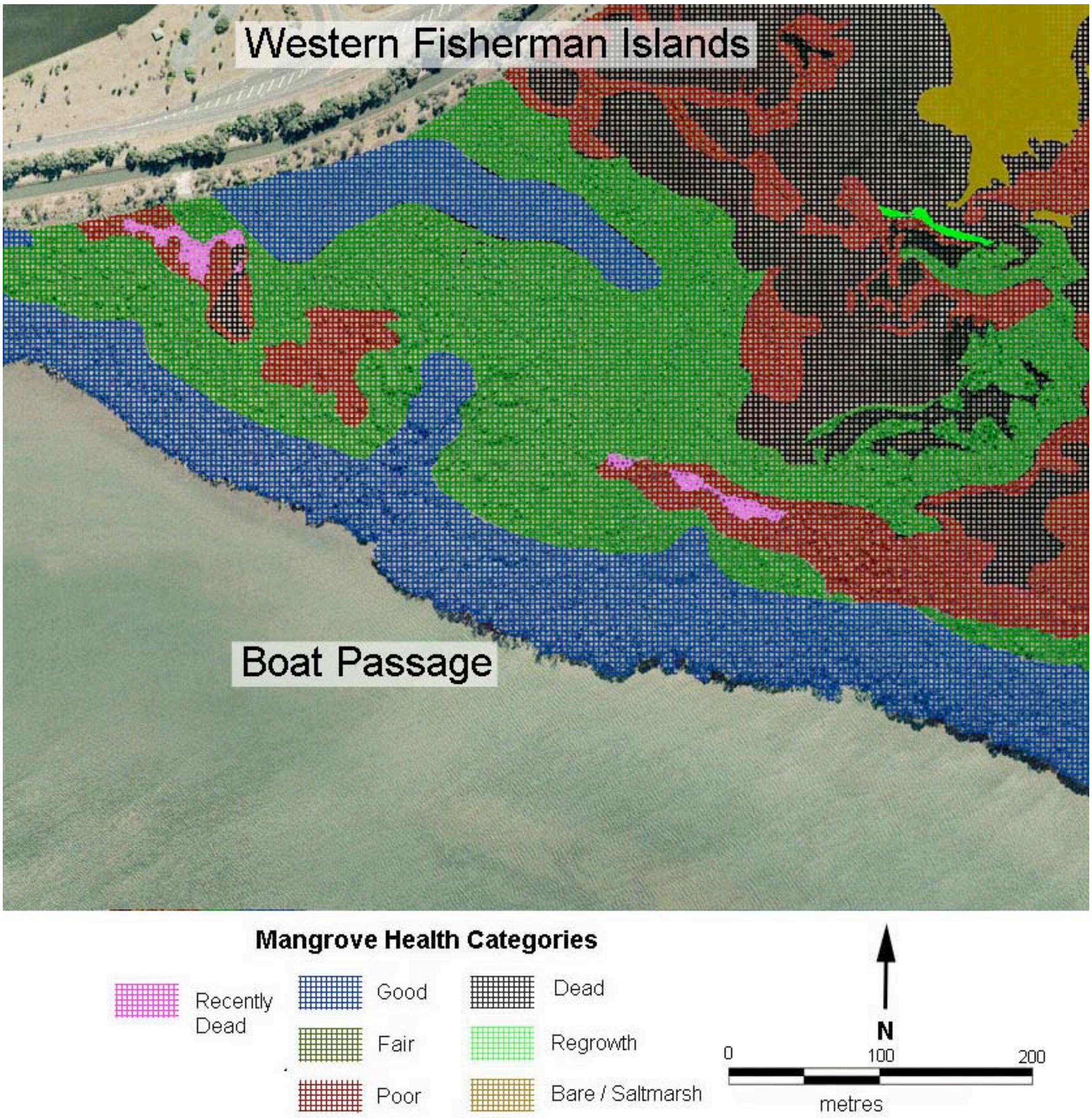
At western Fisherman Islands, there are mangroves in good health along the well-flushed seaward edges and cross channel that divided the western and eastern areas. Inside this outer band of healthy mangroves, there are bands of mangroves in fair and poor health, with dead mangroves and bare saltpan / saltmarsh areas centrally.

The main change between 1999 and 2002 was a decline in health of a relatively large area of mangroves west of the cross channel from good, to fair or poor (Figure 3.10, Figure 3.11). Between 2002 and 2004, there was little change in the area of mangroves in good health, or in the area of dead mangroves (Figure 3.9, Figure 3.10). However, some areas classed as poor in 2002 improved in health to fair.

Between 2004 and 2006 there was an increase in the area of mangroves in good health, particularly near the cross channel and along the southern foreshore (Figure 3.7, Figure 3.8). In 2006 trees here had fewer yellowing leaves, and less damage by insects than in 2004. However, there was a reduction in mangrove health from fair to poor around the dieback area; predominantly *A. marina* trees. These trees had a higher proportion of yellowing / dead leaves and more epicormic growth in 2006 than in 2004, and there were some dead trees (Figure 3.8).

In 2008, the area of mangroves in good health was smaller; in particular large tracts of mangroves in the south had declined from good health in 2006 to fair health in 2008 (Figure 3.7). Changes included a decrease in canopy cover and higher proportion of yellowing leaves. Between 2006 and 2008, the area of mangroves in poor health also increased in this area, with mangrove death in the centre of some of these patches (Figure 3.11). There were no recently dead mangroves in this area in 2010; instead there was a small, central dead area surrounded by mangroves in poor health (Figure 3.13).

In 2008, many of the previous regrowth areas had not survived or were in poor or fair health. Most regrowth in 2008 was confined to the north; there was less regrowth in the central area than in 2006. There were new areas of regrowth along the margin of the dieback area in 2010, and previously recorded (2008) regrowth was now classified as mature forest in poor health.



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 3.12 Mangrove health at south western Fisherman Islands in 2008.
	June 2010

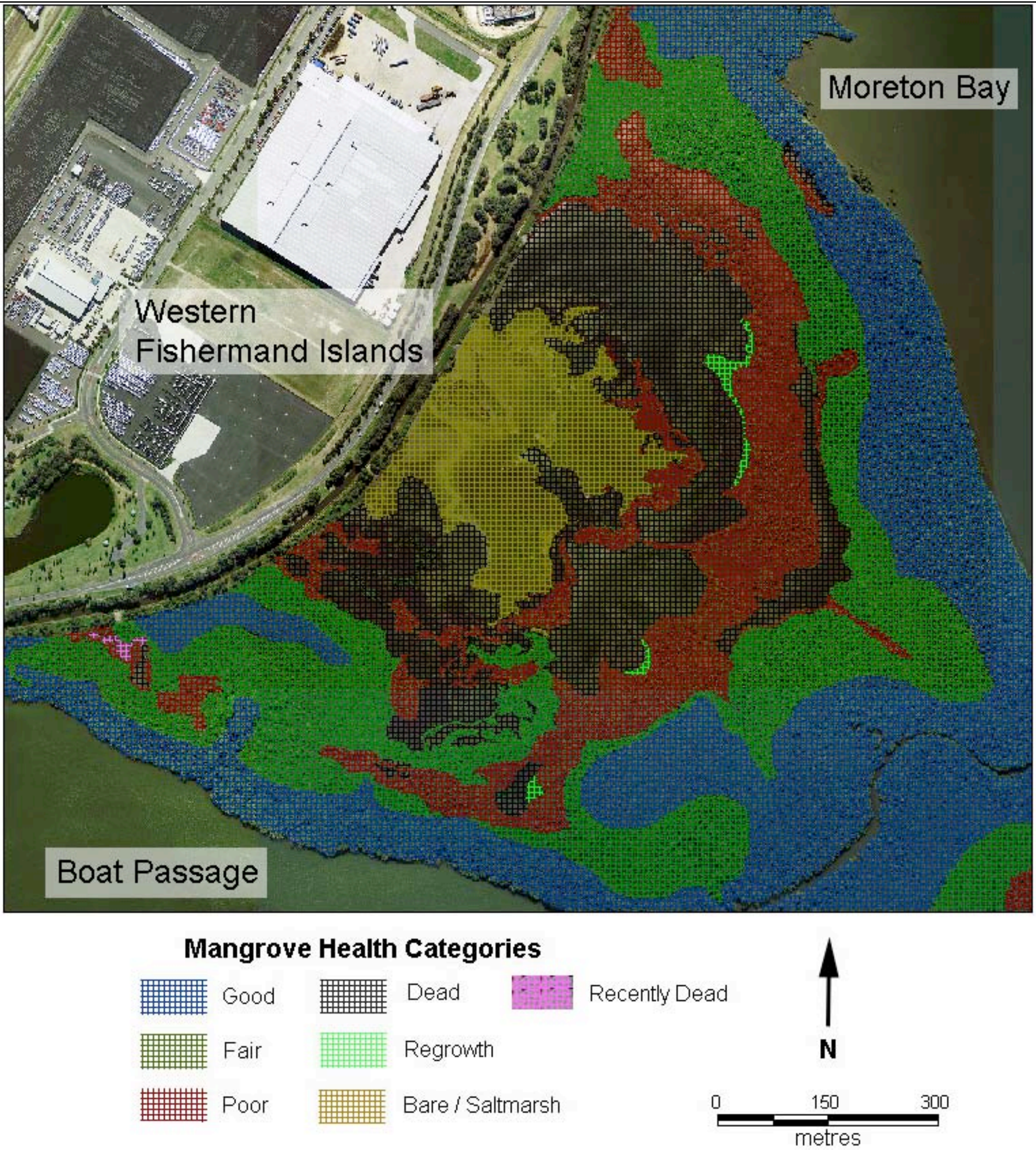


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	Figure 3.13 Mangrove health at western Fisherman Islands in 2010.	
		June 2010

In 2010, there was a decrease in the total area of dead / recently dead mangroves and an increase in the adjacent bare / saltmarsh area. Trees that were dead in 2008 continued to breakdown (i.e. trunks decomposing and falling to the sediment) and there had been extensive recent colonisation by saltmarsh (Figure 3.4). Dense mangrove seedlings were common in the areas where saltmarsh was colonising (Figure 3.14).

Figure 3.14

Seedlings growing on saltmarsh at Western Fisherman Islands.

In other areas, particularly along the seaward margin and to the south of the western dieback area, areas that were recently dead in 2008 had regrown (i.e. there has been extensive epicormic shooting) and were in similar condition to the adjacent forest in poor health (Figure 3.15). These areas often have a small, central dead area.

Figure 3.15

Epicormic growth of *Avicennia marina* (regrowth) along the margin of dead mangroves and forest in poor health at Western Fisherman Islands.

The western dieback area is periodically inundated, with subsequent ponding of water. Dense algal mats often grew in the ponded areas in 2010 (Figure 3.16), as was the case during recent surveys. This was also evident at the eastern Fisherman Islands and Whyte Island dieback areas. Pneumatophores along dieback margins were often slightly elongated, and some were deformed (bifurcating and bent) (e.g. Figure 3.17).

Figure 3.16

Algal mats at the dieback area.

Figure 3.17

Bifurcated pneumatophores adjacent to the eastern Fisherman Islands dieback area (2008).

During the survey, there were several wader birds foraging on benthic invertebrates across the ponded area, particularly on bare sediment (Figure 3.18). Wader bird footprints were also common on these ponded / dieback areas.

Figure 3.18

Ponding areas are often frequented by wader birds (centre of photo).

As in previous years, large pieces of debris had accumulated along the landward edge of the dieback area in 2010 (Figure 3.19). This indicates that there is strong water movement through the area at times.

Figure 3.19

Debris, western Fisherman Islands.

Eastern Area

In 1999 and 2002, the mangroves around the foreshore of eastern Fisherman Islands were in good health. Inside these mangroves, there were concentric rings of mangroves in fair and poor health, with a strip of dead mangroves centrally (Figure 3.10, Figure 3.11).

In 2004, mangroves along the southern foreshore had declined in health, as they were undermined by shore erosion. In some areas, the outer zone of *A. marina* trees were completely eroded away, exposing a zone of *C. tagal* growing on higher ground. In 2004, the health of most of the mangroves in the central area had improved from poor to fair, with only those mangroves close to the dead areas in poor health (Figure 3.9).

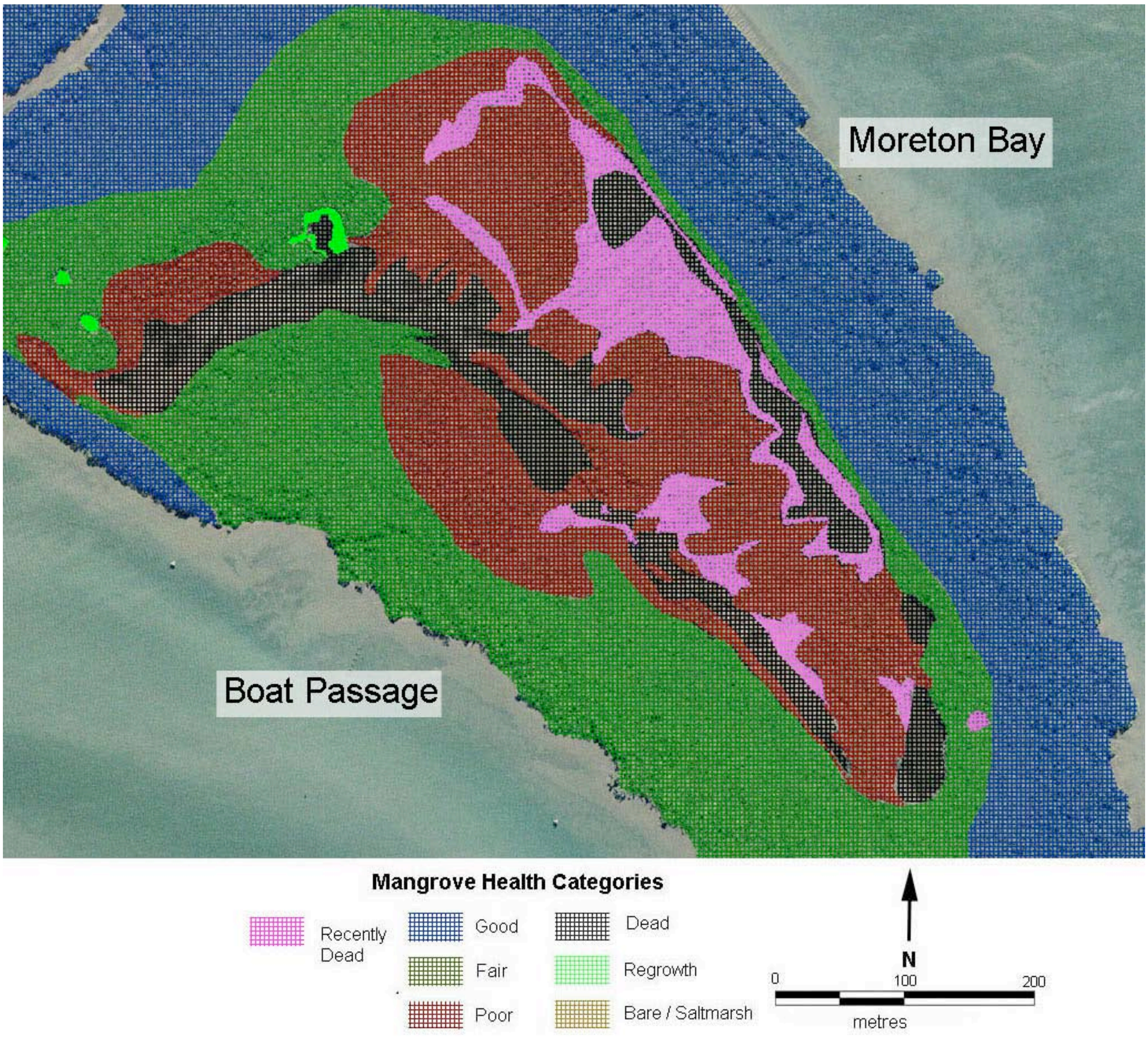
In 2006, there was a new area of dieback on the eastern end of Fisherman Islands, surrounded by an area in poor health.

In 2008, the greatest area of new dieback was at eastern Fisherman Islands (Figure 3.7), with the area of dieback increasing substantially from 2006 to 2008. In 2008, there were recently dead (i.e. brown and curled) leaves on the trees along the margin of the eastern dieback area. New growth, including seedlings, epicormic growth and leaves at the tips of branches, were most susceptible to die-off (leaf curl and browning).

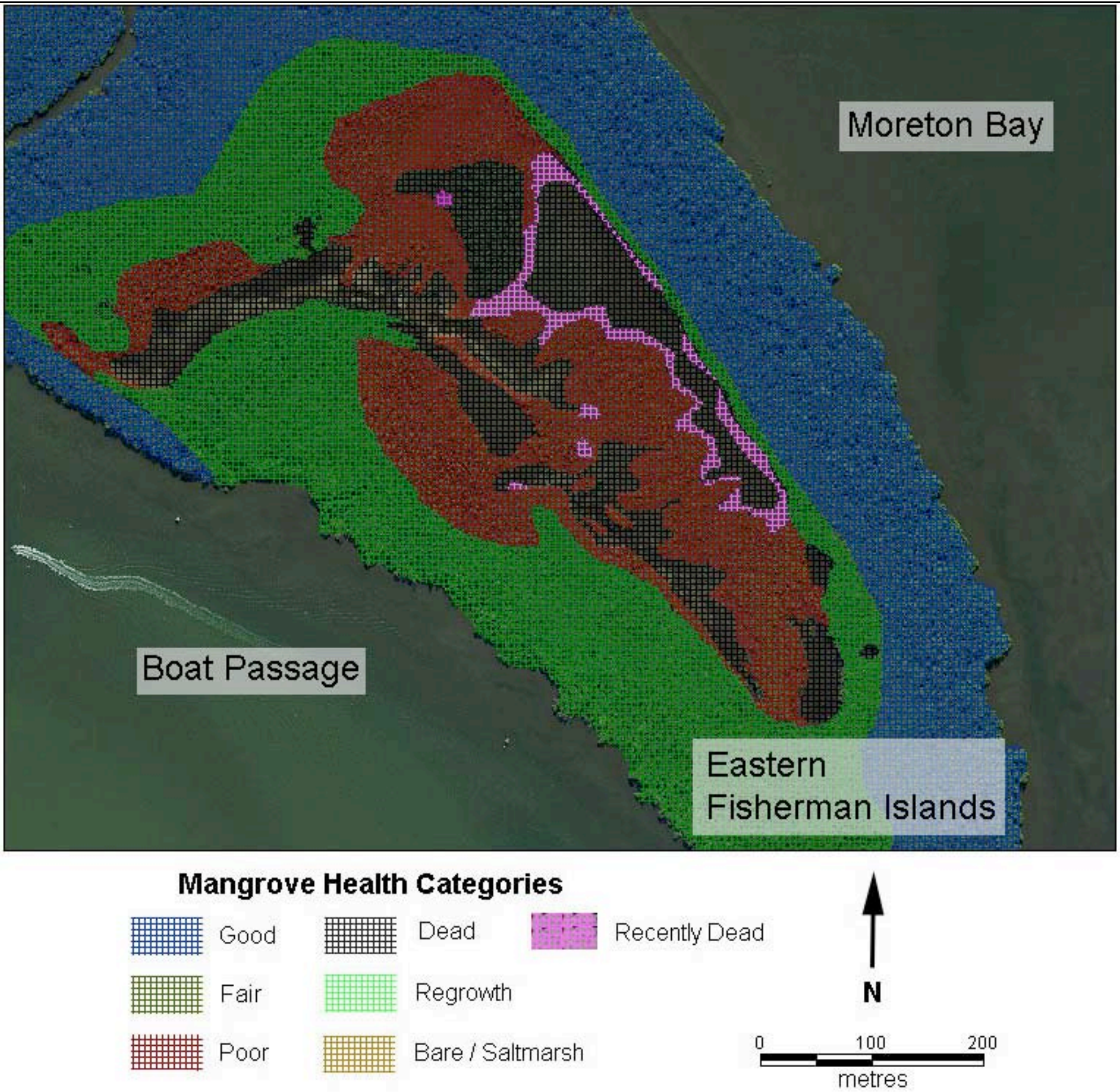
Figure 3.20

The large area of recently dead mangroves at eastern Fisherman Islands (2008).

In 2010, the area of recently dead mangroves was smaller (Figure 3.23), however the area of dead mangroves was substantially larger. The total area of regrowth was smaller as much of the 2008 regrowth was now similar to the surrounding forest of fair health. The surrounding areas of fair and good health were generally similar in 2010 and 2008.



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 3.21 Mangrove health at eastern Fisherman Islands in 2008.
	June 2010



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 3.22 Mangrove health at eastern Fisherman Islands in 2010.	
		June 2010

Figure 3.23

Thin strip of recently dead mangroves between dead mangroves and forest in poor health, eastern Fishermans Islands.

There was less seagrass wrack in 2010 than in previous years. In 2008, there were small accumulations of seagrass wrack on the substrate to the north east of the dieback area, although accumulation was less than in 2006 (Figure 3.24). During 2006, seagrass wrack littered the lower branches of the mangroves on the north eastern and eastern shoreline and formed berms up to 0.5 m high to the south west of the dieback (Figure 3.25). These berms of seagrass wrack were consolidated and likely to have severely impeded tidal drainage.

Figure 3.24

Small accumulations of seagrass to the north east of the new dieback area (2008).

Figure 3.25

Large banks of *Zostera muelleri*[2] wrack on the southern shore of the Fisherman Islands peninsula (2006).

Northern Foreshore

In 1999 and 2002, most of the mangroves at northern Fisherman Islands were in good health, with an area of fair health and regrowth parallel to the shore in the extreme north (Figure 3.10, Figure 3.11). By 2004, one of the regrowth areas to the north of Sandpiper Drive had died and an area of fair health had developed inshore. In 2006, the dead area was of a similar size and the dead trees (visible in the 2004 aerial photographs) had fallen over, leaving a clear ponded area (Figure 3.27). In 2008, this dead patch was similar in size to 2006, but the health of the surrounding forest, particularly to the west, had declined substantially and was in poor health (Figure 3.28).

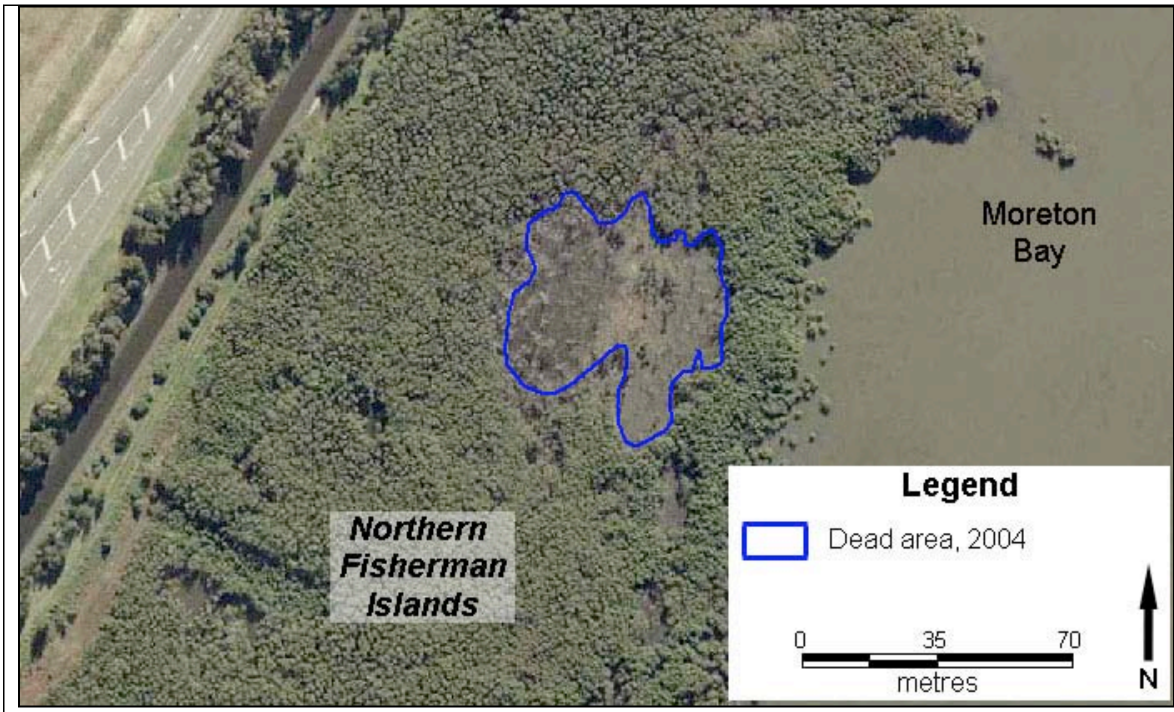
Sediments in the northern foreshore area are particularly soft, and provide little support for the mangrove trees. The pneumatophores and roots of the mangroves on the seaward edge of the forest form a tight clump around the base of the tree, rather than spreading out. Firmer banks of pneumatophores are colonised by seedlings separated by deep holes of mud (Figure 3.26). The combination of soft sediments and smaller root bases may make these trees less stable and more susceptible to wind damage, particularly those near the outer edge. It is possible that trees falling over in strong winds formed this dead patch. Once a patch is formed, the trees around the edge may become more susceptible to wind damage. Fine sediments in the area are also likely to move easily, which may have also contributed to the dieback.

[2] Until recently, and in previous reports, this species was known as *Zostera capricorni*.

Figure 3.26

Seedlings growing in soft sediments at northern Fisherman Islands.

In 2010, northern Fishermans Island mangrove communities were largely similar to those in 2008. The dieback area was smaller than during previous years, with seedlings and saplings growing in from the forest margin (Figure 3.27, Figure 3.28). In addition, the health of some areas had improved, with areas of forest in poor health in 2008 improving to fair health in 2010. However, the small northern-most regrowth area recorded in 2008 was largely dead in 2010.



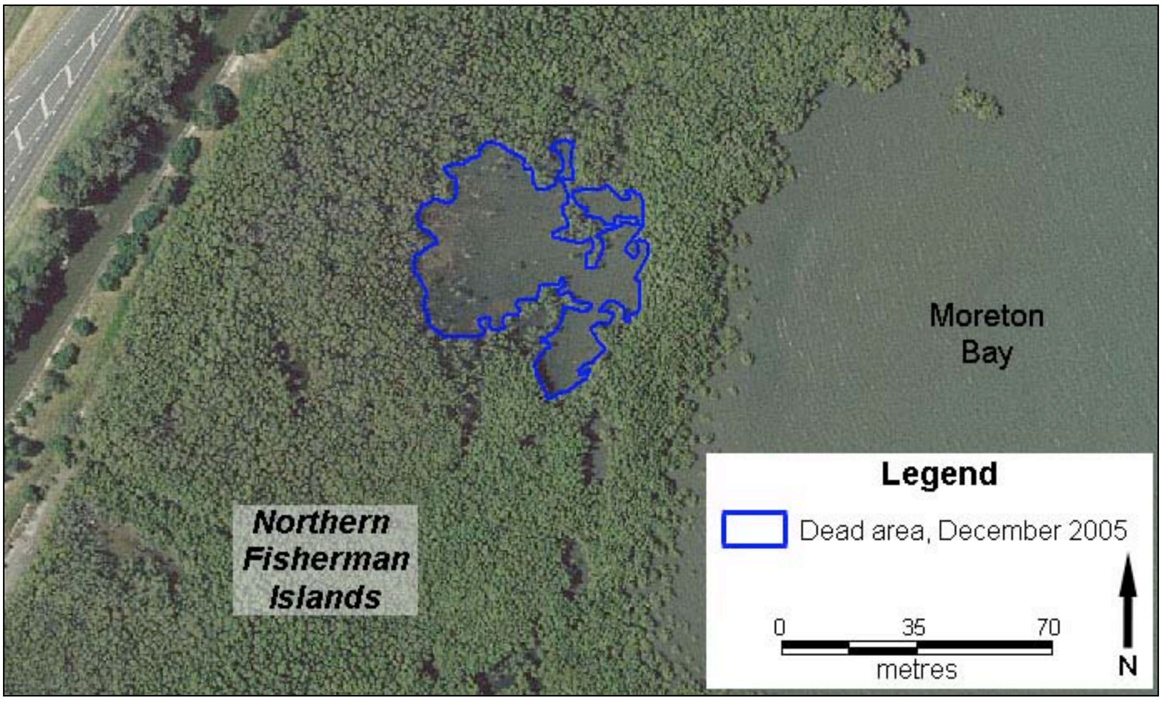


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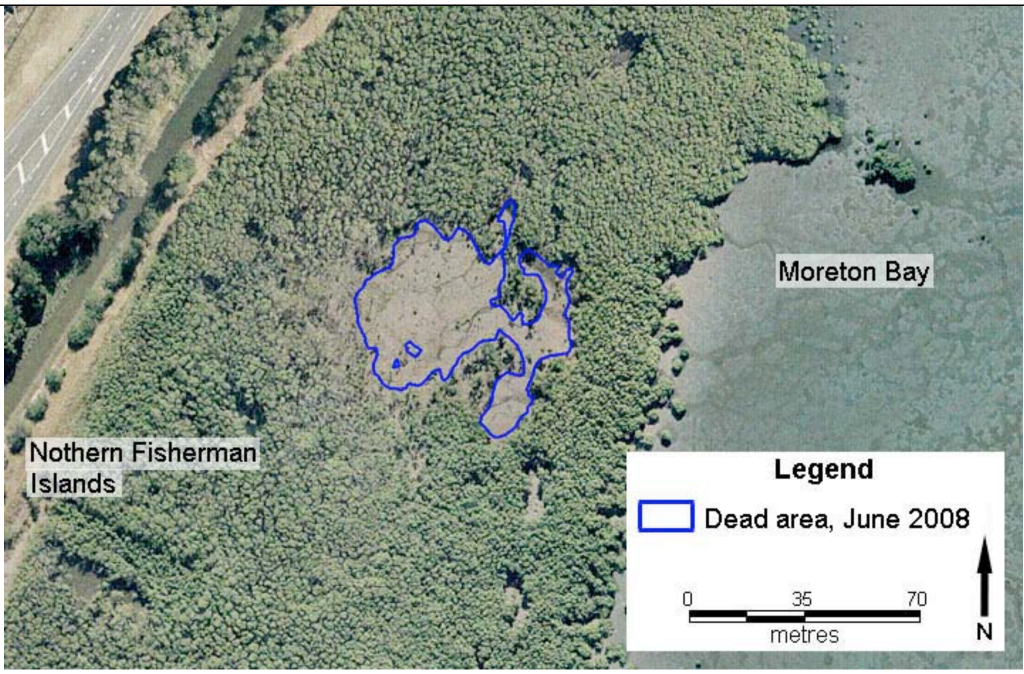
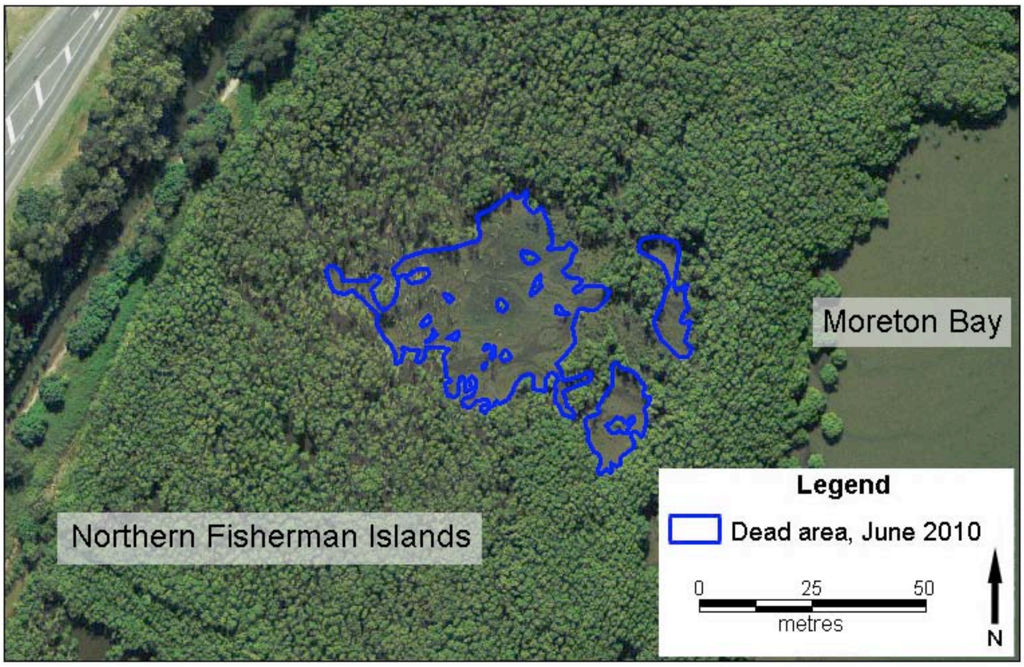
	Figure 3.27 Dead patch at northern Fisherman Islands in 2004 and 2006.
	June 2010





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Fisherman Islands and Whyte Island

Mangrove Health Assessment 2010

Figure 3.28 Dead patch at northern Fisherman Islands in 2008 and 2010.

June 2010

3.3 Sub-lethal Indicators of Mangrove Health

Epiphytic Macroalgae

Algae covering the roots and pneumatophores of mangroves were common on the seaward mangrove communities. In these areas, the pneumatophores of *A. marina* were covered by the red algae *B. moritiziana* and *C. nipae*. The abundance of epiphytic algae was consistently highest in the healthiest areas of mangroves, particularly on the seaward edges of the forests. Mangrove pneumatophores along landward margins and adjacent to dieback areas usually lacked epiphytic algae.

Macroalgal Mats

Algal mats were common in the dieback areas, especially where water was ponded. As in 2008, 2006 and 2004, mats comprised cyanobacteria such as *Lyngbya* sp. (not *Lyngbya majuscula*) and *M. chthonoplastes* Gomont; and green filamentous algae such as *E. intestinalis* (frc environmental 2004).

Insect Damage

Damage by insects was common throughout the mangrove communities at Fisherman Islands. It was most common on new growth in areas of fair or poor health, with leaves on tree tops and epicormic growth particularly susceptible.

Mangrove Seedlings

Patterns in seedling density at Fisherman Islands were generally similar to those recorded in 2008, 2006 and 2004. Seedling densities were sparse in low closed forests and bordering dieback areas. Seedlings were denser in areas of open forest, with seedling density increasing from landward to seaward areas of these forests. However in 2010 seedlings were often dense in association with saltmarsh in the dieback areas (Figure 3.14).

Macrofauna

In general, macrofauna abundance, as indicated by crab hole abundance, was higher in the more seaward mangroves of Fisherman Islands. No fauna was recorded on the substrate in ponded areas, except for the occasional marine snail. Similarly, few crab burrows or fauna were found in areas where a thick algal mat covered the substrate. However infaunal invertebrate communities appear to be abundant based on wader bird foraging in these areas.

4 The Coal Loader Area of Fishermans Islands

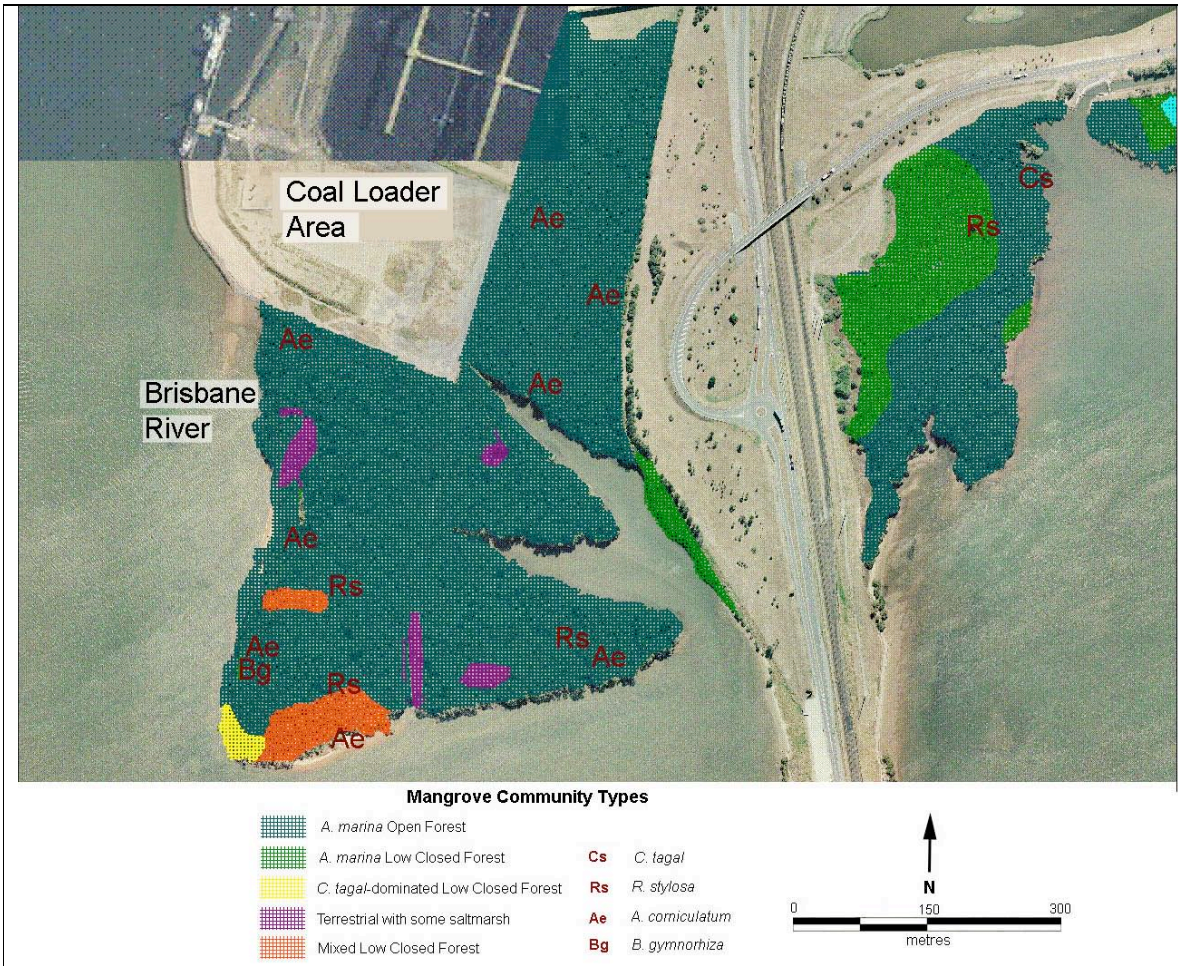
4.1 Community Structure

The Coal Loader area includes the mangrove forests to the west and east of Port Drive.

The Coal Loader area to the west of Port Drive was dominated by an open forest of *Avicennia marina*, with small areas of regrowth, mixed low closed mangrove forest, *Ceriops*-dominated low closed forest, and saltmarsh / terrestrial communities. All of the mangrove species recorded in the eastern area of Fisherman Islands were also recorded in the Coal Loader area; *Bruguiera gymnorrhiza* was also recorded in this area. The area of regrowth recorded along the landward boundary is now mature forest of fair health. (Figure 4.1).

The mixed low closed mangrove forest was composed of *A. marina, Ceriops tagal, Rhizophora stylosa* and *B. gymnorrhiza* in varying compositions. The terrestrial communities were composed of predominantly coastal species including: *Casuarina glauca* (swamp oak); *Carpobrotus glaucescens* (pigface); *Hibiscus tiliaceus* (coastal hibiscus); and *Ipomoea pes-caprae*. Saltmarsh species included *Suaeda australis*, *Suaeda arbusculoides*, *Sarcocornia quinqueflora*, *Enchylaena tomentosa* and *Sesuvium portulacastrum*. These coastal and saltmarsh species predominantly grew on raised sand ridges in this area, with the saltmarsh on the lower, more frequently inundated areas (Figure 4.2). On these ridges, there were also a number of introduced species such as *Schinus terebinthifolius* (broad-leaf pepper tree) and *Ipomoea cairica* (mile-a-minute). The green algae (exotic) *Caulerpa taxifolia,* red algae *Gracilaria* spp. and seagrass *Zostera muelleri* grew in the drain bisecting the southern section. Aquatic plants such as these had not previously been recorded from the drain.

In the Coal Loader area to the east of Port Drive, the mangroves were also dominated by *A. marina* forest. The area of regrowth recorded along the landward boundary during previous surveys is now mature forest of fair health.



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Fisherman Islands and Whyte Island

Mangrove Health Assessment 2008

Figure 4.1 Mangrove community structure and species composition within the Coal Loader area.

June 2010

Figure 4.2

Mangrove forest adjacent to drain, Coal Loader area. Note bank with coastal / terrestrial community to right of drain.

4.2 Mangrove Health

Mangrove health at the Coal Loader area has remained largely unchanged since 2004 (Figure 4.3 – Figure 4.7). Most of the mangrove forest was in good health. The total area of regrowth is smaller in 2010 because the mangroves in the two large regrowth areas (along the landward margin to the east and west of Port Drive) have matured, and are now classified as a mature forest in poor health.

Erosion and deposition of sediment in the south west (primarily adjacent to the Brisbane River) reduced health scores in 2008 and 2010 (Figure 4.8, Figure 4.9). There were also a few small areas of dead mangroves, which appear to be the result of mature trees falling over; seedlings and saplings now cover much of this open forest floor (Figure 4.10). Saltmarsh communities now dominate some areas of dieback (Figure 4.11). An area of poor health had developed in the south east section in 2008, however this area was smaller in 2010 than in 2008.

In 2010, there was a small area of ponding water along the landward margin of the Coal Loader area to the east of Port Drive (Figure 4.12). There appeared to be a small hydrocarbon slick in the same area (Figure 4.13).

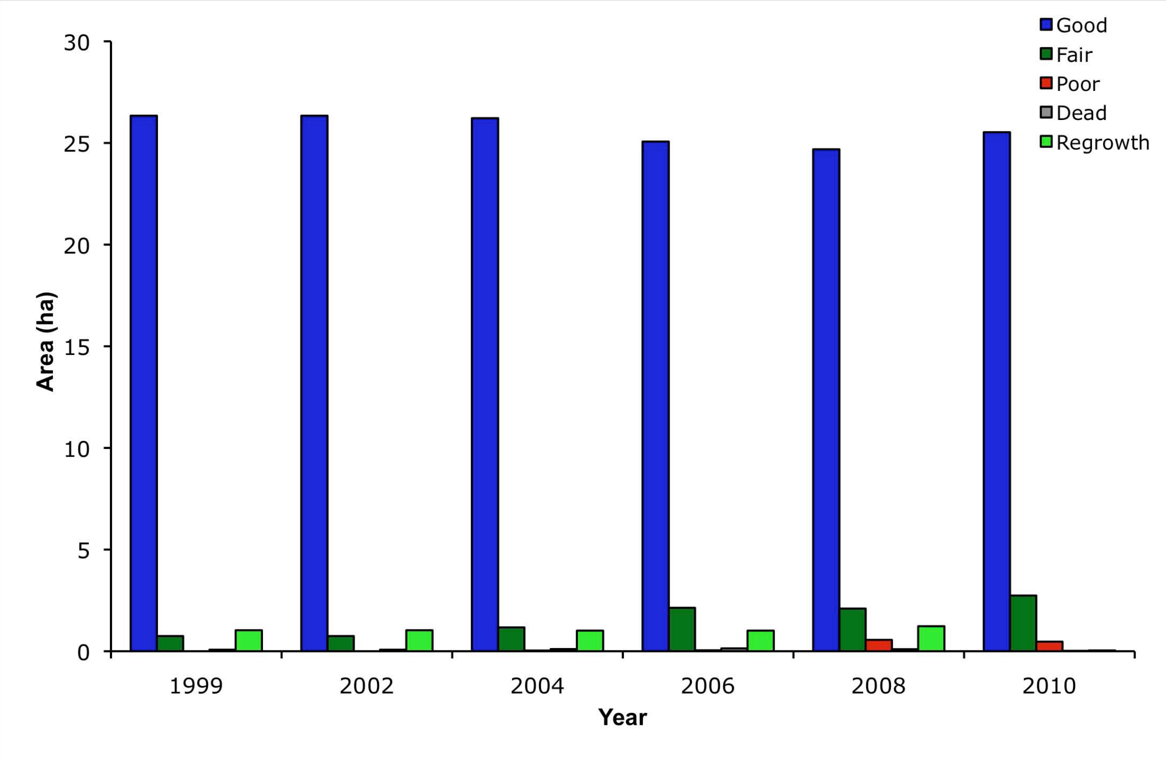

Figure 4.3 Area of mangroves in each health category in the Coal Loader area from 1999 to 2010[3]

[3] Mapping files not available for 1999, so 1999 values based on the values for the Coal Loader Area from 2002 (as mapping of the Coal Loader Area did not significantly change between 1999 and 2002).

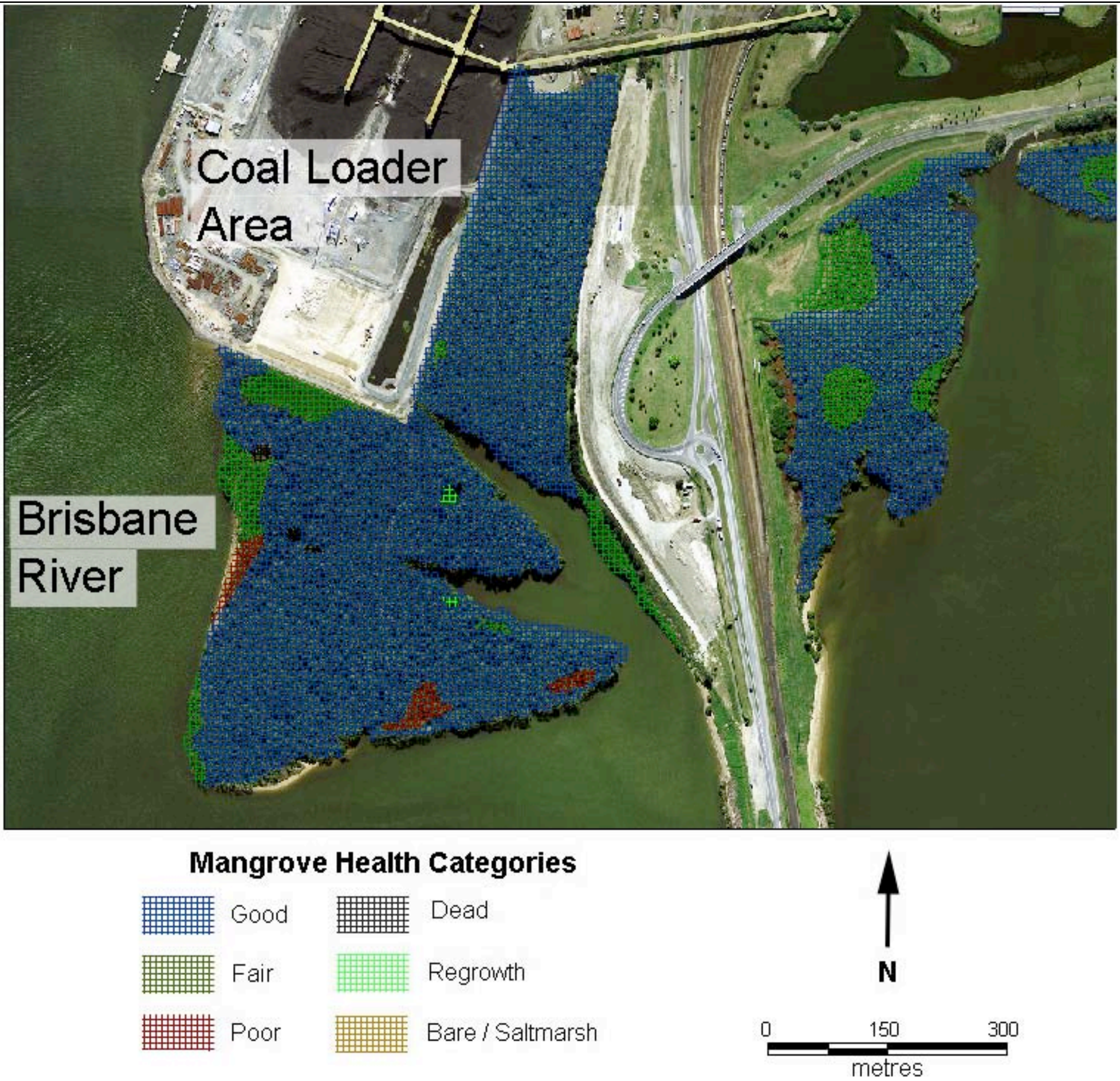

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	Figure 4.4 Mangrove health in the Coal Loader area of Fisherman Islands in 2010.	
		June 2010

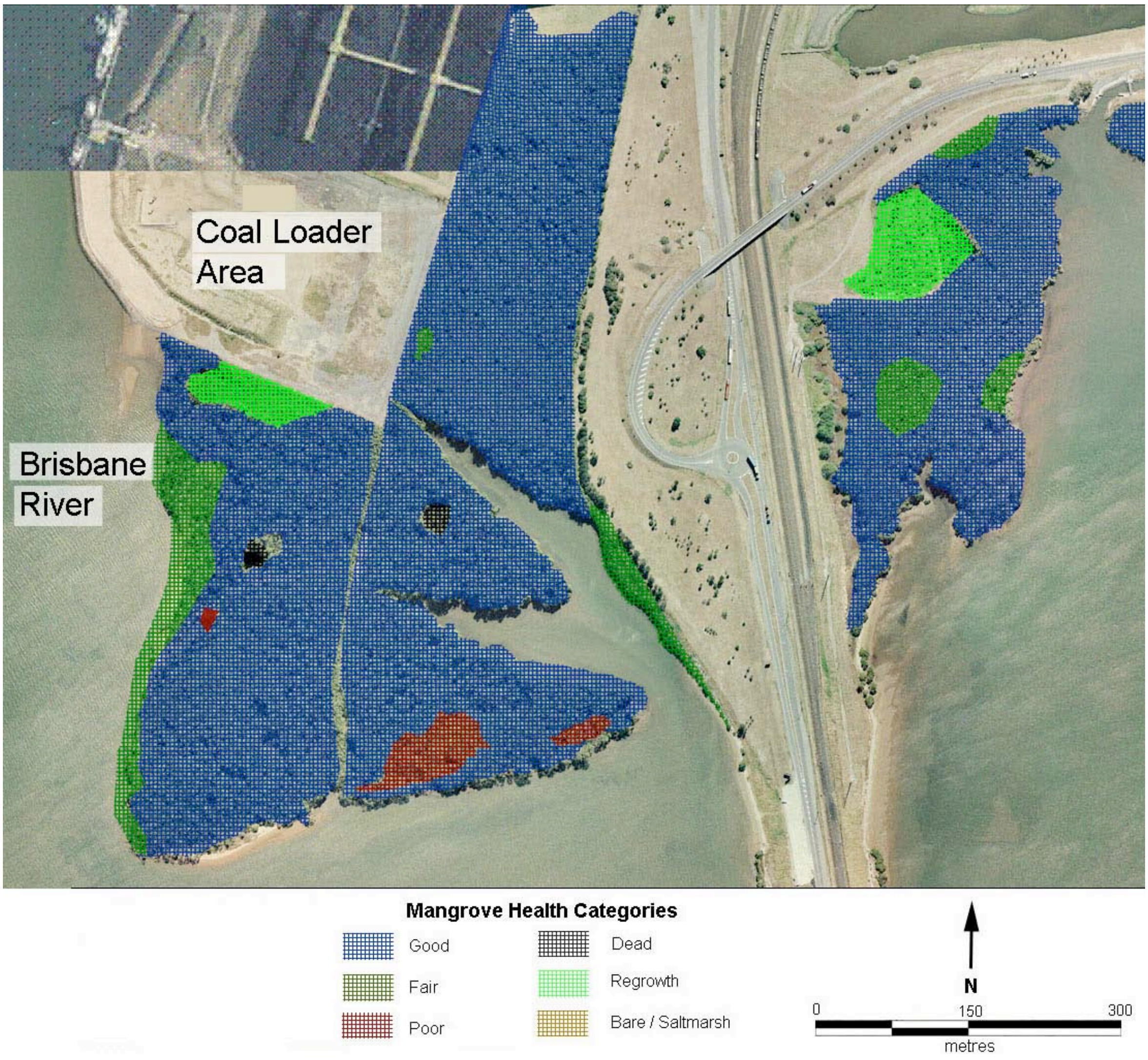

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	Figure 4.5 Mangrove health in the Coal Loader area of Fisherman Islands in 2008.
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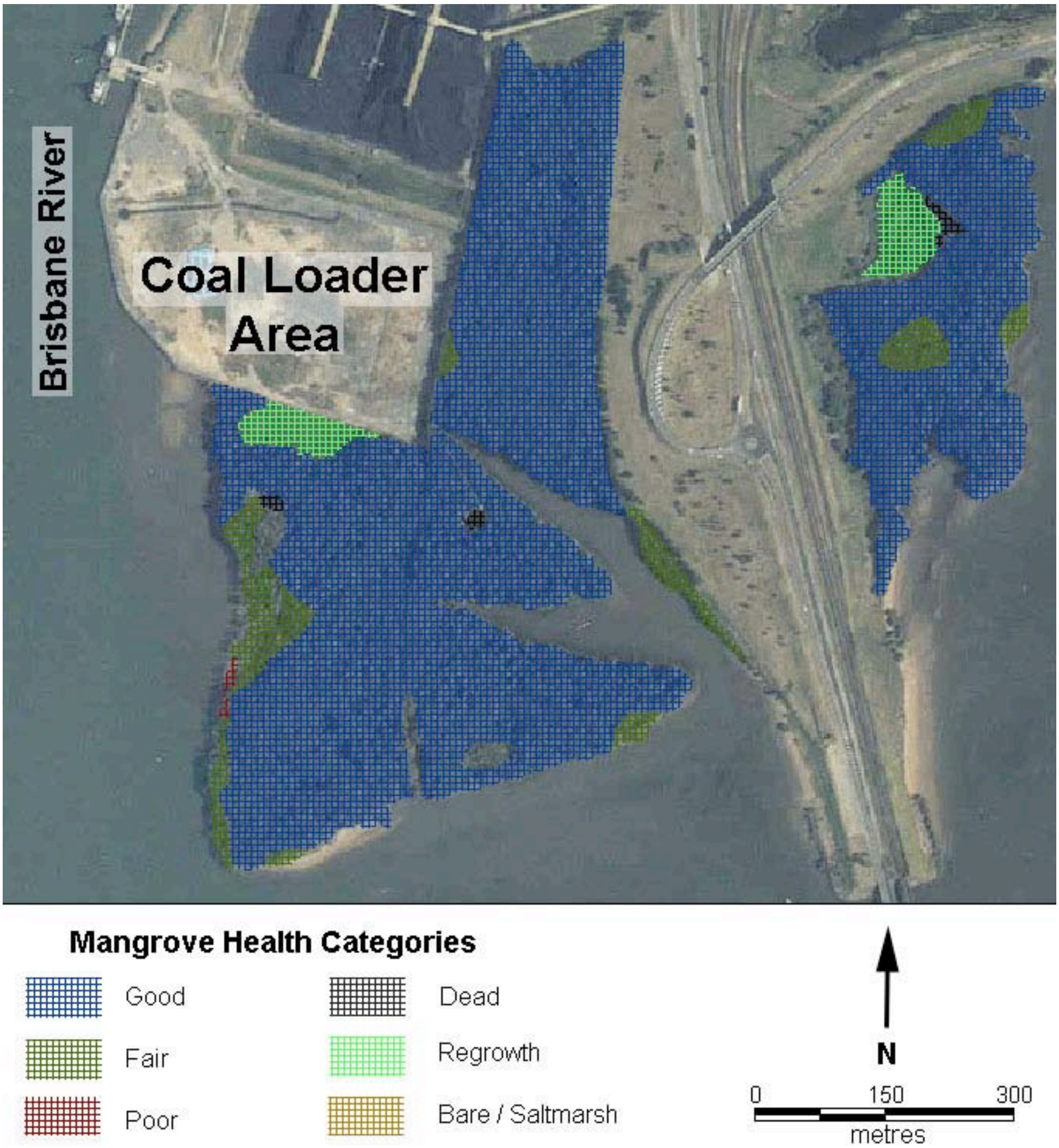

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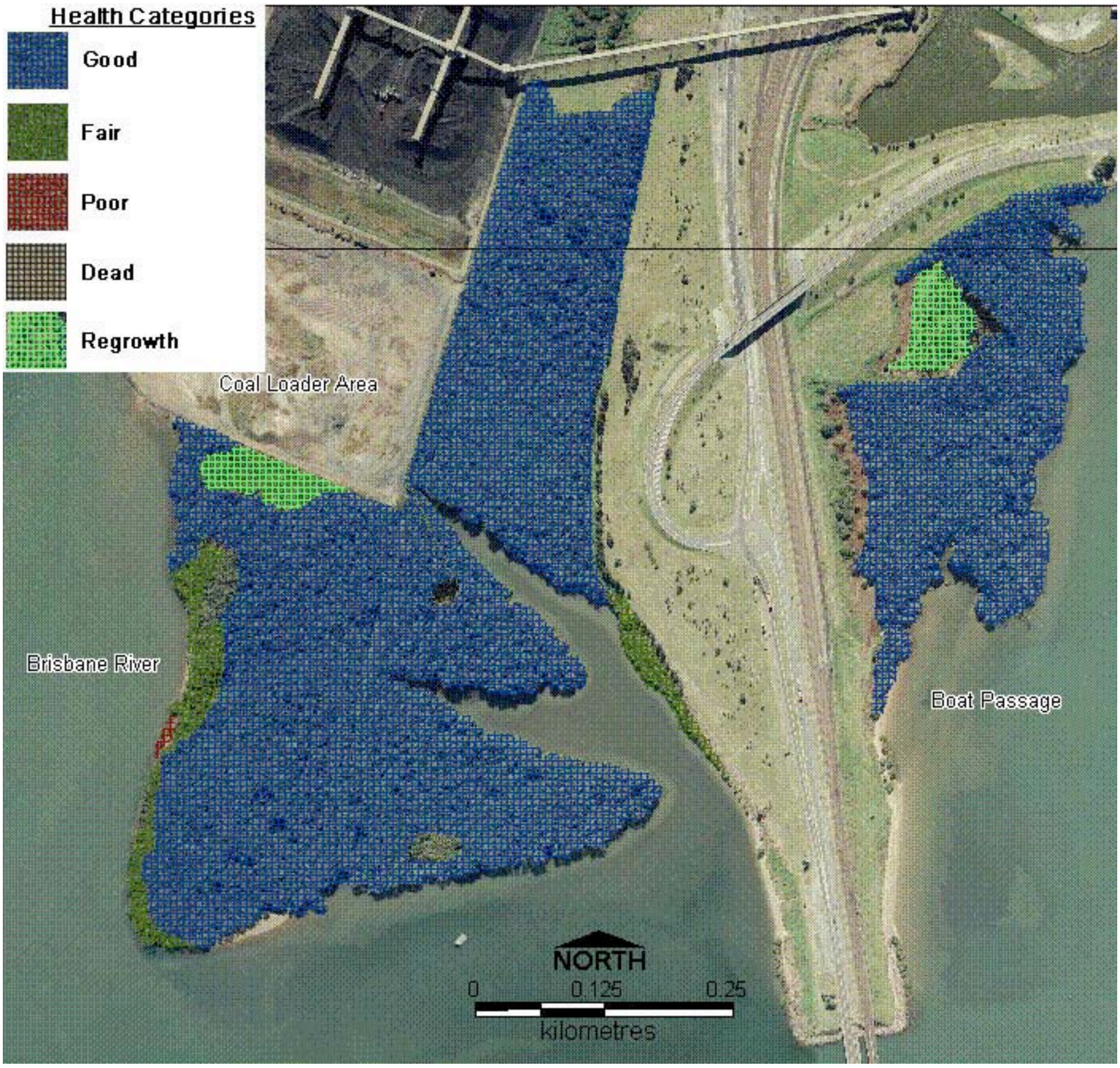
Fisherman Islands and Whyte Island

Mangrove Health Assessment 2010

Figure 4.6 Mangrove health in the Coal Loader area of Fisherman Islands in 2006.

June 2010



frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
	Figure 4.7 Mangrove health in the Coal Loader area of Fisherman Islands in 2004.	
		June 2010

Figure 4.8

Sand deposition across mangroves in the Coal Loader area east of Port Drive.

Figure 4.9

Erosion along south eastern foreshore, Coal Loader area.

Figure 4.10

Seedlings and saplings growing in a small area of previously dead mangroves.

Figure 4.11

Dense saltmarsh growing around a dead mangrove.

Figure 4.12

A small area of ponding water in the Coal Loader area.

Figure 4.13

Hydrocarbon slick along the landward margin of the mangroves to the east of Port Drive.

4.3 Sub-lethal Indicators of Mangrove Health

Epiphytic Macroalgae

Algae, dominated by *Bostrychia moritiziana* and *Catenella nipae* covered the roots and pneumatophores of most *A. marina* mangroves in the Coal Loader area, particularly on the seaward margins.

Macroalgal Mats

Dense macroalgal mats have not been recorded at the Coal Loader area. In 2010, there was sparse algal coverage along the south east shoreline, on the sediment, pneumatophores and mangrove trunks.

Figure 4.14

Sparse algal coverage along the south eastern Coal Loader shoreline.

Insect Damage

There was little or no damage by insects to the mangroves in the Coal Loader area.

Mangrove Seedlings

Avicennia marina seedlings were moderately dense in the Coal Loader area, with some patches of very dense seedlings, particularly in canopy gaps (e.g. Figure 4.10).

Macrofauna

In general, macrofauna abundance, as indicated by crab hole abundance, was high throughout most of the Coal Loader area, with abundances lower in more elevated areas, such as the *Ceriops* forest and saltmarsh area.

5 Whyte Island

5.1 Community Structure

Mangrove communities at Whyte Island were similar to Fisherman Islands, and were dominated by *Avicennia marina*. There were also some isolated *Ceriops tagal* trees (Figure 5.1), and some *Rhizophora stylosa* trees in the open forests. Community type was similar to previous years, with low closed forests dominating the area, and open forests along the seaward margin (Figure 5.1). There were also some areas of low open forest seaward of the closed forests.

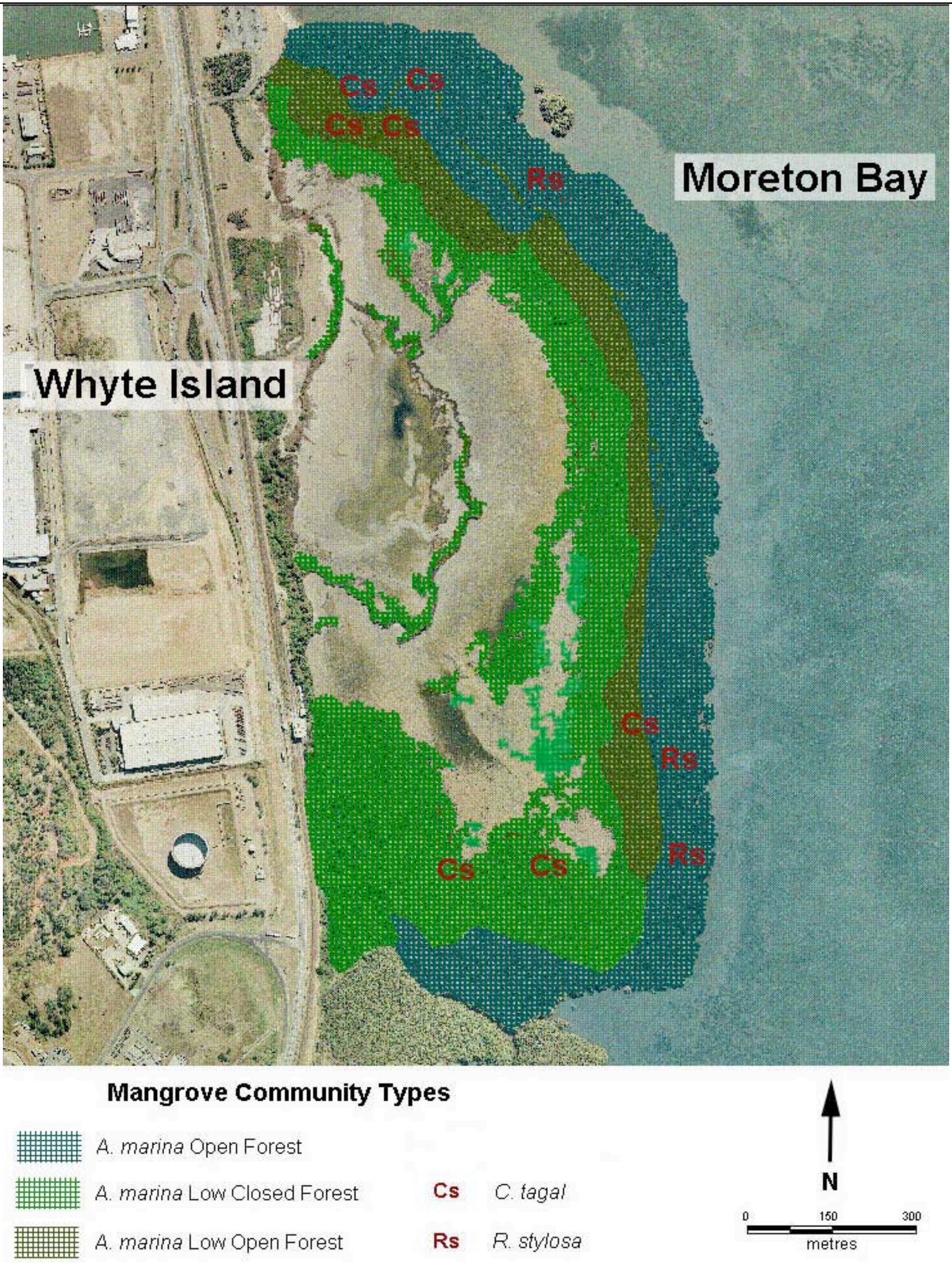
Saltmarsh communities at Whyte Island were similar to those at Fisherman Islands, and were dominated by *Suaeda australis*, *Suaeda arbusculoides*, *Sarcocornia quinqueflora* and *Enchylaena tomentosa*.

5.2 Mangrove Health

At Whyte Island there is a healthy band of mangroves on the seaward edge, with concentric bands of mangroves in fair health and poor health. Centrally, there is a large dieback area and bare saltpan / saltmarsh area. There are thin sections of recent dieback and regrowth, along the dieback margin, which vary spatially and temporally (Figure 5.3 – Figure 5.7).

In 2010, there was a slightly smaller total area of forest in fair health and mangroves that were dead / recently dead[4] than in 2008 (Figure 5.2). The total area of regrowth and forest in poor health had slightly increased. This was because the area of forest in poor health had extended seaward (into forest of fair health) in the south, and regrowth had extended into the recently dead area in the south.

[4] The 'recently dead' and 'dead' categories were mapped separately (as per more recent surveys) however, in order to make meaningful comparisons with the dead area from previous years, dead and recently dead areas have been graphed together as 'dead' mangoves.



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Fisherman Islands and Whyte Island Mangrove Health Assessment 2010	
Figure 5.1	Mangrove community structure and species composition at Whyte Island.
	June 2010

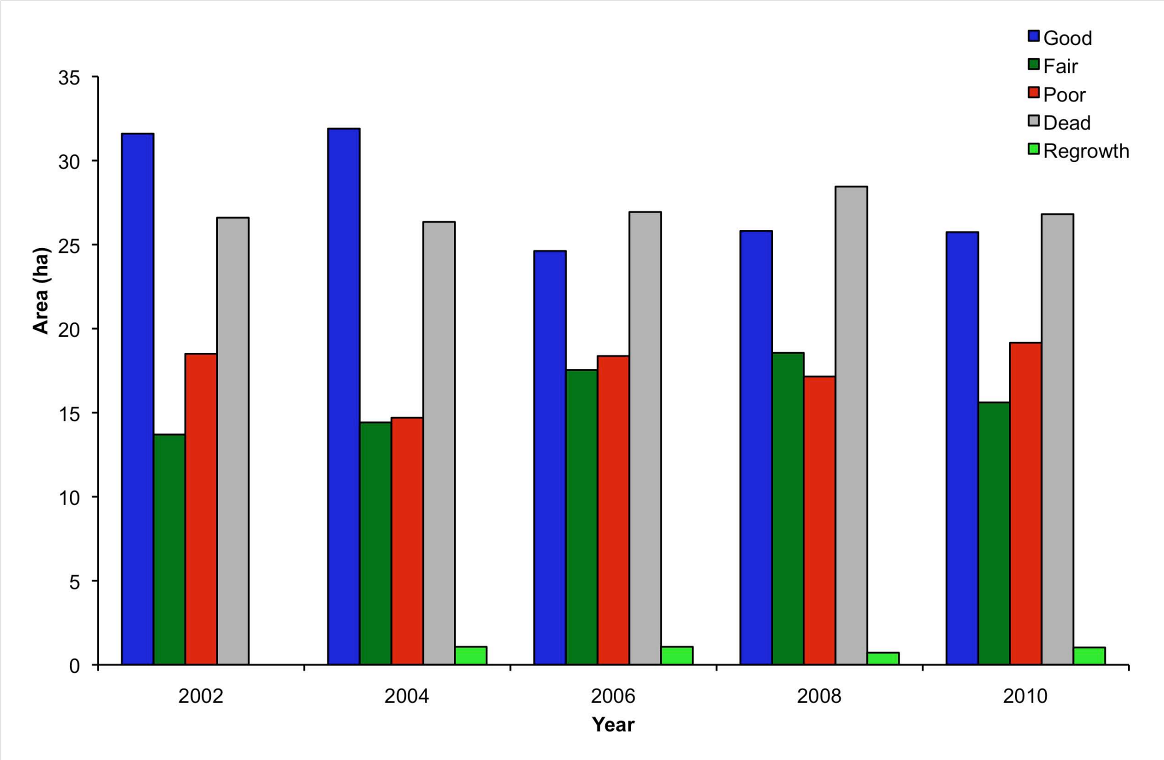
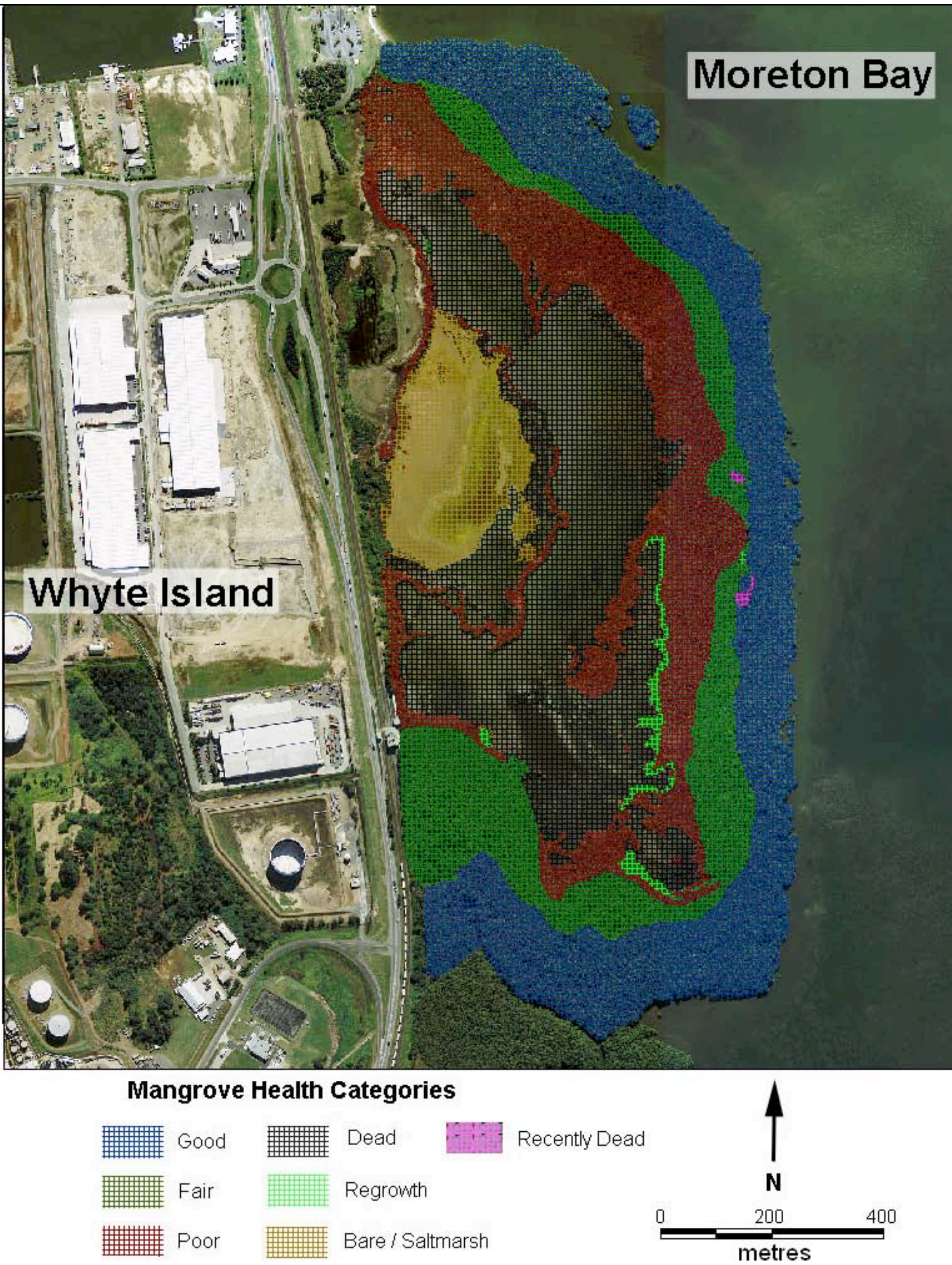


Figure 5.2 Area of mangroves in each health category at Whyte Island from 2002 to 2010.

There has been little change to the total area of dead / recently mangroves and regrowth at Whyte since 2002. However the area and proportion of dead mangroves that had recently died had substantially decreased since 2008. There was 0.92 ha of recently dead mangroves in 2008 (3% of the total area of dead mangroves) and 0.10 ha of recently dead mangroves in 2010 (0.03% of the total area of dead mangroves). Most of the mangroves that had recently died in 2008 were dead in 2010.

The total area of mangroves in good health had declined since 2002 but there had been little change since 2006. The total area of mangroves in fair and poor health is variable with a higher proportion of mangroves in poor health in 2002 and 2010, and a higher proportion of mangroves in fair health in 2006 and 2008.



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Fisherman Islands and Whyte Island

Mangrove Health Assessment 2010

Figure 5.3 Mangrove Health at Whyte Island in 2010.

June 2010

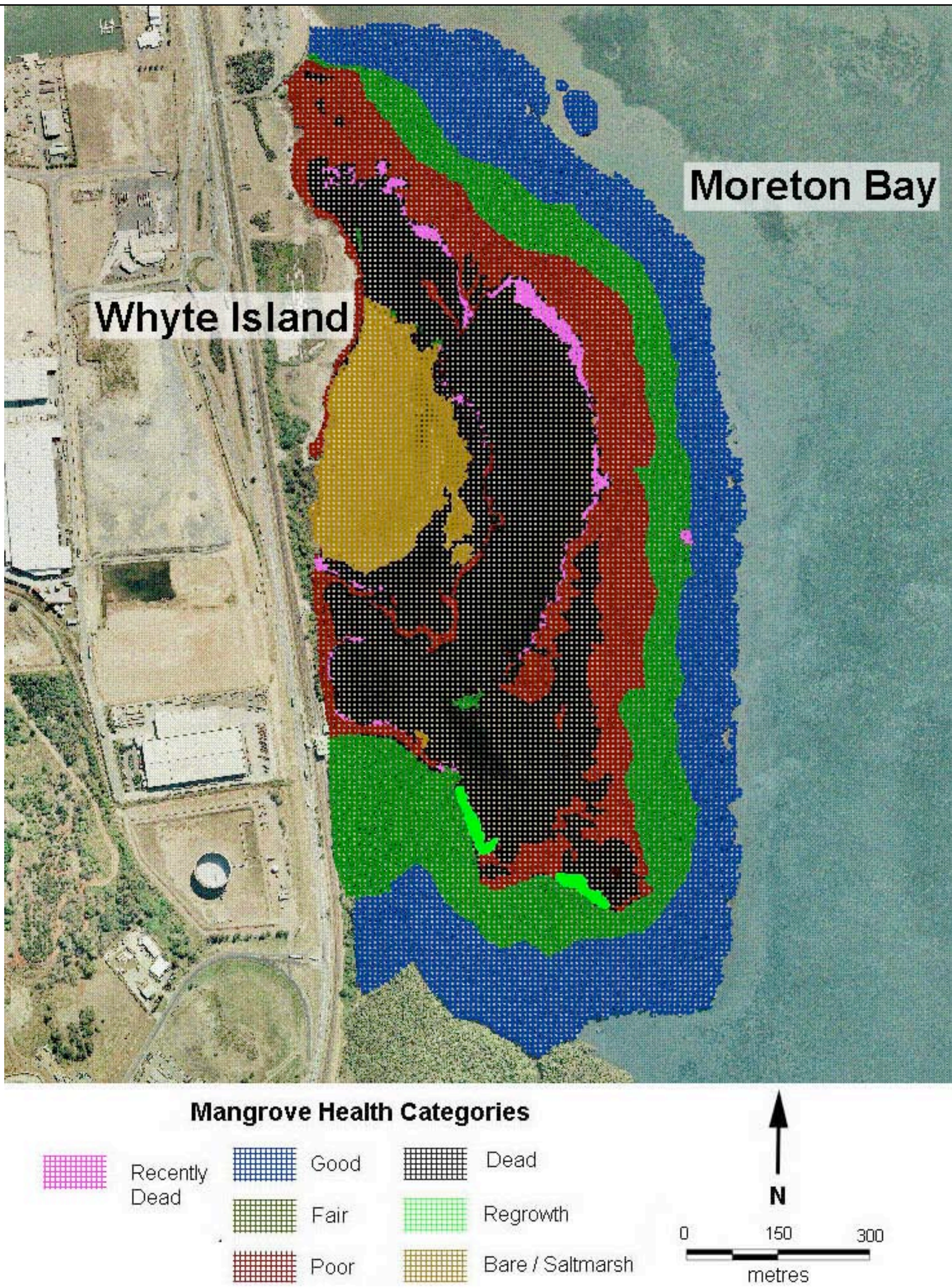

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	Figure 5.4 Mangrove Health at Whyte Island in 2008.	
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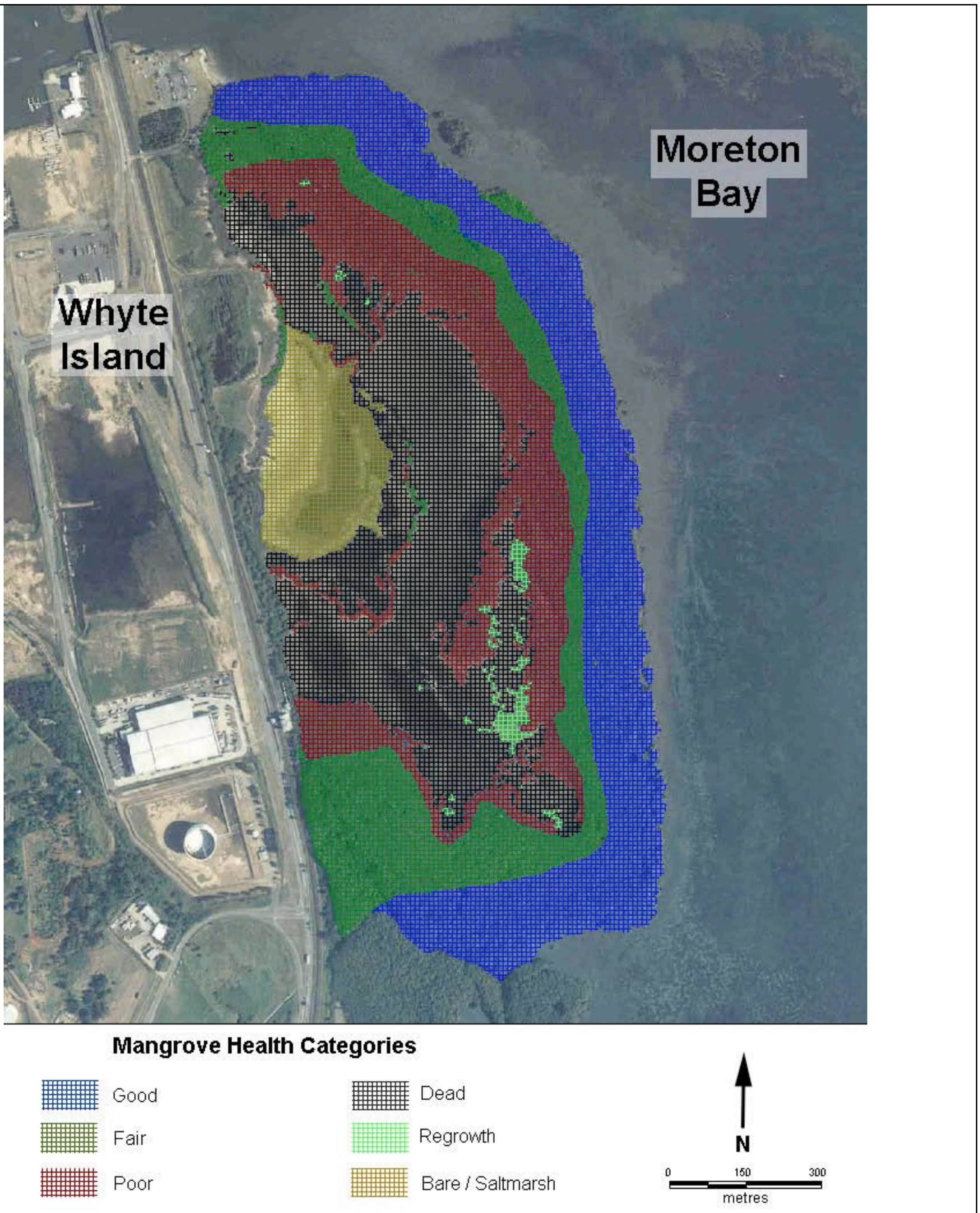

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	Figure 5.5 Mangrove Health at Whyte Island in 2006.
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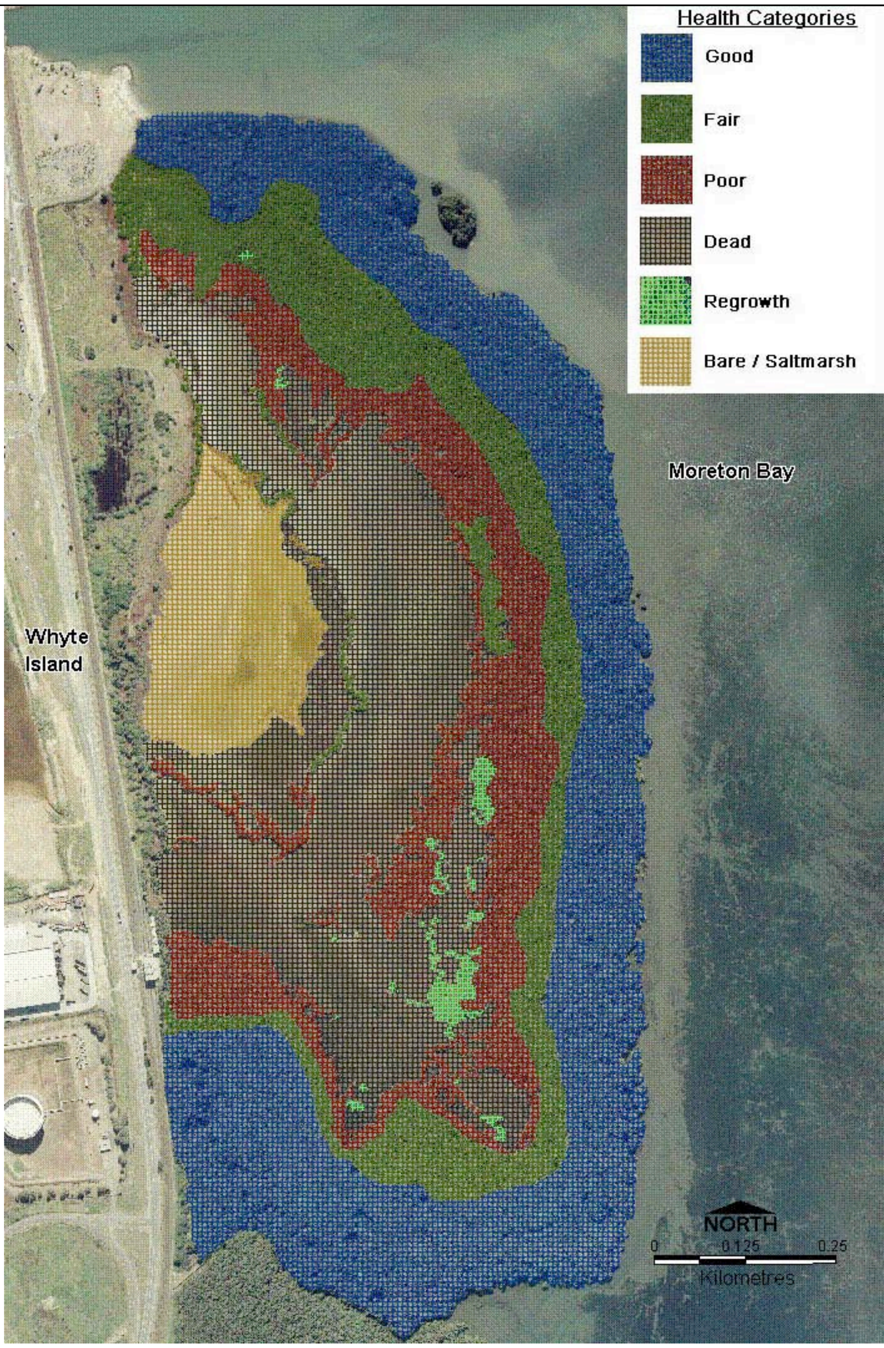

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	Figure 5.6 Mangrove Health at Whyte Island in 2004.	
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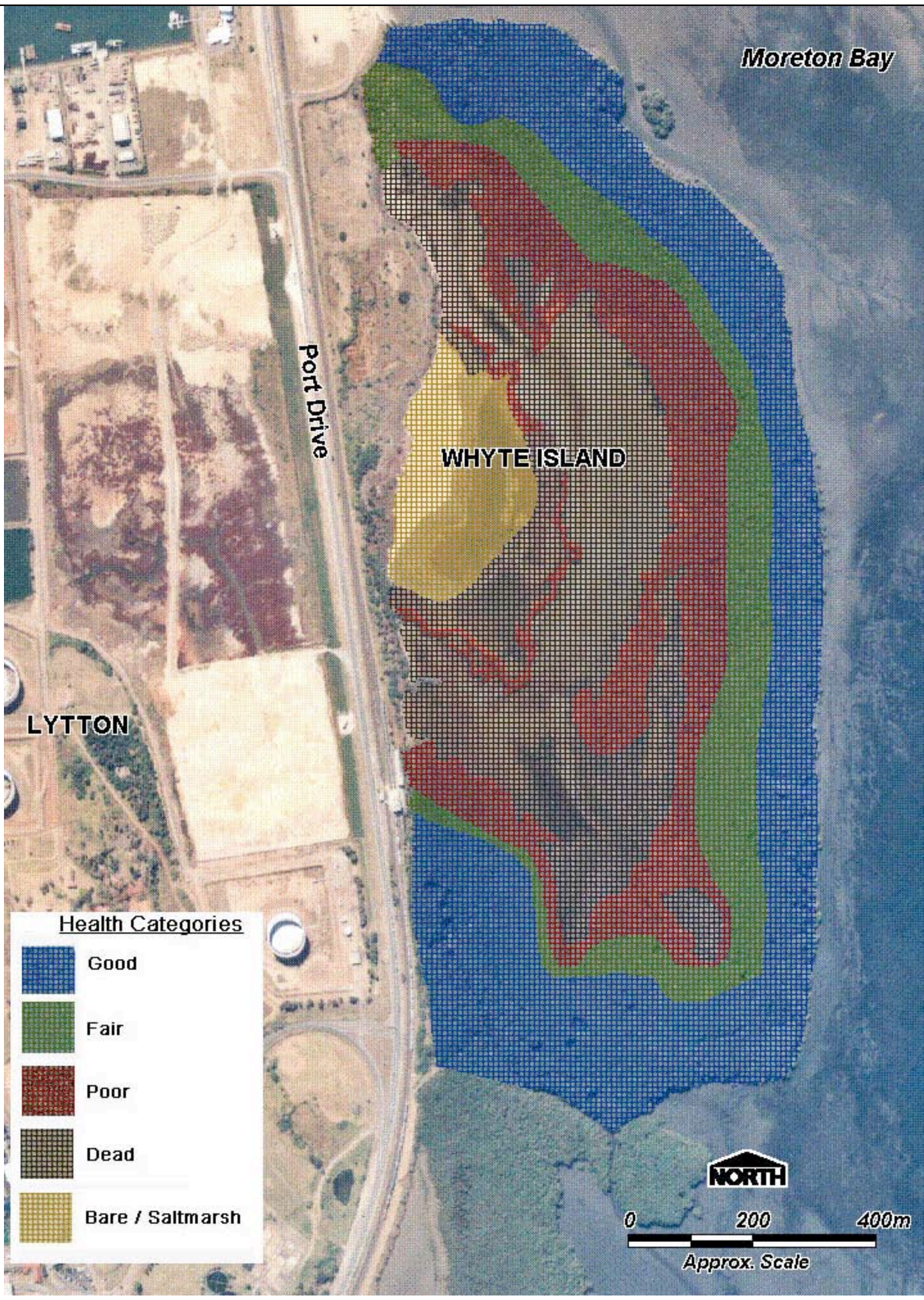

frc environmental deep thinking. science.	Fisherman Islands and Whyte Island Mangrove Health Assessment 2010
	Figure 5.7 Mangrove Health at Whyte Island in 2002 (WBM Oceanics 2002).
	June 2010

Since 2002, the central area in poor health has generally expanded and the trees have thinned and become more patchy. In 2004, there were patches of regrowth along the south east margin of the dieback area. This regrowth continued through 2006, but by 2008, much of the regrowth had died or was in poor health. In 2008, regrowth was confined to two small areas at the far southern end of the dieback area. In 2010, the landward area of regrowth recorded in 2008 had died but the seaward area had extended to the north into an area of previously (recorded in 2008) dead mangroves. The recently dead mangroves lining the northern margin of the dieback area had not recovered in 2010 (i.e. were classified as dead).

During the 2006 survey, which included a high tide of 2.01 m, there was no substantial ponding of water on Whyte Island. However, during the 2008 and 2010 survey the bare / saltmarsh area was submerged at all stages of the tide.

5.3 Sub-lethal Indicators of Mangrove Health

Epiphytic Macroalgae

Epiphytic algae such as *Bostrychia moritiziana* and *Catenella nipae* only grew on *A. marina* pneumatophores in the open forests of Whyte Island.

Macoalgal Mats

In places, particularly in the ponded dieback area, and mangroves in poor health, there were thick algal mats growing over the sediment (Figure 5.8).

Figure 5.8

Ponding water at the Whyte Island dieback area.

Insect Damage

As in previous years, there was damage by insects in many areas at Whyte Island. Insect damage was highest in the south and south east of the island, in areas of poor health and regrowth. There has been no improvement in health in areas previously damaged by insects, with much of this area in fair or poor health in 2008 and 2010.

Mangrove Seedlings

As in previous years, seedling density was highest in areas of open forest along the shoreline in 2010. There were also some seedlings in the dead areas, and in the areas of poor health in the middle of Whyte Island.

Macrofauna

Macrofaunal abundance was higher in the more seaward mangroves of Whyte Island. Very little fauna was recorded in ponded areas; a few snails inhabited some areas.

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Document Control Summary

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Contents

List of Figures

Executive Summary

The Port of Brisbane Corporation (PBC) is responsible for the operation and management of the Port of Brisbane, and has a duty of care to ensure that the operation of the Port and associated activities do not adversely impact adjacent wetland areas. There are some areas of degraded mangroves surrounding the Port of Brisbane facilities that PBC has been monitoring since 1999, using a standard methodology. This report details the results of the most recent monitoring, in 2010.

Overall, mangrove health in 2010 was generally similar to 2008, with fewer mangroves dieing in 2010. In addition there are a number of new areas of regrowth, with some areas in western Fisherman Islands that were classed as recently dead in 2008 regrowing, and much of the older areas of regrowth now mature forest. Further, there has been extensive colonisation by saltmarsh on the edges of the dieback and in bare areas on Fisherman Islands, with dense mangrove seedlings common in these areas.

Since 2007, there has been an increase in rainfall, with annual rainfall in 2008 above the long term average. There has also been a decrease in nutrient concentrations in the sediment at most of the sites. Salinity levels in the sediment pore water of dieing mangroves and mangroves in poor health are high, but the levels of contaminants such as heavy metals and hydrocarbons are not of concern.

The only substantial increase in dead mangroves in 2010 was in the dieback area in the eastern section of Fisherman Islands. In 2008, there was a relatively large area of recently dead mangroves here, which are now mostly dead, and there is a new 'front' of recently dead mangroves. While sediments samples have not been collected for analysis in this area of dieback, the concentrations of nitrogen in the sediment is very high (the highest recorded in this study) at a nearby site, on the eastern tip of Fisherman Islands. The area also appears to be relatively infrequently inundated. Further investigation of the cause of dieback in this area is recommended, in particular a targeted investigation of nutrient and salinity level, and inundation period and frequency.

1 Introduction

The Port of Brisbane Corporation (PBC) is responsible for the operation and management of the Port of Brisbane, at the mouth of the Brisbane River. The PBC has a number of responsibilities, as defined in the Corporation's Environmental Policy and under the *Environment Protection Act 1994*, with respect to the impact of the Port's activities on the surrounding environment.

As part of these responsibilities, the PBC has a duty of care to ensure that the operation of the Port and associated activities do not adversely impact adjacent wetland areas. Presently, there are some areas of degraded mangroves surrounding the Port of Brisbane facilities. The Port of Brisbane was previously known as Fisherman Islands and Whyte Island; these names are used in this report to facilitate comparisons with monitoring in previous years.

The community structure and health of mangroves at Fisherman Islands were assessed and mapped in 1999 and 2002 and every second year since then. Since 2002, the distribution and health of mangroves at Whyte Island have also been mapped every second year. Permanent photographic monitoring stations were established in late 1999 / early 2000, and photographs of the mangrove communities to the north, south, east and west of these points taken in 1999/2000, 2001, 2002, and then every second year. In addition, sediment samples have been collected and analysed for nutrients and contaminants every second year, and in 2008 pore water samples were collected and analysed (WBM Oceanics Australia 2000; 2002b; a; frc environmental 2004; 2007; 2008a).

These data have been used to monitor the condition of mangroves at Fisherman Islands and Whyte Island, and to provide some background for a discussion of the potential causes of their degradation, and opportunities for rehabilitation.

The PBC commissioned the present study to determine the current health of mangrove communities in the Port of Brisbane, and to review this data in the context of previous studies. In this study we:

- resurveyed and mapped the mangrove community structure, species composition and ecological health of mangroves at Fisherman and Whyte Islands using established survey techniques, taking particular care in identifying areas that appeared to be recently dead, or regrown
- rephotographed the permanent photographic monitoring sites using established techniques (sites 1, 2, 3, 4, 5, 6, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23), and have described any changes at these sites

- collected and analysed sediment samples from 18 permanent sites (sites FI1, FI2, FI3, FI4, FI6, FI7, FI9, FI11, FI13, FI15, FI7, FI18, FI19, FI22, FI23, WI1, WI2, WI3)
- resampled and analysed sediment pore water in areas of good, fair and poor health, and from dead areas
- describe the current distribution of mangroves and their health
- report on the concentration of contaminants in mangrove sediments and compare them to previous years, and
- compare the distribution of mangroves to previous years, and discuss potential causes of any recent changes.

1.1 Background

Mangroves grow at the dynamic interface between the land and the sea, growing in extreme environments that other terrestrial plants cannot tolerate. The physiology and structure of mangroves enables them to cope with extreme conditions such as high and varying levels of salinity, water logged soils that inhibit oxygen uptake, and often high temperatures, strong winds and strong currents. Whilst mangroves are able to withstand many of these impacts, they are also easily affected by changes to their environment; for example, changes to inundation or drainage levels can rapidly cause mangrove dieback.

Of the 8 mangrove species in Moreton Bay, five are found in the study area:

- the grey mangrove *Avicennia marina* var. *australasica*
- the yellow mangrove *Ceriops tagal*
- the red mangrove *Rhizophora stylosa*
- the river mangrove *Aegiceras corniculatum,* and
- the orange mangrove *Bruguiera gymnorrhiza* (WBM Oceanics Australia 2000; 2002b; frc environmental 2004; 2007; 2008a).

A. marina var. *australasica* is the most dominant species, and community composition in the study area is typical of mangrove communities in the Moreton Bay region.

At both Fisherman Islands and Whyte Island there are large areas of dead mangroves, associated with saltpan / saltmarsh areas, surrounded by mangroves in poor condition.

This pattern of dieback is common in mangrove communities in the dry tropics (Gordon 1987; Marius & Lucas 1991; Conacher et al. 1996), where it is thought to be largely associated with increased soil salinity due to dry conditions. It has also been observed recently at a number of other places in south-east Queensland (frc environmental 2008b).

Details of the methods and results of the survey, and a discussion of the results are presented in Appendices A to G. A summary of the results and discussion is presented below.

2 Mangrove Health on Fishermans and Whyte Island in 2010

Overall, mangrove health during the 2010 survey was similar to 2008, with most mangroves in good or fair health, but with large areas of dead mangroves, particularly in the middle of the community, and with bands of mangroves in fair and poor health between the healthy and dead communities (Figure 2.1 to Figure 2.3 & Figure 2.7 to Figure 2.9).

While the total area of dead mangroves was similar to 2008, there was a decrease in the area of mangroves classed as recently dead[1], particularly at White Island.

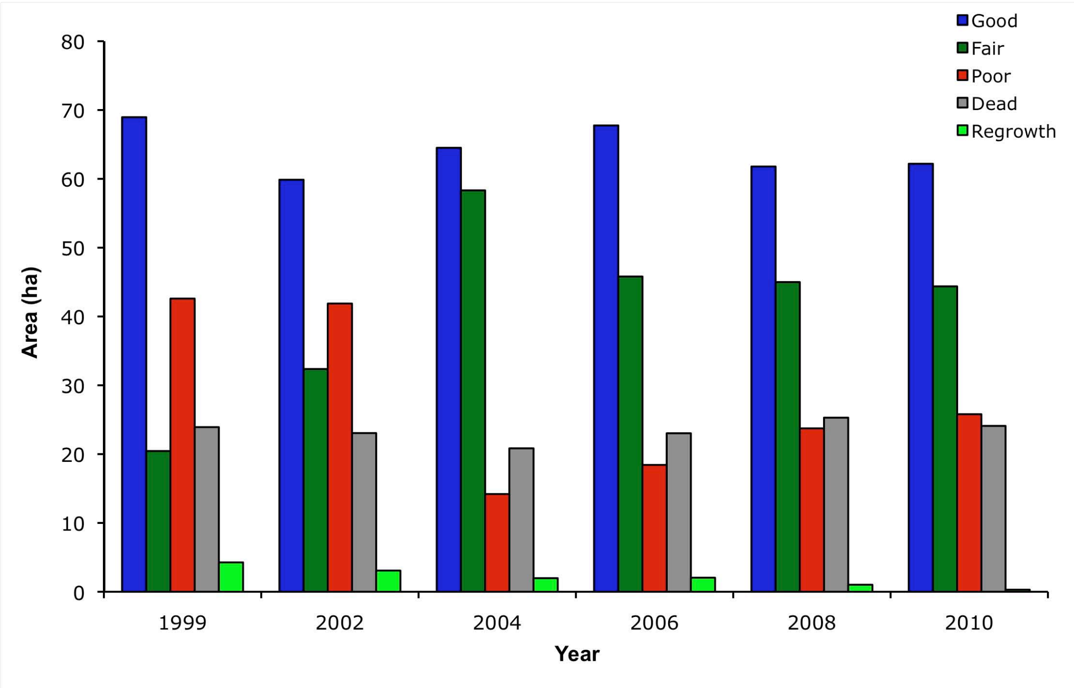

Figure 2.1 Area of mangroves in each health category at Fisherman Islands (excluding the Coal Loader area) 1999 to 2010.

[1] The recently dead category is a subset of the dead category. Trees in this category have either no leaves, or brown leaves, and no new growth. While these trees appear to be dead they can sometimes regrow. For consistency with earlier monitoring reports they are graphed with dead trees.

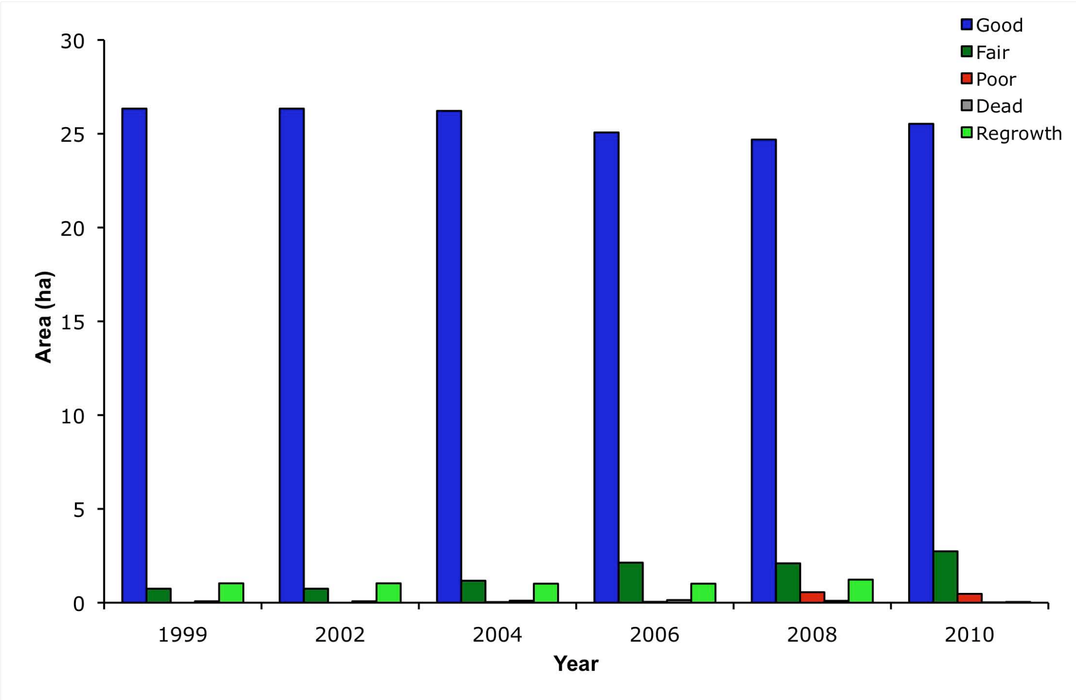

Figure 2.2 Area of mangroves in each health category in the Coal Loader area from 1999 to 2010

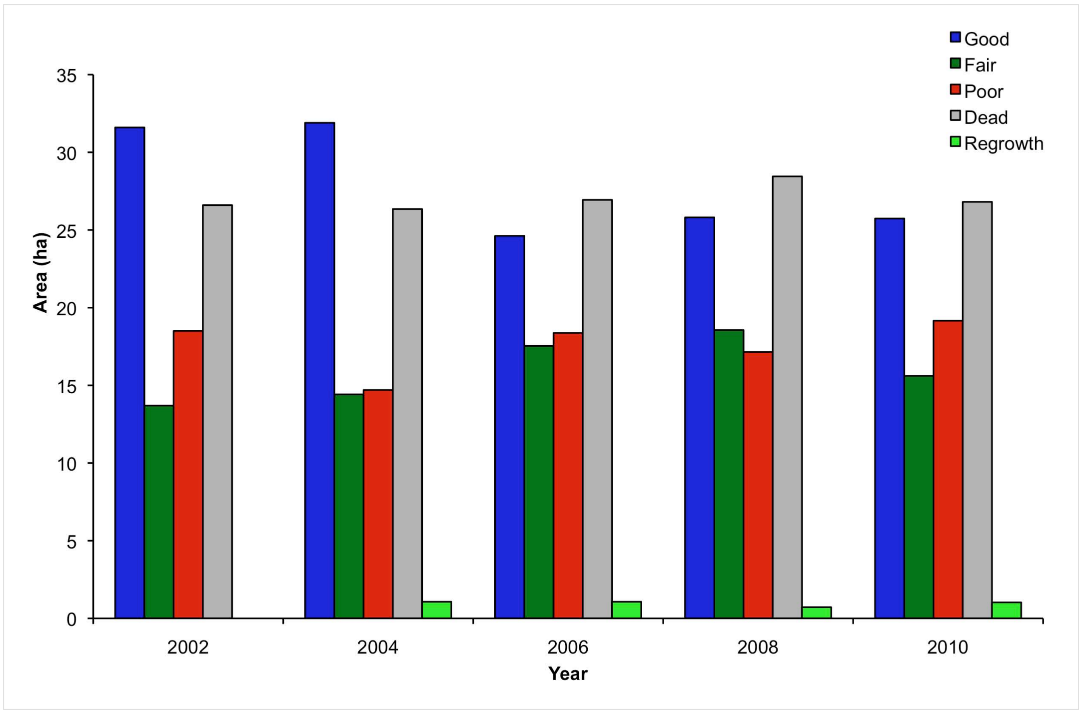

Figure 2.3 Area of mangroves in each health category at Whyte Island from 2002 to 2010.

In 2010, the only substantial increase in the area of dead mangroves was in the eastern section of Fisherman Islands. Most of the large area of mangroves that were recently dead in 2008 were still dead in 2010, and there was a new 'front' of recently dead mangroves, in an area that was previously in poor condition. This area is the furthest away, and presumably least exposed, to any land-based anthropogenic impacts such as port activities (Figure 2.4 & Figure 2.7).

Figure 2.4

Thin strip of recently dead mangroves between dead mangroves and forest in poor health, eastern Fishermans Islands.

At western Fisherman Islands, mangroves that were classed as recently dead in 2008 had regrown (i.e. there has been extensive epicormic shooting) and were in similar condition to the adjacent forest in poor health (Figure 2.5).

Figure 2.5

Epicormic growth of *Avicennia marina* (regrowth) along the margin of dead mangroves and forest in poor health at Western Fisherman Islands.

At Whyte Island, most of the mangroves that were classed as recently dead in 2008 were still dead in 2010.

In 2010, there were new areas of mangrove regrowth at Fisherman and Whyte islands. Most of the forests that were classed regrowth in 2008 had matured, and were now mature forest in poor health.

On Fisherman Islands there has recently been extensive colonisation by saltmarsh, in and along the edges of the dieback areas. These saltmarsh areas are commonly also vegetated with dense mangrove seedlings (Figure 2.6).

Figure 2.6

Seedlings growing on saltmarsh at Western Fisherman Islands.

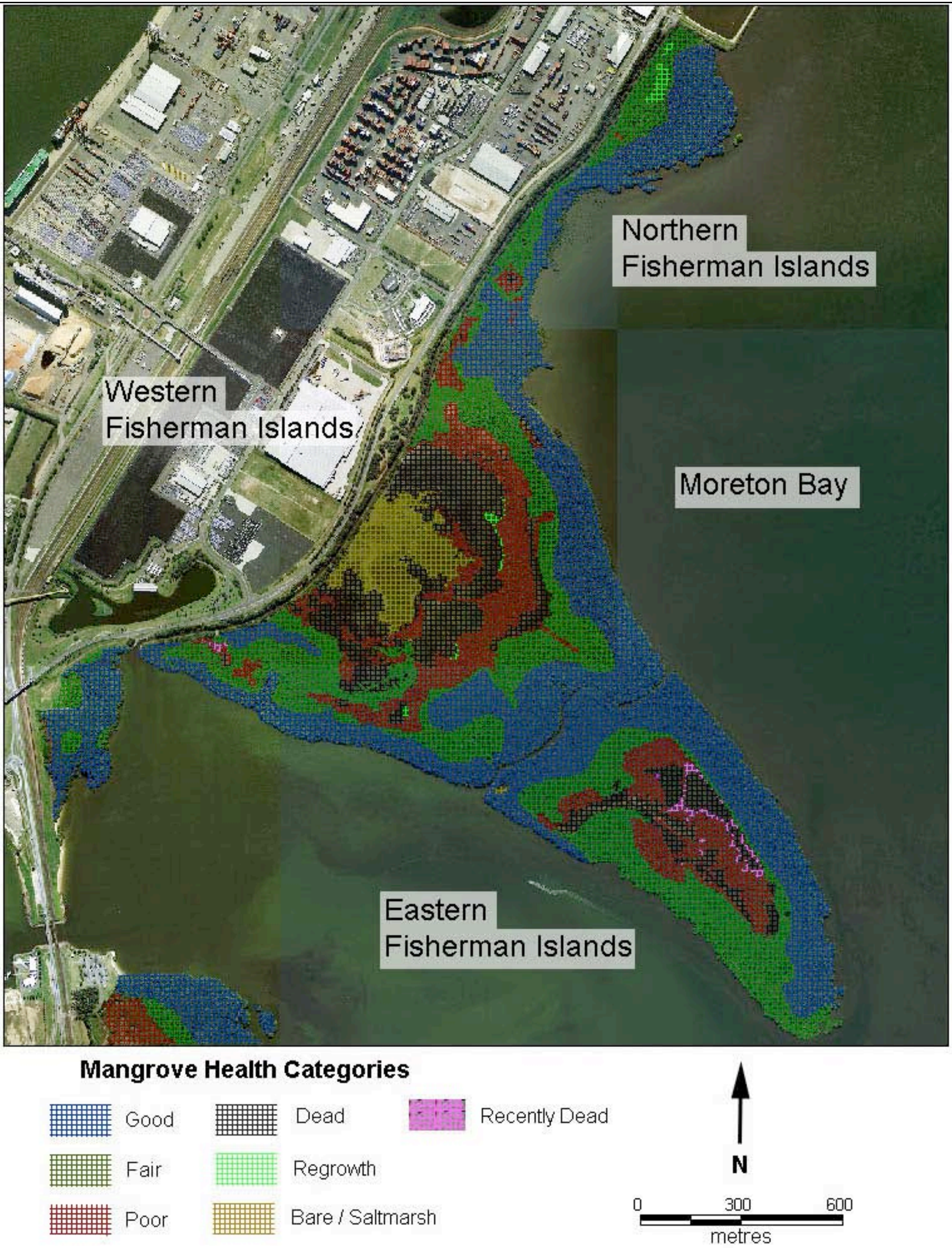

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Figure 2.7 Mangrove health Fisherman Islands, 2010.

June 2010

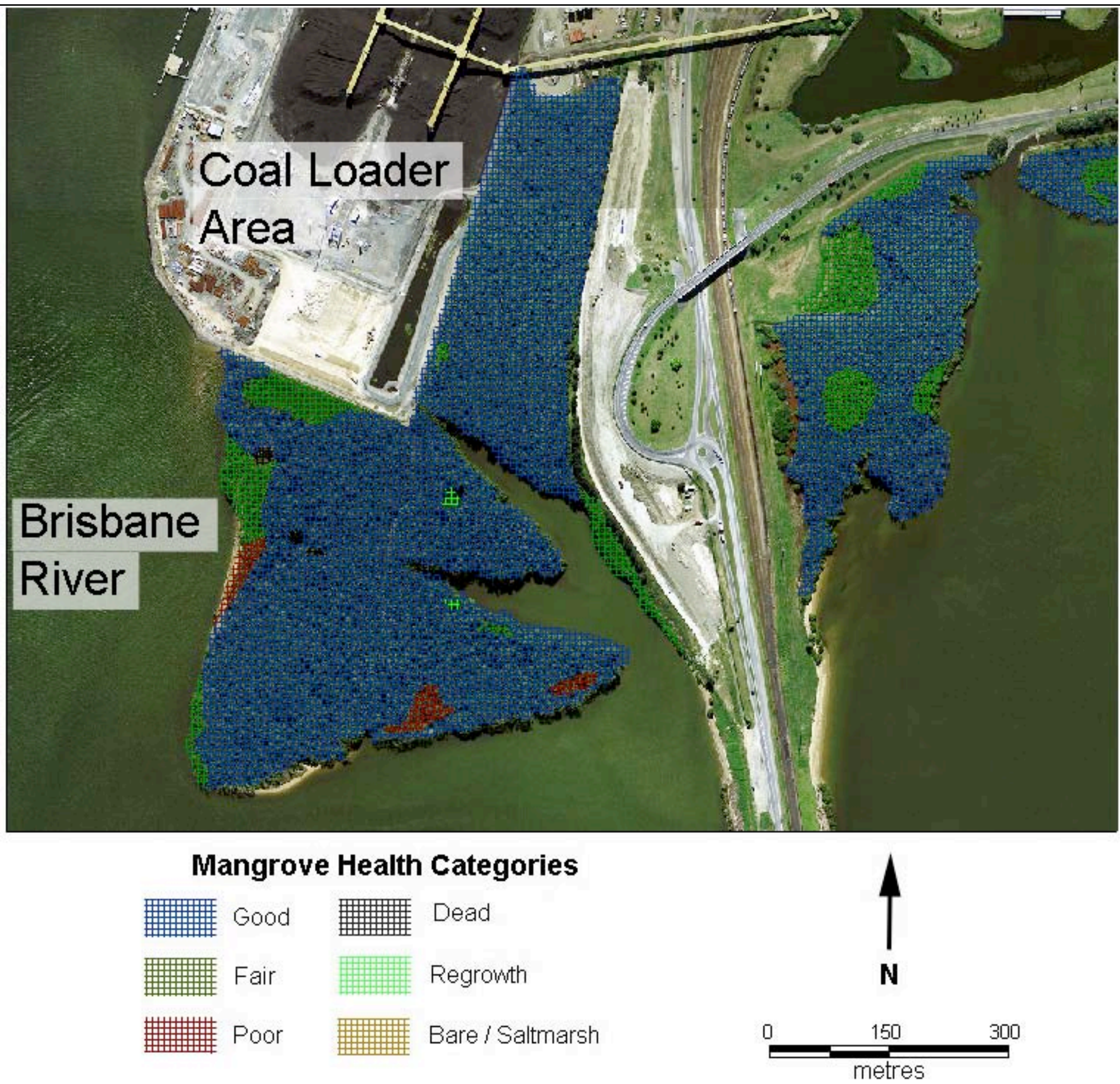

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Figure 2.8 Mangrove health in the Coal Loader area of Fisherman Islands in 2010.

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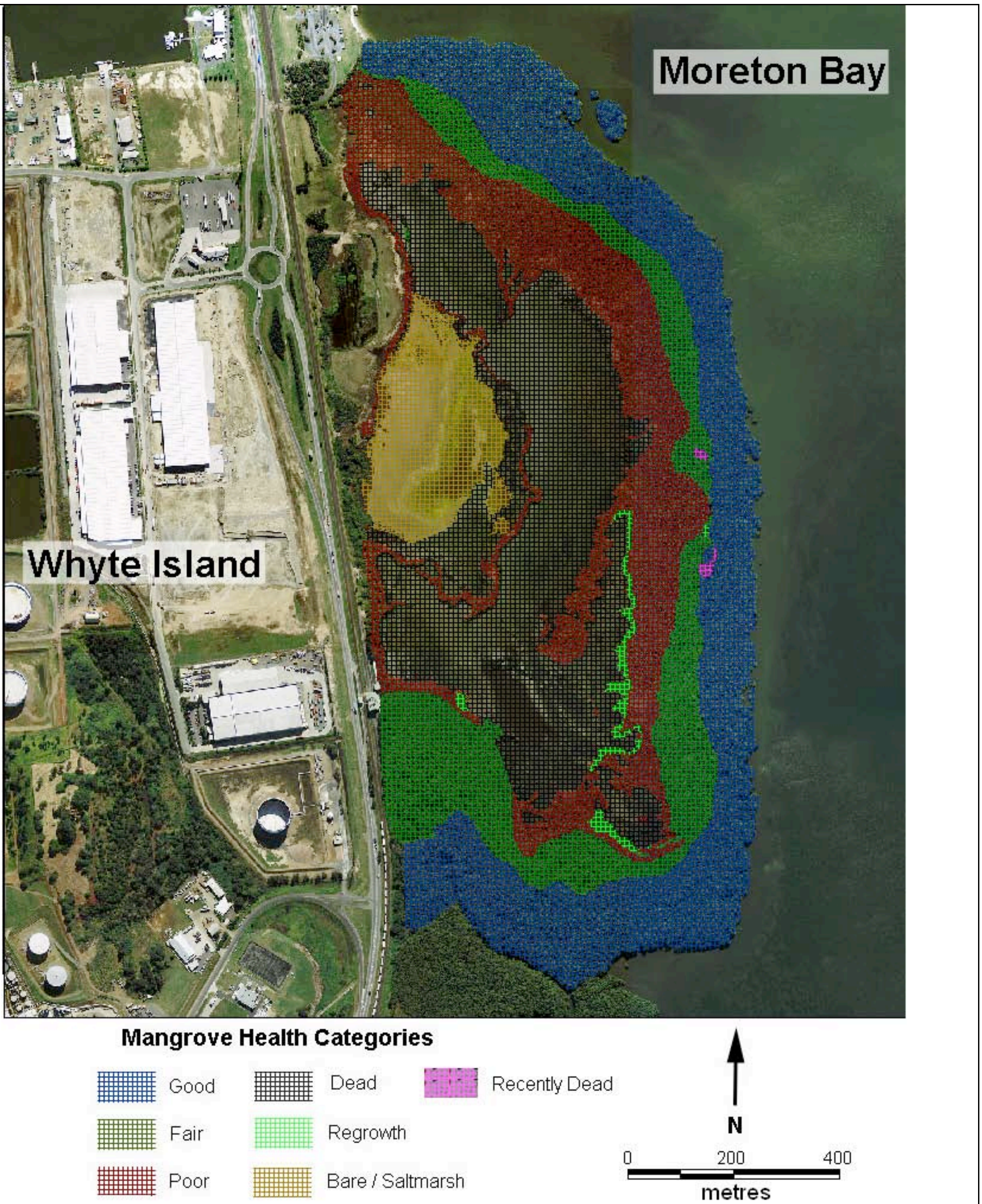

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	Figure 2.9 Mangrove Health at Whyte Island in 2010.	
		June 2010

3 Photographic Monitoring

Overall, the sites that were photographed were similar in 2010 to 2008. Seedling density had increased at most sites, and seedlings from last year had survived and continued to grow.

Saltmarsh had colonised the large areas of dieback on western and eastern Fisherman Islands (sites 13 and 22), and the old dead mangrove trees in the middle of the dieback area in the western section of Fisherman Island had noticeably degraded since 2008.

4 Sediment Quality

4.1 Nutrients

Concentrations of total extractable nitrogen in mangrove sediments vary with sediment type, with higher levels in finer sediments (Alongi et al. 1982). Total nitrogen concentrations in mangrove sediment usually range from 600 to 2 000 mg/kg (Clough et al. 1983) and total phosphorous from 100 to 1 600 mg/kg (Alongi et al. 1982). In Queensland, a range of concentrations have been recorded with relatively high values recorded near the Luggage Point Wastewater Treatment Plant (WWTP) (WBM Oceanics Australia 2000).

At Fisherman Islands, the concentration of total nitrogen in the sediment ranged from relatively low concentrations of ≤1 800 to 9 450 mg/kg, with no clear trends linking total nitrogen concentrations to mangrove health, as a single contaminant.

The concentration of total nitrogen was substantially higher at Whyte Island, ranging between 7 600 to 23 200 mg/kg in the south of the dieback area. The concentration of nitrogen in this southern area of dieback has substantially increased since 2006.

Phosphorous concentrations at Fisherman Islands in 2010 ranged from 300 to 1 200 mg/kg, and at Whyte Island ranged from 490 mg/kg to 3 200 mg/kg, with the highest concentrations in the healthy mangroves close to Crabbe Creek.

Wynnum WWTP discharges into Moreton Bay via a discharge pipe into Crabbe Creek. This WWTP has recently been upgraded, and total nitrogen and phosphorus discharge has decreased since 2004. The main aim of the upgrade was to improve the quality of the treated wastewater, and in particular to remove nitrogen (Brisbane Water Enviro Alliance 2008). While nitrogen concentrations have decreased since 2006 at site 3, the site nearest to the discharge, phosphorous concentrations have increased.

4.2 Petroleum Hydrocarbons and BTEX

At both Fisherman and Whyte Islands both TPH (total petroleum hydrocarbons) and BETEX (benzene, toluene, ethylene & xylene), concentrations were below laboratory detection limits at most sites, and there were no clear trends linking TPH or BTEX concentrations in sediments to mangrove health.

4.3 Heavy Metals

Heavy metal concentrations were below the low Interim Sediment Quality Guidelines (ISQG) level (ANZECC & ARMCANZ 2000), with the exception of nickel at one site. The nickel concentration at this site slightly exceeded the low ISQG level, but was within the background range and similar to that recorded in previous surveys.

Concentrations of several metals were higher in 2010 than in 2008 at some sites. However, mangrove forests at most of the sites with higher heavy metal concentrations were in good health, consequently heavy metals are unlikely to have caused the dieback.

4.4 Oganochlorine Pesticides

As in previous surveys, all organochlorine pesticides concentrations at Fisherman and Whyte islands sites were below laboratory detection limits, and are unlikely to have caused the dieback.

4.5 Summary

Only nitrogen and phosphorous concentrations in the sediment were above expected concentrations for uncontaminated areas, however there were no clear relationships between nutrient concentration and mangrove health.

5 Pore Water Salinity

Worldwide studies of pore water salinity within *Avicennia marina* communities indicate that stunted *Avicennia marina* (that is mature plants under approximately 2.5 m high) are often associated with sediments that have a high pore water salinity (up to 115 ppt), whilst taller forests are associated with lower pore water salinities (Lovelock, Adame & Amir [University of Queensland School of Integrative Biology] pers. comm. 2007, Naidoo 2006,). This suggests the stunting of *A. marina* is likely to be a response to high sediment pore water salinity.

Previous work on Whyte Island indicated that sediment pore water salinity was higher in areas of mangrove dieback, and in areas of poor health than in healthy tall forest; with salinities higher still in scrub forests and highest in the central areas with no mangroves and algal mats (Lovelock, Adame & Amir [University of Queensland School of Integrative Biology] pers. comm. 2007).

Samples of sediment pore water were collected from the sediment of recently dead mangroves and from mangroves in poor, fair and good condition on Fisherman and Whyte Islands, and from forests without large dieback areas at Wellington Point and Mooroondu Point at Thornside (Figure 5.1).

Figure 5.1

The pore water sampling apparatus in use, March 2010.

A nested ANOVA (analysis of variance) test was used to test for differences in pore water salinity between health categories and locations, with health categories nested in location. Pairwise comparisons were undertaken using Tukey's HSD (p = 0.05) to distinguish differences between health categories at each location over time.
In both 2008 and 2010, mean pore water salinity was significantly higher in the sediment of areas of mangroves that had recently died, than in areas of good health (with the

exception of mangroves in good health at Mooroondu Point), and was slightly higher than in areas of fair and poor health, although this was not statistically significant (Figure 5.2).

That is, mangrove death, and a decrease in mangrove health appear to be consistently associated with high pore water salinities.

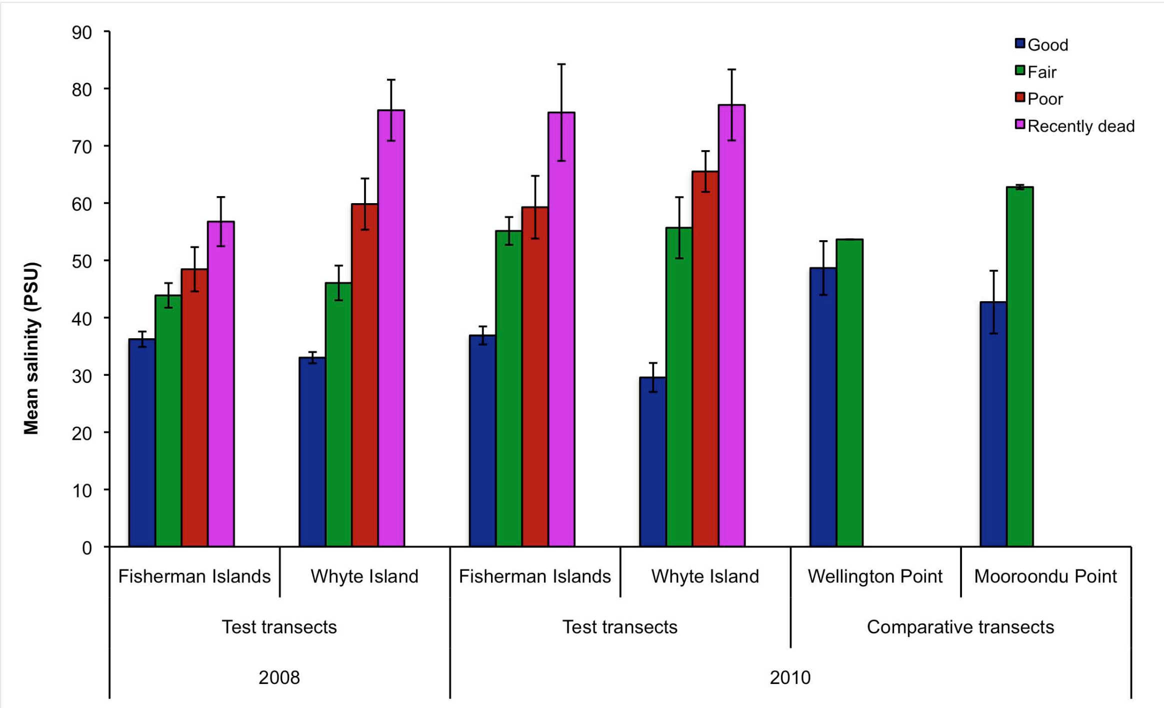

Figure 5.2 Mean pore water salinity at each area surveyed in 2008 and 2010 (vertical bars denote standard error).

6 Potential Causes of Observed Changes Between 2008 and 2010

Overall, mangrove health in 2010 was generally similar to 2008, with fewer mangroves dieing in 2010. In addition there are a number of new areas of regrowth, with some areas in western Fisherman that were classed as recently dead in 2008 regrowing, and much of the older areas of regrowth now mature forest. Further, there has been extensive colonisation by saltmarsh on the edges of the dieback bare areas on Fisherman Islands, with dense mangrove seedlings common in these areas.

In the sediment, salinity levels in the pore water of areas of dieing mangroves and mangroves in poor health are high. In general, while there has been a decrease in nutrient concentrations in the sediment at most of the sites at Fisherman Islands, concentrations have increased at Whyte Island. The levels of contaminants such as heavy metals and hydrocarbons are not of concern.

Since 2007, there has been an increase in rainfall, with annual rainfall in 2008 above the long term average (Figure 6.1), and rainfall from December to March 2010 above long term monthly averages. Evaporation rates were also lower than average from January to March 2010. Higher rainfall and low evaporation rates may have resulted in decreases in the salinity of surface and pore waters, and also a decrease in evapotranspiration, particularly in the hotter summer months. This may have allowed colonisation by saltmarsh in the areas that had been dead for some time, the regrowth of mangrove areas that were dieing in 2008, and may have decreased the rate of dieback.

The only substantial increase in dead mangroves in 2010 was in the dieback area in the eastern section of Fisherman Islands. In 2008, there was a relatively large area of recently dead mangroves here, which are now mostly dead, and there is a new 'front' of recently dead mangroves. This area of dieback is the furthest away, and presumably least exposed, to any land-based anthropogenic impacts such as port activities. While sediments samples have not been collected for analysis in this area of dieback, the concentrations of nitrogen in the sediment is very high (the highest recorded in this study) at a nearby site, on the eastern tip of Fisherman Islands. The area also appears to be relatively infrequently inundated. Further investigation of the cause of dieback in this area is recommended.

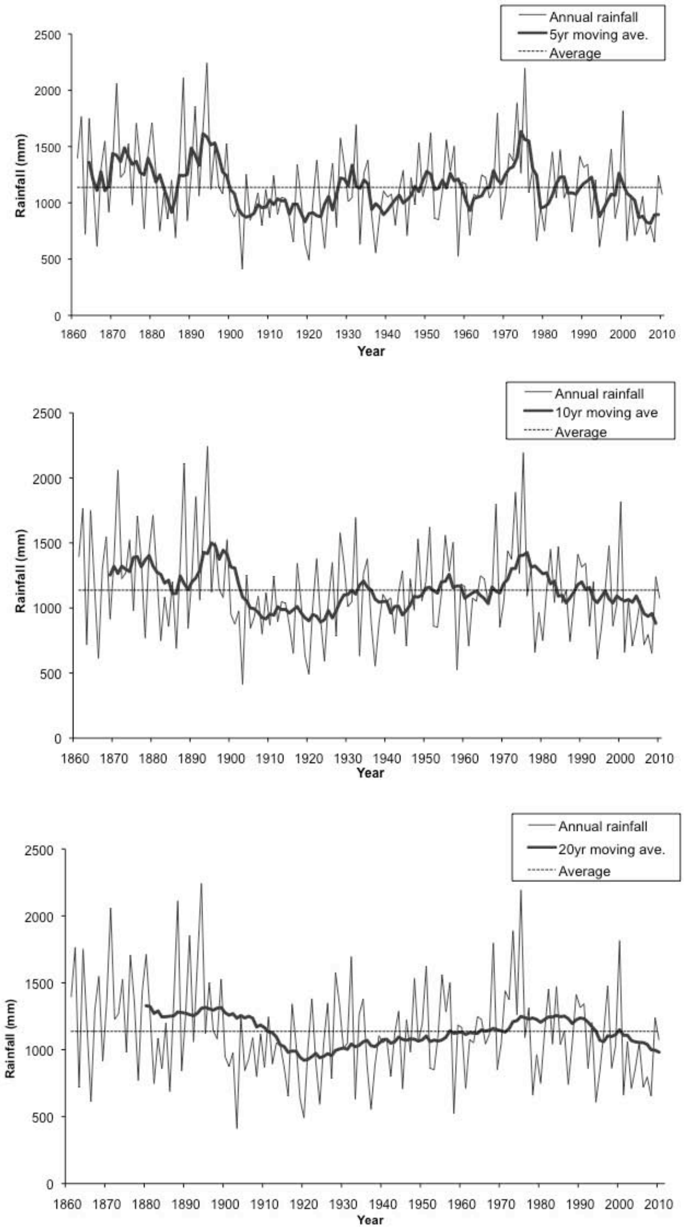

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Figure 6.1 Average annual rainfall between 1860 and 2010, showing 5, 10 and 20 year moving (rolling) averages (updated from Duke et al. 2003)

June 2010

7 Recommendations

Long term changes in rainfall and climate appear to have an over-riding influence on patterns of mangrove dieback and recolonisation in Moreton Bay. However, this may be exacerbated by a number of other factors, including an increase in nutrient concentrations, with mangroves in areas of high salinity and sediment nutrient concentration possibly the most vulnerable communities.

Changes to mangrove communities as a result of growth and dieback also appear to have a feedback mechanism: prolific growth, particularly of pneumatophores can change tidal inundation patterns, while dieback can result in a decrease in sediment levels, resulting in the ponding of water, making an area unsuitable for mangrove growth.

Continued monitoring is recommended, and could be enhanced by further investigations such as:

- ongoing measurement of pore water salinity in sediment from dieback and healthier areas, including the comparative transects and old dieback areas being colonised by saltmarsh, with the same sites sampled each year
- investigation of nutrient levels in sediment along the pore water transects, particularly in the eastern section of Fisherman Islands
- deployment of water depth loggers to confirm the period and frequency of ponding
- a dye run to establish which way the water flows out of the dieback areas, particularly in the new dieback area on Fisherman Islands
- laser survey or similar of dieback areas, to establish benchmark for sediment height, and
- measurement of nutrients, salinity and dissolved oxygen levels in ponded areas.

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