

Appendix 6: Habitat Mapping Raw Datasets

Ukerebagh Island, Tweed River

Table A6.1: Static coastal wetland habitat areas (ha) on Ukerebagh Island, Tweed River, 1948 to 1998.

	1948	1961	1971	1983	1998
dredge spoil	19.7	0	0	0	0
mangrove	47.1	37.7	43.7	42.8	45.2
mixed	2.2	3.6	1.9	1.1	1.9
mudflat	0	0.2	0.4	0.3	0.3
saltmarsh	13.3	13.8	12.4	13.2	11.1
sand	0	0.2	0	0.2	0.5
terrestrial	2.5	22.8	20.7	21.9	19
water	0.9	1	1	1.1	1

Table A6.2: Areas of habitat change on Ukerebagh Island, Tweed River, 1948 to 1961.

change	Area (m2)	Area (ha)
dredge spoil-mangrove	10024.462	1.0
dredge spoil-mixed	8376.738	0.8
dredge spoil-saltmarsh	4779.968	0.5
dredge spoil-sand	1133.38	0.1
dredge spoil-terrestrial	157118.315	15.7
dredge spoil-waterway	16892.135	1.7
mangrove-mangrove	330134.778	33.0
mangrove-mixed	18739.827	1.9
mangrove-mudflat	2439.511	0.2
mangrove-saltmarsh	25153.227	2.5
mangrove-terrestrial	35573.24	3.6
mangrove-water	3757.309	0.4
mangrove-waterway	36697.821	3.7
mixed-mangrove	2195.645	0.2
mixed-saltmarsh	847.958	0.1
mixed-sand	736.356	0.1
mixed-terrestrial	11132.817	1.1
mixed-waterway	6432.483	0.6
saltmarsh-mangrove	16042.22	1.6
saltmarsh-mixed	4816.102	0.5
saltmarsh-saltmarsh	102484.247	10.2
saltmarsh-terrestrial	8734.226	0.9
saltmarsh-waterway	566.689	0.1
terrestrial-mangrove	5794.807	0.6
terrestrial-mixed	2133.474	0.2
terrestrial-saltmarsh	4250.388	0.4
terrestrial-terrestrial	12564.347	1.3
terrestrial-waterway	45.363	0.0
water-mangrove	2128.276	0.2
water-water	5644.872	0.6
water-waterway	1687.893	0.2
waterway-mangrove	9415.114	0.9
waterway-mixed	1300.117	0.1
waterway-terrestrial	3640.074	0.4
waterway-waterway	1115903.941	111.6

Table A6.3: Areas of habitat change on Ukerebagh Island, Tweed River, 1961 to 1971.

change	Area (m2)	Area (ha)
mangrove-mangrove	330204.437	33.0
mangrove-mixed	3913.037	0.4
mangrove-mudflat	473.515	0.1
mangrove-saltmarsh	14095.244	1.4
mangrove-terrestrial	7051.482	0.7
mangrove-water	2323.407	0.2
mangrove-waterway	17731.816	1.8
mixed-mangrove	19145.145	1.9
mixed-mixed	7618.037	0.8
mixed-mudflat	283.344	0.0
mixed-saltmarsh	2244.096	0.2
mixed-terrestrial	3632.548	0.4
mixed-waterway	2377.468	0.2
mudflat-mangrove	990.21	0.1
mudflat-mudflat	1437.855	0.1
saltmarsh-mangrove	22253.785	2.2
saltmarsh-saltmarsh	103058.211	10.3
saltmarsh-terrestrial	11935.968	1.2
saltmarsh-waterway	70.836	0.0
sand-terrestrial	1275.051	0.1
sand-waterway	637.525	0.1
terrestrial-mangrove	27275.71	2.7
terrestrial-mixed	7275.254	0.7
terrestrial-mudflat	1094.152	0.1
terrestrial-saltmarsh	2492.569	0.2
terrestrial-terrestrial	182945.134	18.3
terrestrial-waterway	7574.434	0.8
water-mangrove	3827.94	0.4
water-water	5448.103	0.5
waterway-mangrove	32178.001	3.2
waterway-mixed	425.017	0.0
waterway-mudflat	978.072	0.1
waterway-saltmarsh	1849.001	0.2
waterway-terrestrial	1243.137	0.1
waterway-water	1442.196	0.1
waterway-waterway	1379905.366	138.0

Table A6.4: Areas of habitat change on Ukerebagh Island, Tweed River, 1971 to 1983.

change	Area (m2)	Area (ha)
mangrove-mangrove	348876.631	34.9
mangrove-mixed	7516.566	0.8
mangrove-mudflat	1306.176	0.1
mangrove-saltmarsh	28895.229	2.9
mangrove-sand	212.303	0.0
mangrove-terrestrial	28080.682	2.8
mangrove-water	4302.387	0.4
mangrove-waterway	18635.661	1.9
mixed-mangrove	7361.454	0.7
mixed-saltmarsh	167.672	0.0
mixed-sand	424.606	0.0
mixed-terrestrial	10142.888	1.0
mixed-waterway	1401.672	0.1
mudflat-mangrove	353.84	0.0
mudflat-mudflat	1540.945	0.2
mudflat-waterway	2410.212	0.2
saltmarsh-mangrove	17763.722	1.8
saltmarsh-mixed	3001.79	0.3
saltmarsh-saltmarsh	95092.225	9.5
saltmarsh-terrestrial	7402.954	0.7
terrestrial-mangrove	26645.542	2.7
terrestrial-saltmarsh	5413.956	0.5
terrestrial-sand	2043.548	0.2
terrestrial-terrestrial	167111.679	16.7
terrestrial-waterway	6942.657	0.7
water-mangrove	2857.271	0.3
water-water	6403.302	0.6
water-waterway	70.768	0.0
waterway-mangrove	24465.529	2.4
waterway-mixed	141.536	0.0
waterway-saltmarsh	3209.489	0.3
waterway-terrestrial	5875.551	0.6
waterway-waterway	1538494.7	153.8

Table A6.5: Areas of habitat change on Ukerebagh Island, Tweed River, 1983 to 1998.

change	Area (m2)	Area (ha)
mangrove-mangrove	373491.244	37.3
mangrove-mixed	2768.698	0.3
mangrove-mudflat	468.848	0.1
mangrove-saltmarsh	12200.053	1.2
mangrove-sand	60.508	0.0
mangrove-terrestrial	18168.455	1.8
mangrove-water	2894.723	0.3
mangrove-waterway	17881.356	1.8
mixed-mangrove	6915.39	0.7
mixed-mixed	2620.729	0.3
mixed-saltmarsh	220.273	0.0
mixed-terrestrial	1542.482	0.2
mixed-waterway	60.508	0.0
mudflat-mangrove	995.814	0.1
mudflat-mudflat	2013.633	0.2
saltmarsh-mangrove	27421.686	2.7
saltmarsh-mixed	10643.088	1.1
saltmarsh-saltmarsh	83143.303	8.3
saltmarsh-terrestrial	8494.773	0.8
saltmarsh-waterway	2987.459	0.3
sand-mixed	60.508	0.0
sand-sand	181.524	0.0
sand-terrestrial	60.508	0.0
sand-waterway	1857.621	0.2
terrestrial-mangrove	23173.862	2.3
terrestrial-mixed	2257.306	0.2
terrestrial-saltmarsh	13683.716	1.4
terrestrial-sand	3618.473	0.4
terrestrial-terrestrial	161684.771	16.2
terrestrial-waterway	14679.829	1.5
water-mangrove	3638.052	0.4
water-water	7058.269	0.7
water-waterway	330.511	0.0
waterway-mangrove	16514.512	1.7
waterway-saltmarsh	786.604	0.1
waterway-sand	363.048	0.0
waterway-terrestrial	1224.511	0.1
waterway-waterway	1396713.522	139.7
	41.427	41.4

Table A6.6: Areas of habitat change on Ukerebagh Island, Tweed River, 1948 to 1998.

change	Area (m2)	Area (ha)
dredge spoil-mangrove	21014.736	2.1
dredge spoil-mixed	2201.625	0.2
dredge spoil-saltmarsh	10892.157	2.0
dredge spoil-sand	4233.151	0.4
dredge spoil-terrestrial	120392.968	12.0
dredge spoil-waterway	38813.367	3.0
mangrove-mangrove	342610.288	34.3
mangrove-mixed	3956.599	0.4
mangrove-saltmarsh	29114.186	2.9
mangrove-terrestrial	36332.031	3.6
mangrove-water	4127.182	0.4
mangrove-waterway	40183.586	4.0
mixed-mangrove	5215.452	0.5
mixed-saltmarsh	341.192	0.0
mixed-sand	331.13	0.0
mixed-terrestrial	5812.863	0.6
mixed-waterway	10281.917	1.0
saltmarsh-mangrove	33651.815	3.4
saltmarsh-mixed	13049.051	1.3
saltmarsh-saltmarsh	67520.01	6.8
saltmarsh-terrestrial	18102.14	1.8
saltmarsh-waterway	1128.599	0.1
terrestrial-mangrove	15184.339	1.5
terrestrial-saltmarsh	1268.32	0.1
terrestrial-terrestrial	7990.741	0.8
terrestrial-waterway	58.542	0.0
water-mangrove	3228.416	0.3
water-water	5726.272	0.6
waterway-mangrove	33031.197	3.3
waterway-saltmarsh	949.119	0.1
waterway-sand	58.542	0.0
waterway-terrestrial	2238.57	0.2
waterway-waterway	1009853.91	1001.0

Tilligerry Creek Mouth, Port Stephens

Table A6.7: Static coastal wetland habitat areas (ha) in the Tilligerry Creek mouth, 1954 to 1996.

	1954	1966	1975	1983	1996
coastal veg			0	1.5	2.4
mangrove	113.8	132.3	131.7	149.6	177.4
mixed	66.2	68	74.4	98	73.9
reclaimed land		2.1	10.6	21.3	19.6
saltmarsh	222.5	195.2	206.6	149.9	134.6
sand	3.2	4.2		1	4.3
terrestrial	257.7	263.4	227	235.3	241.3
water	3.2	3.9		4.2	4.4

Table A6.8: Areas of habitat change in the Tilligerry Creek mouth, Port Stephens, 1954 to 1966.

change	Area (m2)	Area (ha)
catchment-catchment	3793282.106	379.3
catchment-mangrove	21938.868	2.2
catchment-mixed	7184.767	0.7
catchment-reclaimed	366.498	0.0
catchment-saltmarsh	77896.584	7.8
catchment-terrestrial	119666.707	12.0
catchment-water	3298.483	0.3
catchment-waterway	1938.225	0.2
mangrove-catchment	3533.184	0.4
mangrove-mangrove	807759.989	80.8
mangrove-mixed	53766.153	5.4
mangrove-reclaimed	2565.488	0.3
mangrove-saltmarsh	82013.414	8.2
mangrove-sand	11361.44	1.1
mangrove-terrestrial	38572.578	3.9
mangrove-water	11990.801	1.2
mangrove-waterway	111273.224	11.1
mixed-catchment	7267.302	0.7
mixed-mangrove	158060.155	15.8
mixed-mixed	392012.452	39.2
mixed-reclaimed	7104.33	0.7
mixed-saltmarsh	86892.765	8.7
mixed-terrestrial	9808.639	1.0
mixed-water	3694.334	0.4
mixed-waterway	366.498	0.0
saltmarsh-catchment	103672.609	10.4
saltmarsh-mangrove	156065.747	15.6
saltmarsh-mixed	211126.018	21.1
saltmarsh-reclaimed	3664.981	0.4
saltmarsh-saltmarsh	1623033.088	162.3
saltmarsh-sand	12177.018	1.2
saltmarsh-terrestrial	109752.299	11.0
saltmarsh-water	17021.251	1.7
saltmarsh-waterway	3550.388	0.4
sand-mangrove	1334.195	0.1
sand-sand	1832.491	0.2
sand-waterway	25880.335	2.6
terrestrial-catchment	40763.239	4.1
terrestrial-mangrove	58216.488	5.8
terrestrial-mixed	7997.127	0.8
terrestrial-reclaimed	6450.37	0.6
terrestrial-saltmarsh	79455.707	7.9
terrestrial-terrestrial	2341252.066	234.1
terrestrial-waterway	35384.872	3.5
water-mangrove	11506.662	1.2
water-mixed	2067.192	0.2
water-saltmarsh	8034.064	0.8
water-terrestrial	366.498	0.0
water-water	2565.486	0.3
water-waterway	366.498	0.0
waterway-catchment	3308.821	0.3
waterway-mangrove	55735.124	5.6
waterway-mixed	732.996	0.1
waterway-sand	17788.098	1.8
waterway-terrestrial	14172.091	1.4
waterway-waterway	2184395.543	218.4

Table A6.9: Areas of habitat change in the Tilligerry Creek mouth, Port Stephens, 1966 to 1975.

change	Area (m²)	Area (ha)
catchment-catchment	3989692.519	399.0
catchment-mangrove	18418.374	1.8
catchment-mixed	12796.325	1.2
catchment-reclaimed	732.996	0.1
catchment-saltmarsh	48496.852	4.8
catchment-terrestrial	54613.473	5.5
catchment-waterway	12864.312	1.3
mangrove-catchment	24174.79	2.4
mangrove-mangrove	910409.808	91.0
mangrove-mixed	106474.59	10.6
mangrove-reclaimed	25923.728	2.6
mangrove-saltmarsh	126737.182	12.7
mangrove-sand	732.996	0.1
mangrove-terrestrial	14239.537	1.4
mangrove-water	24158.381	2.4
mangrove-waterway	36595.143	3.7
mixed-catchment	10631.858	1.1
mixed-mangrove	100506.158	10.1
mixed-mixed	342172.307	34.2
mixed-reclaimed	20471.817	2.0
mixed-saltmarsh	178389.76	17.8
mixed-sand	4397.978	0.4
mixed-terrestrial	9525.98	1.0
mixed-water	732.996	0.1
mixed-waterway	6836.488	0.7
reclaimed-catchment	732.996	0.1
reclaimed-mangrove	366.498	0.0
reclaimed-mixed	1099.494	0.1
reclaimed-reclaimed	10628.443	1.1
reclaimed-saltmarsh	3298.484	0.3
reclaimed-terrestrial	5257.829	0.5
saltmarsh-catchment	109471.992	10.9
saltmarsh-mangrove	102126.44	10.2
saltmarsh-mixed	98110.276	9.8
saltmarsh-reclaimed	28844.002	2.9
saltmarsh-saltmarsh	1561164.973	156.1
saltmarsh-terrestrial	48595.484	4.9
saltmarsh-water	6636.874	0.7
saltmarsh-waterway	967.697	0.1
sand-mangrove	14321.249	1.4
sand-saltmarsh	2198.989	0.2
sand-waterway	24952.478	2.5
terrestrial-catchment	91483.162	0.1
terrestrial-mangrove	62780.764	6.3
terrestrial-mixed	174190.979	17.4
terrestrial-reclaimed	14240.07	1.4
terrestrial-saltmarsh	138511.836	13.9
terrestrial-sand	366.498	0.0
terrestrial-terrestrial	2133249.824	213.3
terrestrial-water	8115.315	0.8
terrestrial-waterway	8091.476	0.8
water-catchment	1465.993	0.1
water-mangrove	12412.187	1.2
water-mixed	2198.988	0.2
water-reclaimed	366.498	0.0
water-saltmarsh	13926.926	1.4
water-water	9030.655	0.9
waterway-mangrove	100435.706	10.0
waterway-mixed	1099.494	0.1
waterway-terrestrial	9015.482	0.9
waterway-water	250.926	0.0
waterway-waterway	2283039.097	228.3

Table A6.10: Areas of habitat change in the Tilligerry Creek mouth, Port Stephens, 1975 to 1983.

change	Area (m2)	Area (ha)
catchment-catchment	3719526.56	372.0
catchment-mangrove	732.996	0.1
catchment-mixed	1099.494	0.1
catchment-reclaimed	1465.992	0.1
catchment-saltmarsh	10178.367	1.0
catchment-terrestrial	101936.223	10.2
mangrove-catchment	17475.028	1.7
mangrove-coastal veg	17868.139	1.8
mangrove-mangrove	884927.871	88.5
mangrove-mixed	83939.473	8.4
mangrove-reclaimed	21741.154	2.2
mangrove-saltmarsh	91196.408	9.1
mangrove-sand	2931.985	0.3
mangrove-terrestrial	110941.36	11.1
mangrove-water	12835.748	1.3
mangrove-waterway	63680.363	6.4
mixed-catchment	3899.682	0.4
mixed-mangrove	180940.758	18.1
mixed-mixed	398765.862	39.9
mixed-reclaimed	12460.934	1.2
mixed-saltmarsh	76325.096	7.6
mixed-terrestrial	62401.605	6.2
mixed-water	3533.184	0.4
reclaimed-catchment	1099.495	0.1
reclaimed-mangrove	14528.127	1.5
reclaimed-mixed	3298.483	0.3
reclaimed-reclaimed	67940.5	6.8
reclaimed-saltmarsh	3678.024	0.4
reclaimed-terrestrial	12541.241	1.3
reclaimed-water	366.498	0.0
saltmarsh-catchment	106870.33	10.7
saltmarsh-mangrove	225818.549	22.6
saltmarsh-mixed	452587.534	45.3
saltmarsh-reclaimed	15404.126	1.5
saltmarsh-saltmarsh	1187805.83	118.8
saltmarsh-terrestrial	70963.337	7.1
saltmarsh-water	6454.35	0.6
saltmarsh-waterway	366.498	0.0
sand-mangrove	1832.491	0.2
sand-saltmarsh	3298.483	0.3
sand-terrestrial	366.498	0.0
terrestrial-catchment	25181.073	2.5
terrestrial-mangrove	8669.97	0.9
terrestrial-mixed	35237.898	3.5
terrestrial-reclaimed	90580.309	9.1
terrestrial-saltmarsh	115320.657	11.5
terrestrial-terrestrial	1975253.21	197.5
terrestrial-water	366.498	0.0
terrestrial-waterway	26254.13	2.6
water-mangrove	21777.758	2.2
water-mixed	2565.486	0.3
water-reclaimed	366.498	0.0
water-saltmarsh	3664.981	0.4
water-terrestrial	7775.522	0.8
water-water	13062.133	1.3
waterway-catchment	24108.507	2.4
waterway-mangrove	138703.381	13.9
waterway-mixed	3298.482	0.3
waterway-reclaimed	3664.981	0.4
waterway-saltmarsh	9832.457	1.0
waterway-sand	5465.258	0.5
waterway-terrestrial	8062.958	0.8
waterway-water	732.996	0.1
waterway-waterway	2207607.292	220.8

Table A6.11: Areas of habitat change in the Tilligerry Creek mouth, Port Stephens, 1983 to 1996.

change	Area (m ²)	Area (ha)
catchment-catchment	3781815	378.2
catchment-mangrove	14224.62	1.4
catchment-mixed	5948.897	0.6
catchment-reclaimed	4323.342	0.4
catchment-saltmarsh	52756.06	5.3
catchment-terrestrial	31524.27	3.2
catchment-water	1116.053	0.1
catchment-waterway	1817.346	0.2
coastal veg-terrestrial	15646.47	1.6
mangrove-catchment	4845.073	0.5
mangrove-coastal veg	302.891	0.0
mangrove-mangrove	1187285	118.7
mangrove-mixed	96585.15	9.7
mangrove-reclaimed	8178.057	0.8
mangrove-saltmarsh	64673.86	6.5
mangrove-sand	12165.97	1.2
mangrove-terrestrial	18033.55	1.8
mangrove-water	8111.009	0.8
mangrove-waterway	97001.32	9.7
mixed-catchment	1514.455	0.2
mixed-coastal veg	3028.91	0.3
mixed-mangrove	287199.6	28.7
mixed-mixed	394348.5	39.4
mixed-reclaimed	3331.801	0.3
mixed-saltmarsh	232523.9	23.3
mixed-terrestrial	44173.07	4.4
mixed-water	3233.658	0.3
mixed-waterway	1817.346	0.2
reclaimed-catchment	4303.388	0.4
reclaimed-mangrove	32294.04	3.2
reclaimed-mixed	14730.42	1.5
reclaimed-reclaimed	106229.8	10.6
reclaimed-saltmarsh	2726.019	0.3
reclaimed-sand	3028.91	0.3
reclaimed-terrestrial	45708.77	4.6
reclaimed-water	908.673	0.1
reclaimed-waterway	1211.564	0.1
saltmarsh-catchment	15685.81	1.6
saltmarsh-coastal veg	13553.63	1.4
saltmarsh-mangrove	148169.3	14.8
saltmarsh-mixed	214632.5	21.5
saltmarsh-reclaimed	7896.81	0.8
saltmarsh-saltmarsh	956706.6	95.7
saltmarsh-sand	2789.483	0.3
saltmarsh-terrestrial	131389.5	13.1
saltmarsh-water	2421.926	0.2
saltmarsh-waterway	2726.019	0.3
sand-mangrove	2117.283	0.2
sand-sand	5650.81	0.6
sand-waterway	1514.455	0.2
terrestrial-catchment	89539.15	9.0
terrestrial-coastal veg	7518.206	0.8
terrestrial-mangrove	24527.61	2.5
terrestrial-mixed	2898.815	0.3
terrestrial-reclaimed	65142.05	6.5
terrestrial-saltmarsh	54755.52	5.5
terrestrial-sand	13114.37	1.3
terrestrial-terrestrial	2092694	209.3
terrestrial-water	8030.366	0.8
terrestrial-waterway	605.782	0.1
water-mangrove	17681.98	1.8
water-mixed	302.891	0.0
water-saltmarsh	4243.414	0.4
water-terrestrial	1902.391	0.2
water-water	14518.11	1.5
water-waterway	302.891	0.0
waterway-catchment	302.891	0.0
waterway-mangrove	58036.2	5.8
waterway-saltmarsh	302.891	0.0
waterway-sand	4917.642	0.5
waterway-terrestrial	25830.21	2.6
waterway-waterway	2162776	216.3

Table A6.12: Areas of habitat change in the Tilligerry Creek mouth, Port Stephens, 1954 to 1996.

change	Area (m2)	Area (ha)
catchment-catchment	3996885.2	399.7
catchment-mangrove	7938.4	0.8
catchment-mixed	302.9	0.0
catchment-reclaimed	10349.2	1.0
catchment-saltmarsh	28335.0	2.8
catchment-terrestrial	115455.5	11.5
catchment-water	5053.6	0.5
catchment-waterway	605.8	0.1
mangrove-catchment	3634.7	0.4
mangrove-coastal veg	6581.6	0.7
mangrove-mangrove	927459.8	92.7
mangrove-mixed	23142.1	2.3
mangrove-reclaimed	7573.8	0.8
mangrove-saltmarsh	29013.8	2.9
mangrove-sand	26493.5	2.6
mangrove-terrestrial	59087.1	5.9
mangrove-water	11121.6	1.1
mangrove-waterway	48429.7	4.8
mixed-catchment	17220.2	1.7
mixed-mangrove	329639.0	33.0
mixed-mixed	269172.0	26.9
mixed-reclaimed	12715.8	1.3
mixed-saltmarsh	20460.4	2.0
mixed-terrestrial	5053.5	0.5
mixed-water	2120.2	0.2
saltmarsh-catchment	139220.3	13.9
saltmarsh-coastal veg	9756.2	1.0
saltmarsh-mangrove	366160.5	36.6
saltmarsh-mixed	432614.4	43.3
saltmarsh-reclaimed	43674.2	4.4
saltmarsh-saltmarsh	1121559.7	112.2
saltmarsh-sand	1211.6	0.1
saltmarsh-terrestrial	105102.2	10.5
saltmarsh-water	6565.3	0.7
saltmarsh-waterway	1817.3	0.2
sand-mangrove	2535.0	0.3
sand-sand	4054.9	0.4
sand-waterway	23259.9	2.3
terrestrial-catchment	82660.8	8.3
terrestrial-coastal veg	8285.8	0.8
terrestrial-mangrove	62323.3	6.2
terrestrial-mixed	4065.0	0.4
terrestrial-reclaimed	117534.0	11.8
terrestrial-saltmarsh	169078.4	16.9
terrestrial-sand	4979.4	0.5
terrestrial-terrestrial	2119399.5	211.9
terrestrial-water	4178.5	0.4
terrestrial-waterway	1211.6	0.1
water-catchment	717.7	0.1
water-mangrove	11292.3	1.1
water-mixed	908.7	0.1
water-saltmarsh	3937.6	0.4
water-terrestrial	1211.6	0.1
water-water	10396.8	1.0
water-waterway	302.9	0.0
waterway-catchment	302.9	0.0
waterway-mangrove	56884.6	5.7
waterway-sand	4723.5	0.5
waterway-terrestrial	6759.4	0.7
waterway-water	302.9	0.0
waterway-waterway	2291888.9	229.2

Black Neds Bay, Swansea Channel, Lake Macquarie

Table A6.13: Static coastal wetland habitat areas (ha) in Black Neds Bay, Lake Macquarie, 1950 to 1999.

	1950	1961	1974	1987	1999
coastal veg	1.7	1.4	1.7	1.4	1.6
mangrove	0.4	23.3	25.5	33.1	40
mixed	6.9	1	7.8	5.4	2.2
reclaimed land	0.7	0	0.7	0.4	0.2
saltmarsh	38.5	43.5	44.4	33.9	33.9
terrestrial	35.8	26.4	14.9	16.7	15.3

Table A6.14: Areas of habitat change in Black Neds Bay, Lake Macquarie, 1950 to 1961.

change	Area (m ²)	Area (ha)
catchment-catchment	79782.428	8.0
catchment-mangrove	2665.736	0.3
catchment-saltmarsh	5221.758	0.5
catchment-terrestrial	2696.061	0.3
coastal veg-coastal veg	1427.012	0.1
coastal veg-mangrove	3518.202	0.4
coastal veg-mixed	4681.083	0.5
coastal veg-saltmarsh	5150.544	0.5
coastal veg-waterway	1994.493	0.2
mangrove-mangrove	1779.168	0.2
mangrove-saltmarsh	314.068	0.0
mangrove-waterway	774.822	0.1
mixed-mangrove	5479.713	0.5
mixed-mixed	1596.595	0.2
mixed-saltmarsh	51608.361	5.2
mixed-terrestrial	10931.055	1.1
reclaimed-catchment	6350.404	0.6
reclaimed-terrestrial	381.806	0.0
saltmarsh-coastal veg	4894.96	0.5
saltmarsh-mangrove	18394.692	1.8
saltmarsh-mixed	6553.489	0.7
saltmarsh-saltmarsh	278026.408	27.8
saltmarsh-terrestrial	33461.98	3.3
saltmarsh-water	451.747	0.1
saltmarsh-waterway	41780.136	4.2
terrestrial-catchment	22478.799	2.2
terrestrial-coastal veg	7037.44	0.7
terrestrial-mangrove	543.268	0.1
terrestrial-mixed	877.235	0.1
terrestrial-saltmarsh	69200.497	6.9
terrestrial-terrestrial	207527.051	20.8
terrestrial-water	108.312	0.0
terrestrial-waterway	50525.146	5.1
water-saltmarsh	468.791	0.1
water-water	487.407	0.1
waterway-catchment	730.477	0.1
waterway-coastal veg	486.794	0.1
waterway-mangrove	201085.41	20.1
waterway-mixed	1404.634	0.1
waterway-mudflat	17529.378	1.8
waterway-saltmarsh	26676.888	2.7
waterway-terrestrial	646.422	0.1
waterway-waterway	767544.443	76.8

Table A6.15: Areas of habitat change in Black Neds Bay, Lake Macquarie, 1961 to 1974.

change	Area (m²)	Area (ha)
catchment-catchment	103248.302	10.3
catchment-reclaimed	113.228	0.0
catchment-terrestrial	413.773	0.0
coastal veg-saltmarsh	1974.909	0.2
coastal veg-waterway	11867.896	1.2
mangrove-catchment	416.632	0.0
mangrove-coastal veg	3118.883	0.3
mangrove-dredge spoil	162.468	0.0
mangrove-mangrove	162885.923	16.3
mangrove-mixed	6887.801	0.7
mangrove-saltmarsh	11423.086	1.1
mangrove-terrestrial	1871.865	0.2
mangrove-water	3259.079	0.3
mangrove-waterway	43491.977	4.3
mixed-mixed	8681.793	0.9
mixed-reclaimed	432.828	0.0
mixed-saltmarsh	3710.964	0.4
mixed-terrestrial	2284.699	0.2
mudflat-mangrove	7010.815	0.7
mudflat-waterway	10515.058	1.1
saltmarsh-catchment	1697.713	0.2
saltmarsh-coastal veg	498.708	0.1
saltmarsh-mangrove	40717.192	4.1
saltmarsh-mixed	36341.48	3.6
saltmarsh-reclaimed	2254.545	0.2
saltmarsh-saltmarsh	311119.09	31.1
saltmarsh-terrestrial	20466.756	2.0
saltmarsh-water	3531.033	0.4
saltmarsh-waterway	19782.175	2.0
terrestrial-catchment	22168.873	2.2
terrestrial-reclaimed	3681.724	0.4
terrestrial-saltmarsh	103503.019	10.4
terrestrial-terrestrial	124133.851	12.4
terrestrial-water	1366.864	0.1
terrestrial-waterway	305.462	0.0
waterway-catchment	523.171	0.1
waterway-coastal veg	12477.437	1.2
waterway-dredge spoil	49544.957	5.0
waterway-mangrove	44359.063	4.4
waterway-mixed	24480.085	2.4
waterway-saltmarsh	14318.571	1.4
waterway-water	216.625	0.0
waterway-waterway	708919.001	70.9

Table A6.16: Areas of habitat change in Black Neds Bay, Lake Macquarie, 1974 to 1987.

change	Area (m²)	Area (ha)
catchment-catchment	124904.881	12.5
catchment-reclaimed	54.052	0.0
catchment-saltmarsh	546.819	0.1
catchment-terrestrial	11397.66	1.1
catchment-waterway	855.704	0.1
coastal veg-coastal veg	1209.474	0.1
coastal veg-mangrove	6150.051	0.6
coastal veg-waterway	9179.708	0.9
dredge spoil-dredge spoil	18885.117	1.9
dredge spoil-mangrove	12057.111	1.2
dredge spoil-reclaimed	308.079	0.0
dredge spoil-waterway	18592.104	1.9
mangrove-coastal veg	706.013	0.1
mangrove-dredge spoil	324.31	0.0
mangrove-mangrove	204137.212	20.4
mangrove-mixed	8854.71	0.9
mangrove-reclaimed	1064.518	0.1
mangrove-saltmarsh	16110.843	1.6
mangrove-terrestrial	54.052	0.0
mangrove-water	810.775	0.1
mangrove-waterway	22561.505	2.3
mixed-coastal veg	1487.364	0.1
mixed-mangrove	26219.688	2.6
mixed-mixed	27345.192	2.7
mixed-reclaimed	216.732	0.0
mixed-saltmarsh	4316.809	0.4
mixed-terrestrial	54.052	0.0
mixed-water	216.207	0.0
mixed-waterway	16606.259	1.7
reclaimed-catchment	1064.219	0.1
reclaimed-reclaimed	648.623	0.1
reclaimed-saltmarsh	570.54	0.1
reclaimed-terrestrial	3649.811	0.4
reclaimed-water	54.052	0.0
reclaimed-waterway	307.794	0.0
saltmarsh-coastal veg	6028.217	0.6
saltmarsh-mangrove	38811.121	3.9
saltmarsh-mixed	17121.046	1.7
saltmarsh-reclaimed	54.052	0.0
saltmarsh-saltmarsh	287497.597	28.7
saltmarsh-terrestrial	47353.574	4.7
saltmarsh-water	1074.69	0.1
saltmarsh-waterway	47226.185	4.7
terrestrial-catchment	1187.491	0.1
terrestrial-mangrove	1414.627	0.1
terrestrial-reclaimed	2000.623	0.2
terrestrial-saltmarsh	27564.916	2.8
terrestrial-terrestrial	101411.996	10.1
terrestrial-water	1451.906	0.1
terrestrial-waterway	14545.122	1.5
water-coastal veg	54.052	0.0
water-mangrove	2771.895	0.3
water-saltmarsh	2873.381	0.3
water-terrestrial	2006.137	0.2
water-water	162.155	0.0
waterway-catchment	216.207	0.0
waterway-coastal veg	2026.131	0.2
waterway-dredge spoil	4456.799	0.4
waterway-mangrove	39558.29	4.0
waterway-reclaimed	162.156	0.0
waterway-waterway	559649.113	56.0

Table A6.17: Areas of habitat change in Black Neds Bay, Lake Macquarie, 1987 to 1999.

change	Area (m ²)	Area (ha)
catchment-catchment	89195.946	8.9
catchment-mangrove	54.156	0.0
catchment-reclaimed	296.155	0.0
catchment-terrestrial	1799.231	0.2
catchment-waterway	741.263	0.1
coastal veg-coastal veg	4823.211	0.5
coastal veg-mangrove	3264.711	0.3
coastal veg-mixed	108.313	0.0
coastal veg-saltmarsh	1016.77	0.0
coastal veg-terrestrial	1392.389	0.1
coastal veg-waterway	2997.146	0.3
dredge spoil-dredge spoil	12619.087	1.3
dredge spoil-mangrove	8075.447	0.8
dredge spoil-waterway	3099.455	0.3
mangrove-coastal veg	1723.008	0.2
mangrove-dredge spoil	1558.44	0.2
mangrove-mangrove	301358.142	30.1
mangrove-mixed	1729.803	0.2
mangrove-saltmarsh	11384.318	1.1
mangrove-terrestrial	1657.536	0.2
mangrove-water	275.697	0.0
mangrove-waterway	11444.213	1.0
mixed-mangrove	33643.351	1.1
mixed-mixed	13015.103	1.3
mixed-saltmarsh	7313.612	0.7
mudflat-mangrove	541.302	0.1
reclaimed-dredge spoil	216.626	0.0
reclaimed-mangrove	1562.749	0.2
reclaimed-reclaimed	487.404	0.1
reclaimed-saltmarsh	54.156	0.0
reclaimed-terrestrial	1536.081	0.2
reclaimed-waterway	304.866	0.0
saltmarsh-catchment	3774.409	0.4
saltmarsh-coastal veg	1660.609	0.2
saltmarsh-mangrove	14745.831	1.5
saltmarsh-mixed	4364.3	0.4
saltmarsh-saltmarsh	290588.773	29.1
saltmarsh-terrestrial	19507.017	2.0
saltmarsh-water	2125.952	0.2
saltmarsh-waterway	1247.749	0.1
terrestrial-catchment	9446.1	0.9
terrestrial-coastal veg	54.156	0.0
terrestrial-mangrove	780.158	0.1
terrestrial-reclaimed	721.634	0.1
terrestrial-saltmarsh	29330.268	2.9
terrestrial-terrestrial	124323.256	12.4
terrestrial-water	324.938	0.0
terrestrial-waterway	1392.552	0.1
water-mangrove	550.107	0.1
water-saltmarsh	1255.202	0.1
water-terrestrial	595.72	0.1
water-water	1290.444	0.1
waterway-catchment	1385.999	0.1
waterway-coastal veg	7094.439	0.7
waterway-dredge spoil	4723.235	0.5
waterway-mangrove	30070.953	3.0
waterway-mixed	1236.078	0.1
waterway-saltmarsh	572.394	0.1
waterway-terrestrial	464.948	0.1
waterway-waterway	655075.728	65.5

Table A6.18: Areas of habitat change in Black Neds Bay, Lake Macquarie, 1950 to 1999.

change	Area (m²)	Area (ha)
catchment-catchment	66095.228	6.6
catchment-mangrove	2045.138	0.2
catchment-saltmarsh	44.757	0.0
catchment-terrestrial	1844.084	0.2
catchment-waterway	564.466	0.1
coastal veg-coastal veg	879.489	0.1
coastal veg-mangrove	3610.662	0.4
coastal veg-mixed	73.419	0.0
coastal veg-waterway	12154.055	1.2
mangrove-catchment	60.416	0.0
mangrove-mangrove	1624.442	0.2
mangrove-saltmarsh	211.911	0.0
mangrove-terrestrial	89.515	0.0
mangrove-waterway	879.533	0.1
mixed-mangrove	16618.616	1.7
mixed-mixed	328.687	0.0
mixed-reclaimed	337.088	0.0
mixed-saltmarsh	40205.087	4.0
mixed-terrestrial	11619.566	1.2
reclaimed-catchment	7163.851	0.7
reclaimed-terrestrial	227.952	0.0
saltmarsh-coastal veg	6122.051	0.6
saltmarsh-mangrove	87785.021	8.8
saltmarsh-mixed	19922.679	2.0
saltmarsh-saltmarsh	199447.605	19.9
saltmarsh-terrestrial	7018.34	0.7
saltmarsh-water	1834.7	0.2
saltmarsh-waterway	63294.463	6.3
terrestrial-catchment	36910.467	3.7
terrestrial-coastal veg	5075.383	0.5
terrestrial-mangrove	596.394	0.1
terrestrial-reclaimed	830.971	0.1
terrestrial-saltmarsh	83753.057	8.4
terrestrial-terrestrial	132319.574	13.2
terrestrial-water	802.813	0.1
terrestrial-waterway	90546.589	9.1
waterway-coastal veg	3384.628	0.3
waterway-dredge spoil	18994.964	1.9
waterway-mangrove	286116.49	28.6
waterway-mixed	1249.526	0.1
waterway-saltmarsh	15856.353	1.6
waterway-terrestrial	179.029	0.0
waterway-water	1085.906	0.1
waterway-waterway	590846.699	59.1

Pelican, Rileys and St Huberts Islands, Brisbane Water

Table A6.19: Static coastal wetland habitat areas (ha) on Pelican, Rileys and St Huberts Islands, Brisbane Water, 1954 to 1998.

	1954	1965	1975	1986	1998
'developed' habitat	29.3	31.4	17	4.2	0
mangrove	51.9	54.2	65.2	63.9	64
mixed	27.4	30.6	12.9	14.3	13.4
reclaimed land	14.1	17.4	59.6	54.5	59.6
saltmarsh	44.3	34.6	16.2	13.5	13
terrestrial	20.6	22.5	13.5	22.6	28.3

Table A6.20: Areas of habitat change on Pelican, Rileys and St Huberts Islands, Brisbane Water, 1954 to 1965.

change	Area (m ²)	Area (ha)
'developed' habitat-'developed' habitat	248084.348	24.8
'developed' habitat-mangrove	844.613	0.8
'developed' habitat-mixed	1266.919	0.1
'developed' habitat-reclaimed	41884.76	4.2
'developed' habitat-waterway	211.153	0.0
mangrove-'developed' habitat	6968.324	0.7
mangrove-mangrove	404015.754	40.4
mangrove-mixed	60705.774	6.1
mangrove-reclaimed	1570.919	0.2
mangrove-saltmarsh	22770.621	2.3
mangrove-terrestrial	844.614	0.1
mangrove-waterway	17827.348	1.8
mixed-mangrove	55507.488	5.6
mixed-mixed	171266.595	17.1
mixed-reclaimed	6141.378	0.6
mixed-saltmarsh	14846.076	1.5
mixed-terrestrial	22851.725	2.3
mixed-waterway	7390.363	0.7
reclaimed-'developed' habitat	10446.177	1.0
reclaimed-mangrove	2816.751	0.3
reclaimed-mixed	211.153	0.0
reclaimed-reclaimed	104479.925	10.4
reclaimed-saltmarsh	12696.723	1.3
reclaimed-terrestrial	3767.406	0.4
reclaimed-waterway	7934.592	0.8
saltmarsh-'developed' habitat	27373.357	2.7
saltmarsh-mangrove	21591.463	2.2
saltmarsh-mixed	65283.337	6.5
saltmarsh-reclaimed	15892.111	1.6
saltmarsh-saltmarsh	270164.478	27.0
saltmarsh-terrestrial	24105.157	2.4
saltmarsh-waterway	14762.07	1.5
terrestrial-mangrove	211.153	0.0
terrestrial-mixed	557.526	0.1
terrestrial-reclaimed	566.874	0.1
terrestrial-saltmarsh	12144.097	1.2
terrestrial-terrestrial	193155.11	19.3
waterway-'developed' habitat	422.307	0.0
waterway-mangrove	52957.754	5.3
waterway-mixed	1613.292	0.2
waterway-reclaimed	5158.639	0.5
waterway-saltmarsh	15998.823	1.6
waterway-waterway	7631011.122	763.1

Table A6.21: Areas of habitat change on Pelican, Rileys and St Huberts Islands, Brisbane Water, 1965 to 1975.

change	Area (m²)	Area (ha)
'developed' habitat-'developed' habitat	42714.551	4.3
'developed' habitat-mangrove	8235.593	0.8
'developed' habitat-reclaimed	234348.081	23.4
'developed' habitat-waterway	29640.928	3.0
mangrove-mangrove	344754.645	34.5
mangrove-mixed	6047.512	0.6
mangrove-reclaimed	112994.23	11.3
mangrove-saltmarsh	1402.138	0.1
mangrove-waterway	75394.401	7.5
mixed-'developed' habitat	422.306	0.0
mixed-mangrove	186912.253	18.7
mixed-mixed	57852.507	5.8
mixed-reclaimed	45382.468	4.5
mixed-saltmarsh	5424.918	0.5
mixed-waterway	6009.708	0.6
reclaimed-'developed' habitat	18076.266	1.8
reclaimed-mangrove	2275.114	0.2
reclaimed-mixed	1797.503	0.2
reclaimed-reclaimed	137569.599	13.8
reclaimed-terrestrial	2533.84	0.3
reclaimed-waterway	12469.24	1.2
saltmarsh-'developed' habitat	20060.237	2.0
saltmarsh-mangrove	72465.295	7.2
saltmarsh-mixed	50073.689	5.0
saltmarsh-reclaimed	26843.93	2.7
saltmarsh-saltmarsh	148974.853	14.9
saltmarsh-terrestrial	15054.012	1.5
saltmarsh-waterway	12575.45	1.3
terrestrial-'developed' habitat	89313.275	8.9
terrestrial-mangrove	1689.227	0.2
terrestrial-mixed	1824.447	0.2
terrestrial-reclaimed	5378.91	0.5
terrestrial-saltmarsh	7659.219	0.8
terrestrial-terrestrial	116470.764	11.6
terrestrial-waterway	1266.92	0.1
waterway-mangrove	36545.143	3.7
waterway-mixed	7875.376	0.8
waterway-reclaimed	32559.359	3.3
waterway-waterway	7551636.013	755.2

Table A6.22: Areas of habitat change on Pelican, Rileys and St Huberts Islands, Brisbane Water, 1975 to 1986.

change	Area (m²)	Area (ha)
'developed' habitat-'developed' habitat	23490.528	2.3
'developed' habitat-mangrove	1478.073	0.1
'developed' habitat-reclaimed	60711.926	6.1
'developed' habitat-saltmarsh	5959.867	0.6
'developed' habitat-terrestrial	79198.752	7.9
mangrove-'developed' habitat	1911.777	0.2
mangrove-mangrove	529283.319	52.9
mangrove-mixed	42712.779	4.3
mangrove-reclaimed	7120.88	0.7
mangrove-saltmarsh	15503.06	1.6
mangrove-terrestrial	4321.995	0.4
mangrove-waterway	53969.007	5.4
mixed-'developed' habitat	633.46	0.1
mixed-mangrove	30952.89	3.1
mixed-mixed	69007.197	6.9
mixed-reclaimed	211.153	0.0
mixed-saltmarsh	12626.1	1.3
mixed-terrestrial	1991.077	0.2
mixed-waterway	8064.183	0.8
reclaimed-'developed' habitat	12651.741	1.3
reclaimed-mangrove	6107.676	0.6
reclaimed-mixed	3070.978	0.3
reclaimed-reclaimed	473525.783	47.4
reclaimed-saltmarsh	1689.226	0.2
reclaimed-terrestrial	5602.532	0.6
reclaimed-waterway	91620.211	9.2
saltmarsh-'developed' habitat	1554.006	0.2
saltmarsh-mangrove	26118.47	2.6
saltmarsh-mixed	24171.764	2.4
saltmarsh-reclaimed	2031.651	0.2
saltmarsh-saltmarsh	81638.731	8.2
saltmarsh-terrestrial	25567.485	2.6
saltmarsh-waterway	983.182	0.1
terrestrial-'developed' habitat	1755.877	0.2
terrestrial-mangrove	5817.146	0.6
terrestrial-mixed	2581.568	0.3
terrestrial-reclaimed	346.373	0.0
terrestrial-saltmarsh	14665.372	1.5
terrestrial-terrestrial	109364.689	10.9
waterway-'developed' habitat	211.153	0.0
waterway-mangrove	38088.422	3.8
waterway-mixed	422.306	0.0
waterway-reclaimed	2202.496	0.2
waterway-saltmarsh	1900.378	0.2
waterway-terrestrial	211.153	0.0
waterway-waterway	7037373.231	703.7

Table A6.23: Areas of habitat change on Pelican, Rileys and St Huberts Islands, Brisbane Water, 1986 to 1998.

change	Area (m²)	Area (ha)
'developed' habitat-mangrove	856.011	0.1
'developed' habitat-mixed	1202.123	0.1
'developed' habitat-reclaimed	1755.306	0.2
'developed' habitat-saltmarsh	3199.248	0.3
'developed' habitat-terrestrial	32853.675	3.3
'developed' habitat-waterway	1785.548	0.2
mangrove-mangrove	525176.217	52.5
mangrove-mixed	44069.325	4.4
mangrove-reclaimed	5244.598	0.5
mangrove-saltmarsh	18275.508	1.8
mangrove-terrestrial	9115.885	0.9
mangrove-waterway	36421.826	3.6
mixed-mangrove	37205.178	3.7
mixed-mixed	69918.349	7.0
mixed-reclaimed	2015.212	0.2
mixed-saltmarsh	26831.251	2.7
mixed-terrestrial	5117.653	0.5
mixed-waterway	844.612	0.1
reclaimed-mangrove	3028.128	0.3
reclaimed-reclaimed	534149.881	53.4
reclaimed-saltmarsh	422.306	0.0
reclaimed-terrestrial	5239.653	0.5
reclaimed-waterway	4282.348	0.4
saltmarsh-mangrove	24188.908	2.4
saltmarsh-mixed	9023.611	0.9
saltmarsh-saltmarsh	71460.828	7.1
saltmarsh-terrestrial	25339.292	2.5
saltmarsh-waterway	4339.068	0.4
terrestrial-mangrove	4301.608	0.4
terrestrial-mixed	5130.148	0.5
terrestrial-reclaimed	304.001	0.0
terrestrial-saltmarsh	9506.985	1.0
terrestrial-terrestrial	206545.027	20.7
terrestrial-waterway	633.459	0.1
waterway-mangrove	43502.161	4.4
waterway-mixed	1055.765	0.1
waterway-reclaimed	51901.771	5.2
waterway-saltmarsh	1561.521	0.2
waterway-waterway	6704194.597	670.4

Table A6.24: Areas of habitat change on Pelican, Rileys and St Huberts Islands, Brisbane Water, 1954 to 1998.

change	Area (m²)	Area (ha)
'developed' habitat-mangrove	2807.628	0.3
'developed' habitat-waterway	289570.266	29.0
mangrove-mangrove	322862.325	32.3
mangrove-mixed	21892.327	2.2
mangrove-reclaimed	85375.975	8.5
mangrove-saltmarsh	7456.251	0.7
mangrove-terrestrial	4929.112	0.5
mangrove-waterway	73807.883	7.4
mixed-mangrove	140759.27	14.1
mixed-mixed	45860.416	4.6
mixed-reclaimed	59157.074	5.9
mixed-saltmarsh	13617.037	1.4
mixed-terrestrial	1900.379	0.2
mixed-waterway	14854.917	1.5
reclaimed-reclaimed	93827.662	9.4
reclaimed-saltmarsh	3714.097	0.4
reclaimed-terrestrial	28132.094	2.8
reclaimed-waterway	17566.995	1.8
saltmarsh-mangrove	116608.826	11.7
saltmarsh-mixed	58877.651	5.9
saltmarsh-reclaimed	77531.843	7.8
saltmarsh-saltmarsh	101212.223	10.1
saltmarsh-terrestrial	53363.027	5.3
saltmarsh-waterway	30474.969	3.0
terrestrial-mangrove	1194.335	0.1
terrestrial-mixed	2356.931	0.2
terrestrial-reclaimed	3323.899	0.3
terrestrial-saltmarsh	3301.918	0.3
terrestrial-terrestrial	195403.013	19.5
terrestrial-waterway	844.613	0.1
waterway-mangrove	52155.26	5.2
waterway-mixed	2533.841	0.3
waterway-reclaimed	16539.957	1.7
waterway-saltmarsh	2111.531	0.2
waterway-terrestrial	748.292	0.1
waterway-waterway	6724485.615	672.4

Courangra Point, Hawkesbury River

Table A6.25: Static coastal wetland habitat areas (ha) at Courangra Point, Hawkesbury River, 1954 to 1998.

	1954	1966	1975	1986	1994
mangrove	34.6	41	54.5	50.9	54
mixed	6	11.8	7.1	7.5	6.8
reclaimed land	1.4	0.2	0	0	0
saltmarsh	47.7	37.5	32.1	31.6	29.5
terrestrial	11.1	15.2	20.3	17.7	18.6

Table A6.26: Areas of habitat change at Courangra Point, Hawkesbury River, 1954 to 1966.

change	Area (m²)	Area (ha)
catchment-catchment	779560.403	78.0
catchment-mangrove	80.098	0.0
catchment-mixed	8223.75	0.8
catchment-saltmarsh	18622.003	1.9
catchment-terrestrial	34342.5	3.4
mangrove-catchment	10170.702	1.0
mangrove-mangrove	190939.259	19.1
mangrove-mixed	36294.361	3.6
mangrove-saltmarsh	48414.479	4.8
mangrove-terrestrial	14359.21	1.4
mangrove-waterway	44727.839	4.5
mixed-catchment	7787.934	0.8
mixed-mangrove	19195.834	1.9
mixed-mixed	5782.166	0.6
mixed-saltmarsh	16960.614	1.7
mixed-terrestrial	8854.555	0.9
mudflat-mangrove	320.391	0.0
reclaimed-catchment	134.937	0.0
reclaimed-saltmarsh	13637.77	1.4
reclaimed-terrestrial	560.685	0.1
saltmarsh-catchment	44063.49	4.4
saltmarsh-mangrove	104856.063	10.5
saltmarsh-mixed	49668.372	5.0
saltmarsh-reclaimed	1733.347	0.2
saltmarsh-saltmarsh	233988.456	23.4
saltmarsh-terrestrial	44057.51	4.4
saltmarsh-waterway	480.588	0.1
terrestrial-catchment	16736.401	1.7
terrestrial-mangrove	1612.38	0.2
terrestrial-mixed	2062.584	0.2
terrestrial-reclaimed	640.783	0.1
terrestrial-saltmarsh	42298.101	4.2
terrestrial-terrestrial	46702.766	4.7
waterway-catchment	3598.551	0.4
waterway-mangrove	93265.06	9.3
waterway-mixed	4416.363	0.4
waterway-saltmarsh	1834.031	0.2
waterway-terrestrial	1923.885	0.2
waterway-waterway	484273.07	48.4

Table A6.27: Areas of habitat change at Courangra Point, Hawkesbury River, 1966 to 1975.

change	Area (m²)	Area (ha)
catchment-catchment	733831.427	73.4
catchment-mangrove	32130.935	3.2
catchment-mixed	10374.683	1.0
catchment-saltmarsh	28828.378	2.9
catchment-terrestrial	64236.293	6.4
catchment-waterway	9328.356	0.9
mangrove-mangrove	275045.28	27.5
mangrove-mixed	17601.845	1.8
mangrove-saltmarsh	50141.031	5.0
mangrove-terrestrial	1737.935	0.2
mangrove-waterway	64267.071	6.4
mixed-catchment	6261.174	0.6
mixed-mangrove	68786.869	6.9
mixed-mixed	5427.415	0.5
mixed-saltmarsh	21552.624	2.2
mixed-terrestrial	3242.567	0.3
mixed-waterway	2025.983	0.2
reclaimed-saltmarsh	678.426	0.1
reclaimed-terrestrial	1787.356	0.2
saltmarsh-catchment	6854.406	0.7
saltmarsh-mangrove	81428.805	8.1
saltmarsh-mixed	31512.099	3.2
saltmarsh-saltmarsh	192594.951	19.3
saltmarsh-terrestrial	63468.325	6.3
saltmarsh-waterway	750.148	0.1
terrestrial-catchment	21649.127	2.2
terrestrial-mangrove	28570.687	2.9
terrestrial-mixed	5445.61	0.5
terrestrial-saltmarsh	26215.259	2.6
terrestrial-terrestrial	67462.59	6.7
terrestrial-waterway	2175.59	0.2
waterway-mangrove	60331.965	6.0
waterway-waterway	520333.183	52.0

Table A6.28: Areas of habitat change at Courangra Point, Hawkesbury River, 1975 to 1986.

change	Area (m²)	Area (ha)
catchment-catchment	883646.535	88.4
catchment-saltmarsh	193.836	0.0
catchment-terrestrial	2322.942	0.2
catchment-waterway	96.918	0.0
mangrove-catchment	7650.526	0.8
mangrove-mangrove	450263.828	45.0
mangrove-mixed	36629.718	3.7
mangrove-saltmarsh	26710.641	2.7
mangrove-terrestrial	3392.132	0.3
mangrove-waterway	21497.771	2.1
mixed-catchment	3445.758	0.3
mixed-mangrove	28652.666	2.9
mixed-mixed	18923.81	1.9
mixed-saltmarsh	18952.777	1.9
mixed-terrestrial	387.672	0.0
saltmarsh-catchment	11119.385	1.1
saltmarsh-mangrove	17790.603	1.8
saltmarsh-mixed	18084.477	1.8
saltmarsh-saltmarsh	248300.903	24.8
saltmarsh-terrestrial	24755.598	2.5
terrestrial-catchment	19307.609	1.9
terrestrial-mangrove	14276.037	1.4
terrestrial-mixed	1237.819	0.1
terrestrial-saltmarsh	21427.176	2.1
terrestrial-terrestrial	145648.464	14.6
waterway-catchment	792.003	0.1
waterway-mangrove	1066.098	0.1
waterway-waterway	610443.772	61.0

Table A6.29: Areas of habitat change at Courangra Point, Hawkesbury River, 1986 to 1994.

change	Area (m²)	Area (ha)
catchment-catchment	881245.36	88.1
catchment-mangrove	3679.084	0.4
catchment-saltmarsh	387.297	0.0
catchment-terrestrial	6522.159	0.7
catchment-waterway	96.824	0.0
mangrove-catchment	511.306	0.1
mangrove-mangrove	466541.476	46.7
mangrove-mixed	19732.549	2.0
mangrove-saltmarsh	13570.683	1.4
mangrove-terrestrial	9389.554	0.9
mangrove-waterway	1839.659	0.2
mixed-catchment	290.473	0.0
mixed-mangrove	29830.927	3.0
mixed-mixed	32853.096	3.3
mixed-saltmarsh	9824.171	1.0
mixed-terrestrial	2246.331	0.2
saltmarsh-catchment	3425.781	0.3
saltmarsh-mangrove	26426.796	2.6
saltmarsh-mixed	14388.569	1.4
saltmarsh-saltmarsh	253114.655	25.3
saltmarsh-terrestrial	17204.662	1.7
terrestrial-catchment	8620.669	0.9
terrestrial-mangrove	1901.665	0.2
terrestrial-mixed	96.824	0.0
terrestrial-saltmarsh	14398.406	1.4
terrestrial-terrestrial	151137.046	15.1
waterway-catchment	96.824	0.0
waterway-mangrove	16243.425	1.6
waterway-waterway	590966.659	59.1

Table A6.30: Areas of habitat change at Courangra Point, Hawkesbury River, 1954 to 1994.

change	Area (m²)	Area (ha)
catchment-catchment	809956.163	81.0
catchment-mangrove	5169.193	0.5
catchment-saltmarsh	1517.091	0.2
catchment-terrestrial	42867.432	4.3
catchment-waterway	1531.761	0.2
mangrove-catchment	96.918	0.0
mangrove-mangrove	325130.309	32.5
mangrove-mixed	10460.033	1.0
mangrove-saltmarsh	4755.011	0.5
mangrove-terrestrial	2337.512	0.2
mangrove-waterway	6494.403	0.6
mixed-catchment	989.091	0.1
mixed-mangrove	41286.98	4.1
mixed-mixed	9316.866	0.9
mixed-saltmarsh	4484.314	0.4
mixed-terrestrial	2319.907	0.2
mudflat-mangrove	290.754	0.0
mudflat-mixed	96.918	0.0
reclaimed-catchment	1169.939	0.1
reclaimed-saltmarsh	7049.049	0.7
reclaimed-terrestrial	5101.089	0.5
saltmarsh-catchment	3527.723	0.4
saltmarsh-mangrove	119341.125	11.9
saltmarsh-mixed	46634.045	4.7
saltmarsh-saltmarsh	274797.166	27.5
saltmarsh-terrestrial	32057.867	3.2
terrestrial-catchment	872.263	0.1
terrestrial-mangrove	5236.735	0.5
terrestrial-mixed	193.836	0.0
terrestrial-saltmarsh	5526.08	0.6
terrestrial-terrestrial	98795.377	9.9
waterway-mangrove	42480.586	4.2
waterway-waterway	510576.89	51.1

Careel Bay, Pittwater

Table A6.31: Static coastal wetland habitat areas (ha) in Careel Bay, Pittwater, 1940 to 1996.

	1940	1965	1974	1986	1996
mangrove	2	8.3	8.7	10.3	10.3
mixed		7.1	3.2	2.3	2.1
reclaimed land		0.5	8.7	8.1	7.2
saltmarsh	21.6	8.6	1	0.8	0.7
terrestrial	8.4	4.4	7.2	6.1	7.1

Table A6.32: Areas of habitat change in Careel Bay, Pittwater, 1940 to 1965.

change	Area (m²)	Area (ha)
catchment-catchment	99819.949	10.0
catchment-mangrove	3150.05	0.3
catchment-mixed	358.858	0.0
catchment-reclaimed	22.496	0.0
catchment-saltmarsh	329.703	0.0
catchment-terrestrial	3390.44	0.3
mangrove-mangrove	14423.375	1.4
mangrove-mixed	2195.147	0.2
mangrove-reclaimed	22.496	0.0
mangrove-saltmarsh	1973.83	0.2
mangrove-terrestrial	22.496	0.0
mangrove-waterway	165.829	0.0
saltmarsh-catchment	2759.771	0.3
saltmarsh-mangrove	54453.975	5.4
saltmarsh-mixed	58873.019	5.9
saltmarsh-reclaimed	978.597	0.1
saltmarsh-saltmarsh	65401.706	6.5
saltmarsh-terrestrial	9529.984	9.5
saltmarsh-waterway	23076.811	2.3
terrestrial-catchment	18080.081	1.8
terrestrial-mangrove	5846.106	0.6
terrestrial-mixed	8360.559	0.8
terrestrial-reclaimed	2420.392	0.2
terrestrial-saltmarsh	18278.802	1.8
terrestrial-terrestrial	30522.449	3.1
terrestrial-waterway	485.554	0.1
waterway-catchment	542.927	0.1
waterway-mangrove	3451.489	0.3
waterway-mixed	1133.57	0.1
waterway-reclaimed	126.559	0.0
waterway-waterway	30770.925	3.1

Table A6.33: Areas of habitat change in Careel Bay, Pittwater, 1965 to 1974.

change	Area (m²)	Area (ha)
catchment-catchment	96365.911	9.6
catchment-reclaimed	268.204	0.0
catchment-terrestrial	22885.602	2.3
catchment-waterway	633.664	0.1
mangrove-catchment	8728.505	0.9
mangrove-mangrove	49115.496	4.9
mangrove-mixed	8007.355	0.8
mangrove-reclaimed	5270.067	0.5
mangrove-saltmarsh	1202.694	0.1
mangrove-terrestrial	7129.834	0.7
mangrove-waterway	3712.117	0.4
mixed-catchment	8152.225	0.8
mixed-mangrove	20515.818	2.1
mixed-mixed	18282.116	1.8
mixed-reclaimed	17682.014	1.8
mixed-saltmarsh	1693.456	0.2
mixed-terrestrial	3924.762	0.4
mixed-waterway	587.754	0.1
reclaimed-catchment	3603.017	0.4
reclaimed-mangrove	79.331	0.0
reclaimed-mixed	334.52	0.0
reclaimed-reclaimed	620.278	0.1
saltmarsh-catchment	11384.373	1.1
saltmarsh-mangrove	5844.016	0.6
saltmarsh-mixed	4639.31	0.5
saltmarsh-reclaimed	46092.698	4.6
saltmarsh-saltmarsh	6537.578	0.7
saltmarsh-terrestrial	11584.22	1.2
saltmarsh-waterway	41.814	0.0
terrestrial-catchment	550.473	0.1
terrestrial-mangrove	20.907	0.0
terrestrial-reclaimed	16760.39	1.7
terrestrial-terrestrial	26453.57	2.6
waterway-catchment	6028.364	0.6
waterway-mangrove	11594.774	1.2
waterway-reclaimed	470.786	0.1
waterway-terrestrial	20.907	0.0
waterway-waterway	34587.469	3.5

Table A6.34: Areas of habitat change in Careel Bay, Pittwater, 1974 to 1986.

change	Area (m²)	Area (ha)
catchment-catchment	98339.111	9.8
catchment-mangrove	2324.79	0.2
catchment-reclaimed	75.894	0.1
catchment-saltmarsh	883.513	0.1
catchment-terrestrial	1897.976	0.2
catchment-waterway	2045.139	0.2
mangrove-catchment	2539.451	0.3
mangrove-mangrove	78652.017	7.9
mangrove-mixed	937.117	0.1
mangrove-reclaimed	2261.367	0.2
mangrove-saltmarsh	328.874	0.0
mangrove-terrestrial	1539.024	0.2
mangrove-waterway	385.383	0.0
mixed-catchment	238.806	0.0
mixed-mangrove	10035.127	1.0
mixed-mixed	19175.322	1.9
mixed-reclaimed	348.516	0.0
mixed-saltmarsh	1085.623	0.1
mixed-terrestrial	151.788	0.0
reclaimed-catchment	126.49	0.0
reclaimed-mangrove	2777.215	0.3
reclaimed-reclaimed	73772.145	7.4
reclaimed-terrestrial	9354.644	0.9
saltmarsh-catchment	1052.236	0.1
saltmarsh-mangrove	673.197	0.1
saltmarsh-mixed	3166.716	0.3
saltmarsh-saltmarsh	4812.003	0.5
saltmarsh-terrestrial	94.122	0.0
terrestrial-catchment	15245.729	1.5
terrestrial-mangrove	3061.301	0.3
terrestrial-mixed	41.499	0.0
terrestrial-reclaimed	5734.383	0.6
terrestrial-saltmarsh	177.987	0.0
terrestrial-terrestrial	46902.329	4.7
terrestrial-waterway	143.81	0.0
waterway-catchment	75.894	0.0
waterway-mangrove	5414.549	0.6
waterway-terrestrial	25.298	0.0
waterway-waterway	31194.828	3.1

Table A6.35: Areas of habitat change in Careel Bay, Pittwater, 1986 to 1996.

change	Area (m²)	Area (ha)
catchment-catchment	111283.322	11.1
catchment-mangrove	97.18	0.0
catchment-mixed	19.826	0.0
catchment-terrestrial	4635.353	0.5
mangrove-catchment	2423.859	0.2
mangrove-mangrove	87730.557	8.8
mangrove-mixed	2221.903	0.2
mangrove-reclaimed	1033.882	0.1
mangrove-saltmarsh	1037.502	0.1
mangrove-terrestrial	5211.653	0.5
mangrove-waterway	1627.78	0.2
mixed-catchment	39.653	0.0
mixed-mangrove	4251.325	0.4
mixed-mixed	17819.848	1.8
mixed-saltmarsh	1111.799	0.1
mixed-terrestrial	102.347	0.0
reclaimed-catchment	237.914	0.0
reclaimed-mangrove	2615.95	0.3
reclaimed-reclaimed	65979.982	6.6
reclaimed-saltmarsh	39.652	0.0
reclaimed-terrestrial	12422.718	1.2
saltmarsh-catchment	1697.243	0.2
saltmarsh-mangrove	670.724	0.0
saltmarsh-mixed	991.807	0.1
saltmarsh-saltmarsh	4104.482	0.4
saltmarsh-terrestrial	72.176	0.0
terrestrial-catchment	2921.913	0.3
terrestrial-mangrove	3049.2	0.3
terrestrial-mixed	12.697	0.0
terrestrial-reclaimed	5069.915	0.5
terrestrial-saltmarsh	688.189	0.1
terrestrial-terrestrial	48417.506	4.8
terrestrial-waterway	19.826	0.0
waterway-catchment	2103.526	0.2
waterway-mangrove	2557.615	0.3
waterway-terrestrial	32.523	0.0
waterway-waterway	28536.35	2.9

Table A6.36: Areas of habitat change in Careel Bay, Pittwater, 1940 to 1996.

change	Area (m²)	Area (ha)
catchment-catchment	100845.07	10.1
catchment-terrestrial	8768.899	0.9
catchment-waterway	20.01	0.0
mangrove-catchment	127.493	0.0
mangrove-mangrove	12454.084	1.2
mangrove-reclaimed	1808.472	0.2
mangrove-saltmarsh	320.155	0.0
mangrove-terrestrial	3263.764	0.3
saltmarsh-catchment	16786.826	1.7
saltmarsh-mangrove	82232.946	8.2
saltmarsh-mixed	21024.733	2.1
saltmarsh-reclaimed	52355.526	5.2
saltmarsh-saltmarsh	6560.541	0.7
saltmarsh-terrestrial	24027.966	2.4
saltmarsh-waterway	11466.936	1.1
terrestrial-catchment	29764.015	3.0
terrestrial-mangrove	551.677	0.1
terrestrial-reclaimed	18303.463	1.8
terrestrial-terrestrial	34965.081	3.5
terrestrial-waterway	138.791	0.0
waterway-catchment	3904.222	0.4
waterway-mangrove	6548.63	0.7
waterway-reclaimed	107.956	0.0
waterway-terrestrial	190.968	0.0
waterway-waterway	21489.418	2.1

Towra Point, Botany Bay

Table A6.37: Static coastal wetland habitat areas (ha) at Towra Point, Botany Bay, 1956 to 1999.

	1956	1961	1970	1983	1999
coastal veg		0.8	14.2	23.4	19.9
mangrove	351.6	401.8	377.7	395.2	470.5
mixed	73.6	42.9	36.7	55.4	43.5
reclaimed land	5.5	8.3	16.7	38.7	30.6
saltmarsh	229.3	238.6	194.3	141	88.1
terrestrial	159.4	165	151.7	165.6	188.4

Table A6.38: Areas of habitat change at Towra Point, Botany Bay, 1956 to 1961.

change	Area (m ²)	Area (ha)
catchment-catchment	5624100.099	562.4
catchment-mangrove	10824.103	1.1
catchment-mixed	3608.034	0.4
catchment-reclaimed	2164.82	0.2
catchment-saltmarsh	69731.516	7.0
catchment-sand	5051.249	0.5
catchment-terrestrial	79229.486	7.9
catchment-waterway	10873.38	1.1
mangrove-catchment	12267.316	1.2
mangrove-coastal veg	3608.033	0.4
mangrove-mangrove	3142201.031	314.2
mangrove-mixed	73332.273	7.3
mangrove-mudflat	10075.288	1.0
mangrove-reclaimed	2886.427	0.3
mangrove-saltmarsh	114650.745	11.5
mangrove-sand	3893.216	0.4
mangrove-terrestrial	21331.82	2.1
mangrove-water	956.162	0.1
mangrove-waterway	137616.107	13.8
mixed-mangrove	431509.529	43.2
mixed-mixed	228086.083	22.8
mixed-reclaimed	462.109	0.1
mixed-saltmarsh	66543.715	6.7
mixed-terrestrial	7216.068	0.7
mudflat-mangrove	39962.697	4.0
mudflat-mixed	1443.214	0.1
mudflat-mudflat	18637.749	1.9
mudflat-reclaimed	2164.82	0.2
mudflat-saltmarsh	12678.596	1.3
mudflat-sand	1443.213	0.1
mudflat-terrestrial	7706.811	0.8
mudflat-water	2886.427	0.3
reclaimed-catchment	2164.821	0.2
reclaimed-mangrove	2164.821	0.2
reclaimed-mixed	721.607	0.1
reclaimed-reclaimed	8745.472	0.9
reclaimed-saltmarsh	11737.381	1.2
reclaimed-terrestrial	20204.987	2.0
saltmarsh-catchment	10824.105	1.1
saltmarsh-mangrove	124364.305	12.4
saltmarsh-mixed	101085.434	10.1
saltmarsh-mudflat	721.607	0.1
saltmarsh-reclaimed	34514.282	3.5
saltmarsh-saltmarsh	1884071.728	188.4
saltmarsh-sand	1443.214	0.1
saltmarsh-terrestrial	130287.321	13.0
saltmarsh-water	17357.616	1.7
saltmarsh-waterway	2886.428	0.3
sand-mangrove	14172.637	1.4
sand-mixed	721.607	0.1
sand-reclaimed	14441.47	1.4
sand-saltmarsh	62927.788	6.3
sand-sand	263669.433	26.4
sand-terrestrial	10102.495	1.0
sand-waterway	28371.706	2.8
terrestrial-catchment	22452.883	2.2
terrestrial-mangrove	29890.78	3.0
terrestrial-mixed	5772.854	0.6
terrestrial-mudflat	3608.033	0.4
terrestrial-reclaimed	10564.605	1.1
terrestrial-saltmarsh	166700.642	16.7
terrestrial-sand	20597.421	2.1
terrestrial-terrestrial	1370526.063	137.1
terrestrial-water	3656.448	0.4
terrestrial-waterway	12267.316	1.2
water-mangrove	4956.782	0.5
water-mudflat	2164.82	0.2
water-saltmarsh	5808.837	0.6
water-sand	1443.214	0.1
waterway-catchment	18600.166	1.9
waterway-mangrove	192177.468	19.2
waterway-mixed	3359.982	0.3
waterway-mudflat	9121.391	0.9

Table A6.39: Areas of habitat change at Towra Point, Botany Bay, 1961 to 1970.

change	Area (m ²)	Area (ha)
catchment-catchment	5048800.891	504.9
catchment-mangrove	4325.453	0.4
catchment-reclaimed	10422.214	1.0
catchment-saltmarsh	7929.999	0.8
catchment-terrestrial	9371.817	0.9
catchment-waterway	38219.076	3.8
coastal veg-catchment	720.909	0.1
coastal veg-sand	720.909	0.1
mangrove-catchment	300599.921	30.1
mangrove-coastal veg	5046.362	0.5
mangrove-mangrove	3269072.56	326.9
mangrove-mixed	98998.396	9.9
mangrove-mudflat	10804.266	1.1
mangrove-reclaimed	25091.023	2.5
mangrove-saltmarsh	106497.577	10.6
mangrove-sand	1441.818	0.3
mangrove-terrestrial	24536.567	2.5
mangrove-waterway	123327.317	12.3
mixed-catchment	36578.015	3.7
mixed-mangrove	199327.612	19.9
mixed-mixed	147379.387	14.7
mixed-mudflat	7475.33	0.7
mixed-reclaimed	3604.545	0.4
mixed-saltmarsh	56717.243	5.7
mixed-terrestrial	720.909	0.1
mudflat-mangrove	10254.56	1.0
mudflat-mixed	720.909	0.1
mudflat-mudflat	25018.011	2.5
mudflat-terrestrial	4325.453	0.4
mudflat-waterway	6488.181	0.6
reclaimed-catchment	3604.545	0.4
reclaimed-mangrove	1441.818	0.1
reclaimed-mixed	1903.474	0.2
reclaimed-reclaimed	21172.597	2.1
reclaimed-saltmarsh	38948.558	3.9
reclaimed-terrestrial	7475.33	0.7
saltmarsh-catchment	382543.515	38.3
saltmarsh-mangrove	101601.364	10.2
saltmarsh-mixed	84269.085	8.4
saltmarsh-mudflat	1676.146	0.2
saltmarsh-reclaimed	73043.123	7.3
saltmarsh-saltmarsh	1581199.198	158.1
saltmarsh-sand	5046.362	0.5
saltmarsh-terrestrial	157014.934	15.7
saltmarsh-waterway	5891.177	0.6
sand-catchment	15417.975	1.5
sand-coastal veg	138620.901	13.9
sand-mangrove	6488.181	0.6
sand-mixed	11983.127	1.2
sand-saltmarsh	13830.068	1.4
sand-sand	162640.445	16.3
sand-terrestrial	12255.45	1.2
sand-waterway	90688.155	9.1
terrestrial-catchment	121762.584	12.2
terrestrial-mangrove	11275.295	1.1
terrestrial-mixed	6747.432	0.7
terrestrial-reclaimed	32648.414	3.3
terrestrial-saltmarsh	129996.972	13.0
terrestrial-sand	24510.905	2.5
terrestrial-terrestrial	1311532.533	131.2
terrestrial-water	2188.385	0.2
water-mangrove	3870.786	0.4
water-saltmarsh	10092.723	1.0
water-terrestrial	2624.389	0.3
water-water	10092.724	1.0
waterway-catchment	15560.744	1.6
waterway-mangrove	163620.174	16.4
waterway-mixed	1441.818	0.1
waterway-mudflat	4254.486	0.4
waterway-reclaimed	720.909	0.1
waterway-sand	55132.028	5.5
waterway-terrestrial	3604.544	0.4
waterway-waterway	9500304.443	950.0

Table A6.39: Areas of habitat change at Towra Point, Botany Bay, 1970 to 1983.

change	Area (m ²)	Area (ha)
catchment-catchment	4922470.555	492.2
catchment-mangrove	18207.51	1.8
catchment-mixed	2880.847	0.3
catchment-reclaimed	8642.541	0.9
catchment-saltmarsh	2160.636	0.2
catchment-sand	720.212	0.1
catchment-terrestrial	78549.489	7.9
catchment-waterway	4321.27	0.4
coastal veg-catchment	720.212	0.1
coastal veg-coastal veg	134041.956	13.4
coastal veg-mixed	1440.423	0.1
coastal veg-reclaimed	7740.12	0.8
coastal veg-sand	4782.486	0.5
mangrove-catchment	9103.758	0.9
mangrove-coastal veg	4321.271	0.4
mangrove-mangrove	3367457.112	336.7
mangrove-mixed	96256.352	9.6
mangrove-reclaimed	62437.396	6.2
mangrove-saltmarsh	69395.789	6.9
mangrove-sand	9103.755	0.9
mangrove-terrestrial	19606.768	2.0
mangrove-waterway	125959.518	12.6
mixed-catchment	2160.635	0.2
mixed-mangrove	139331.217	13.9
mixed-mixed	127942.858	12.7
mixed-reclaimed	32404.967	3.2
mixed-saltmarsh	34089.234	3.4
mixed-sand	8901.535	0.9
mixed-terrestrial	11399.599	1.1
mudflat-mangrove	29994.51	3.0
mudflat-mudflat	7634.921	0.8
mudflat-reclaimed	1440.423	0.1
mudflat-saltmarsh	3490.751	0.3
mudflat-terrestrial	2160.635	0.2
mudflat-waterway	3530.159	0.4
reclaimed-catchment	3601.06	0.4
reclaimed-mangrove	12963.814	1.3
reclaimed-mixed	4321.272	0.4
reclaimed-reclaimed	99382.831	9.9
reclaimed-saltmarsh	18342.728	1.8
reclaimed-terrestrial	27602.154	2.8
reclaimed-waterway	1440.424	0.1
saltmarsh-catchment	11808.025	1.2
saltmarsh-coastal veg	25863.997	2.6
saltmarsh-mangrove	149670.938	15.0
saltmarsh-mixed	272092.602	27.2
saltmarsh-mudflat	720.212	0.1
saltmarsh-reclaimed	117615.51	11.8
saltmarsh-saltmarsh	1200165.459	120.0
saltmarsh-sand	5761.693	0.6
saltmarsh-terrestrial	142868.839	14.3
saltmarsh-water	5041.483	0.5
saltmarsh-waterway	4062.274	0.4
sand-catchment	5761.693	0.6
sand-coastal veg	76624.945	7.7
sand-mangrove	720.212	0.1
sand-reclaimed	2880.847	0.3
sand-saltmarsh	5041.482	0.5
sand-sand	139809.328	14.0
sand-terrestrial	12963.814	1.3
sand-waterway	11471.059	1.1
terrestrial-catchment	7663.334	0.8
terrestrial-coastal veg	4321.27	0.4
terrestrial-mangrove	23766.988	2.4
terrestrial-mixed	5761.693	0.6
terrestrial-reclaimed	44783.647	4.5
terrestrial-saltmarsh	77249.332	7.7
terrestrial-sand	10803.177	1.1
terrestrial-terrestrial	1359572.029	136.0
terrestrial-waterway	2880.847	0.3
water-coastal veg	461.215	0.1
water-saltmarsh	720.212	0.1
water-terrestrial	4321.27	0.4

Table A6.40: Areas of habitat change at Towra Point, Botany Bay, 1983 to 1999.

change	Area (m ²)	Area (ha)
catchment-catchment	4277926.192	427.8
catchment-mangrove	61243.458	6.1
catchment-mixed	1192.738	0.1
catchment-reclaimed	1192.738	0.1
catchment-saltmarsh	7937.632	0.8
catchment-terrestrial	42107.139	4.2
catchment-waterway	6965.624	0.7
coastal veg-catchment	381.908	0.0
coastal veg-coastal veg	163078.495	16.4
coastal veg-mangrove	8222.238	0.8
coastal veg-mixed	2171.01	0.2
coastal veg-mudflat	14534.135	1.5
coastal veg-reclaimed	17245.596	1.7
coastal veg-saltmarsh	23982.817	2.4
coastal veg-sand	9327.438	0.9
mangrove-catchment	4770.952	0.5
mangrove-coastal veg	3149.292	0.3
mangrove-mangrove	3801143.31	380.1
mangrove-mixed	16054.95	1.6
mangrove-reclaimed	4770.953	0.5
mangrove-saltmarsh	17247.682	1.7
mangrove-sand	2981.845	0.3
mangrove-terrestrial	21747.059	2.2
mangrove-waterway	98033.939	9.8
mixed-catchment	596.369	0.1
mixed-coastal veg	6457.56	0.6
mixed-mangrove	355759.152	35.6
mixed-mixed	138231.65	13.8
mixed-reclaimed	2385.476	0.2
mixed-saltmarsh	22178.619	2.2
mixed-terrestrial	5963.691	0.6
mudflat-mangrove	11286.25	1.1
mudflat-mixed	596.369	0.1
mudflat-mudflat	14237.437	1.4
mudflat-saltmarsh	596.369	0.1
mudflat-sand	1192.738	0.1
mudflat-terrestrial	9707.148	1.0
mudflat-waterway	8960.621	0.9
reclaimed-catchment	1192.738	0.1
reclaimed-mangrove	36574.42	3.7
reclaimed-mixed	1789.107	0.2
reclaimed-reclaimed	259623.205	26.0
reclaimed-saltmarsh	4394.83	0.4
reclaimed-terrestrial	74573.288	7.5
reclaimed-water	1412.877	0.1
reclaimed-waterway	596.369	0.1
saltmarsh-catchment	7258.931	0.7
saltmarsh-coastal veg	14446.045	1.4
saltmarsh-mangrove	181096.21	18.1
saltmarsh-mixed	247683.339	24.8
saltmarsh-mudflat	1601.046	0.2
saltmarsh-reclaimed	11148.736	1.1
saltmarsh-saltmarsh	790080.963	79.0
saltmarsh-terrestrial	145125.289	14.5
saltmarsh-water	1192.738	0.1
sand-coastal veg	25995.104	2.6
sand-mangrove	31278.092	3.1
sand-mixed	13120.123	1.3
sand-saltmarsh	2385.476	0.2
sand-sand	123023.357	12.3
sand-terrestrial	23244.418	2.3
sand-waterway	68355.131	6.8
terrestrial-catchment	32260.306	3.2
terrestrial-coastal veg	596.369	0.1
terrestrial-mangrove	36460.972	3.6
terrestrial-mixed	5534.769	0.6
terrestrial-reclaimed	12623.924	1.3
terrestrial-saltmarsh	13695.873	1.4
terrestrial-sand	4174.584	0.4
terrestrial-terrestrial	1553434.403	155.3
water-saltmarsh	3578.214	0.4
water-water	2981.846	0.3
waterway-catchment	9720.162	1.0

Table A6.41: Areas of habitat change at Towra Point, Botany Bay, 1956 to 1999.

change	Area (m ²)	Area (ha)
catchment-catchment	4219849.543	422.0
catchment-mangrove	15390.231	1.5
catchment-reclaimed	2164.821	0.2
catchment-saltmarsh	14189.329	1.4
catchment-terrestrial	47321.246	4.7
catchment-waterway	2886.428	0.3
mangrove-catchment	178802.491	17.9
mangrove-coastal veg	13100.282	1.3
mangrove-mangrove	3158974.452	315.9
mangrove-mixed	8248.077	0.8
mangrove-mudflat	2626.93	0.3
mangrove-reclaimed	17508.176	1.8
mangrove-saltmarsh	13476.716	1.3
mangrove-sand	1443.213	0.2
mangrove-terrestrial	44193.669	4.4
mangrove-water	721.607	0.1
mangrove-waterway	99831.725	10.0
mixed-catchment	69082.723	6.9
mixed-mangrove	520560.238	52.1
mixed-mixed	44292.418	4.4
mixed-reclaimed	77456.008	7.7
mixed-saltmarsh	8893.837	0.9
mixed-terrestrial	5513.357	0.6
mixed-water	721.607	0.1
mudflat-catchment	721.607	0.1
mudflat-mangrove	65623.526	6.6
mudflat-mixed	9207.786	0.9
mudflat-saltmarsh	1443.214	0.1
mudflat-terrestrial	8000.985	0.8
mudflat-waterway	1443.214	0.1
reclaimed-catchment	924.218	0.1
reclaimed-mangrove	11318.156	1.1
reclaimed-mixed	721.607	0.1
reclaimed-reclaimed	19819.561	2.0
reclaimed-saltmarsh	2738.062	0.3
reclaimed-terrestrial	12267.315	1.2
saltmarsh-catchment	314208.201	31.4
saltmarsh-coastal veg	14923.358	1.5
saltmarsh-mangrove	414137.13	41.4
saltmarsh-mixed	353494.818	35.3
saltmarsh-mudflat	2886.427	0.3
saltmarsh-reclaimed	125531.608	12.6
saltmarsh-saltmarsh	790059.061	79.0
saltmarsh-sand	721.607	0.1
saltmarsh-terrestrial	282136.651	28.2
saltmarsh-water	5772.853	0.6
sand-catchment	15718.083	1.6
sand-coastal veg	170511.362	17.1
sand-mangrove	35706.712	3.6
sand-mixed	4532.245	0.5
sand-reclaimed	29595.156	3.0
sand-saltmarsh	32251.545	3.2
sand-sand	26864.473	2.7
sand-terrestrial	34443.351	3.4
sand-waterway	31742.289	3.2
terrestrial-catchment	68673.358	6.9
terrestrial-mangrove	50367.482	5.0
terrestrial-mixed	1443.214	0.1
terrestrial-reclaimed	29012.305	2.9
terrestrial-saltmarsh	18916.318	1.9
terrestrial-sand	30059.436	3.0
terrestrial-terrestrial	1437152.614	143.7
terrestrial-waterway	7216.068	0.7
water-mangrove	7034.62	0.7
water-mixed	6443.998	0.6
water-mudflat	1006.788	0.1
waterway-catchment	26475.819	2.6
waterway-coastal veg	35061.35	3.5
waterway-mangrove	405985.188	40.6
waterway-mudflat	6956.57	0.7
waterway-reclaimed	2886.427	0.3
waterway-saltmarsh	721.607	0.1
waterway-sand	151993.196	15.2

Currambene Creek, Jervis Bay

Table A6.42: Static coastal wetland habitat areas (ha) in Currambene Creek, Jervis Bay, 1949 to 1993.

	1949	1961	1975	1987	1993
casuarina	12.6	13.6	14.9	16.2	15
mangrove	9.7	13.5	21.6	31.4	38.4
mixed	41.4	45	45.7	40.1	38.2
saltmarsh	51	43.3	31.6	33.9	26.4

Table A6.43: Areas of habitat change in Currambene Creek, Jervis Bay, 1949 to 1961.

change	Area (m²)	Area (ha)
casuarina-casuarina	109567.574	11.0
casuarina-catchment	2484.165	0.2
casuarina-mangrove	716.472	0.1
casuarina-mixed	2577.959	0.3
casuarina-saltmarsh	6802.356	0.7
casuarina-waterway	3343.536	0.3
catchment-casuarina	7383.802	0.7
catchment-catchment	345039.577	34.5
catchment-mangrove	1910.592	0.2
catchment-mixed	8672.892	0.9
catchment-saltmarsh	12734.464	1.3
catchment-waterway	3645.865	0.4
mangrove-casuarina	1671.768	0.2
mangrove-mangrove	49020.585	4.9
mangrove-mixed	25133.864	2.5
mangrove-saltmarsh	4369.587	0.4
mangrove-waterway	14939.903	1.5
mixed-casuarina	1194.12	0.1
mixed-catchment	955.296	0.1
mixed-mangrove	49806.602	5.0
mixed-mixed	335170.468	33.5
mixed-saltmarsh	19399.578	1.9
mixed-waterway	8358.84	0.8
saltmarsh-casuarina	12326.427	1.2
saltmarsh-catchment	33064.136	3.3
saltmarsh-mangrove	15160.76	1.5
saltmarsh-mixed	61560.993	6.2
saltmarsh-saltmarsh	388973.832	38.9
saltmarsh-waterway	1910.592	0.2
waterway-casuarina	3333.217	0.3
waterway-catchment	2865.888	0.3
waterway-mangrove	15083.982	1.5
waterway-mixed	19226.075	1.9
waterway-saltmarsh	3031.931	0.3
waterway-waterway	257927.732	25.8

Table A6.44: Areas of habitat change in Currumbene Creek, Jervis Bay, 1961 to 1975.

change	Area (m²)	Area (ha)
casuarina-casuarina	109228.576	10.9
casuarina-catchment	5282.724	0.5
casuarina-mangrove	4139.609	0.4
casuarina-mixed	9148.903	0.9
casuarina-saltmarsh	3779.781	0.4
casuarina-waterway	9951.377	1.0
catchment-casuarina	18549.076	1.9
catchment-catchment	355195.056	35.5
catchment-mangrove	2022.839	0.2
catchment-mixed	5201.586	0.5
catchment-saltmarsh	8461.473	0.8
catchment-waterway	6044.445	0.6
mangrove-casuarina	577.954	0.1
mangrove-mangrove	80109.313	8.0
mangrove-mixed	31313.318	3.1
mangrove-saltmarsh	6808.749	0.7
mangrove-waterway	13581.725	1.4
mixed-casuarina	3178.748	0.3
mixed-catchment	4034.538	0.4
mixed-mangrove	83968.529	8.4
mixed-mixed	310403.739	31.0
mixed-saltmarsh	31246.454	3.1
mixed-waterway	20259.631	2.0
saltmarsh-casuarina	14933.484	1.5
saltmarsh-catchment	26868.619	2.7
saltmarsh-mangrove	13551.955	1.4
saltmarsh-mixed	98525.278	9.9
saltmarsh-saltmarsh	266642.775	26.7
saltmarsh-waterway	4623.632	0.5
waterway-casuarina	2889.77	0.3
waterway-catchment	288.977	0.0
waterway-mangrove	29299.099	2.9
waterway-mixed	866.931	0.1
waterway-saltmarsh	1155.908	0.1
waterway-waterway	404132.535	40.4

Table A6.45: Areas of habitat change in Currumbene Creek, Jervis Bay, 1975 to 1987.

change	Area (m²)	Area (ha)
casuarina-casuarina	123788.895	12.4
casuarina-catchment	11343.411	1.1
casuarina-mangrove	5574.123	0.6
casuarina-mixed	2529.773	0.3
casuarina-saltmarsh	9285.836	0.9
casuarina-waterway	1686.516	0.2
catchment-casuarina	7327.562	0.7
catchment-catchment	396264.85	39.6
catchment-mangrove	7006.207	0.7
catchment-mixed	23729.012	2.4
catchment-saltmarsh	17049.923	1.7
mangrove-casuarina	5444.439	0.5
mangrove-catchment	2428.69	0.2
mangrove-mangrove	157163.592	15.7
mangrove-mixed	28831.386	2.9
mangrove-saltmarsh	11892.284	1.2
mangrove-waterway	12809.433	1.3
mixed-casuarina	14558.701	1.5
mixed-catchment	2428.691	0.2
mixed-mangrove	96653.184	9.7
mixed-mixed	262178.103	26.2
mixed-saltmarsh	76275.257	7.6
saltmarsh-casuarina	6418.864	0.6
saltmarsh-catchment	16272.878	1.6
saltmarsh-mangrove	18754.178	1.9
saltmarsh-mixed	67081.512	6.7
saltmarsh-saltmarsh	206793.118	20.7
saltmarsh-waterway	281.086	0.0
waterway-casuarina	4778.458	0.5
waterway-catchment	6938.506	0.7
waterway-mangrove	27821.406	2.8
waterway-mixed	14407.298	1.4
waterway-saltmarsh	17506.691	1.8
waterway-waterway	393334.216	39.3

Table A6.46: Areas of habitat change in Currumbene Creek, Jervis Bay, 1987 to 1993.

change	Area (m²)	Area (ha)
casuarina-casuarina	135120.838	13.5
casuarina-catchment	3946.486	0.4
casuarina-mangrove	1405.43	0.1
casuarina-mixed	13869.823	1.4
casuarina-saltmarsh	5373.086	0.5
casuarina-waterway	2529.773	0.3
catchment-casuarina	4163.993	0.4
catchment-catchment	528469.305	52.8
catchment-mangrove	3834.118	0.4
catchment-mixed	281.086	0.0
catchment-saltmarsh	10018.006	1.0
catchment-waterway	3326.627	0.3
mangrove-casuarina	3130.306	0.3
mangrove-catchment	6429.658	0.6
mangrove-mangrove	244755.48	24.5
mangrove-mixed	32726.278	3.3
mangrove-saltmarsh	6563.861	0.7
mangrove-waterway	20781.625	2.1
mixed-casuarina	2640.858	0.3
mixed-catchment	27031.773	2.7
mixed-mangrove	88816.396	8.9
mixed-mixed	254466.363	25.4
mixed-saltmarsh	19995.414	2.0
mixed-waterway	7426.194	0.7
saltmarsh-casuarina	4576.297	0.5
saltmarsh-catchment	13097.88	1.3
saltmarsh-mangrove	9983.389	1.0
saltmarsh-mixed	80534.7	8.1
saltmarsh-saltmarsh	217862.562	21.8
saltmarsh-waterway	12085.031	1.2
waterway-casuarina	2810.858	0.3
waterway-catchment	4511.019	0.5
waterway-mangrove	26797.322	2.7
waterway-mixed	3846.561	0.4
waterway-saltmarsh	2108.081	0.2
waterway-waterway	396356.188	39.6

Table A6.47: Areas of habitat change in Currumbene Creek, Jervis Bay, 1949 to 1993.

change	Area (m²)	Area (ha)
casuarina-casuarina	108477.587	10.8
casuarina-catchment	3167.966	0.3
casuarina-mangrove	3484.532	0.3
casuarina-mixed	4925.735	0.5
casuarina-saltmarsh	3728.789	0.4
casuarina-waterway	3949.134	0.4
catchment-casuarina	20614.591	2.1
catchment-catchment	429442.788	42.9
catchment-mangrove	7171.828	0.7
catchment-mixed	1626.115	0.2
catchment-saltmarsh	10416.42	1.0
catchment-waterway	5311.29	0.5
mangrove-casuarina	1381.043	0.1
mangrove-catchment	232.302	0.0
mangrove-mangrove	78013.916	7.8
mangrove-mixed	2667.534	0.3
mangrove-saltmarsh	1534.547	0.2
mangrove-waterway	8921.261	0.9
mixed-casuarina	232.302	0.0
mixed-catchment	1626.114	0.2
mixed-mangrove	184876.183	18.5
mixed-mixed	202262.532	20.2
mixed-saltmarsh	19395.959	1.9
mixed-waterway	3865.598	0.4
saltmarsh-casuarina	17693.145	1.8
saltmarsh-catchment	48836.213	4.9
saltmarsh-mangrove	56044.058	5.6
saltmarsh-mixed	158955.509	15.9
saltmarsh-saltmarsh	226315.779	22.6
saltmarsh-waterway	2630.831	0.3
waterway-casuarina	232.302	0.0
waterway-catchment	3949.136	0.4
waterway-mangrove	53211.186	5.3
waterway-mixed	9630.726	1.0
waterway-saltmarsh	4257.61	0.4
waterway-waterway	236366.566	23.6

Cararma Inlet, Jarvis Bay

Table A6.48: Static coastal wetland habitat areas (ha) in Cararma Inlet, Jarvis Bay, 1948 to 1999.

	1948	1961	1974	1981	1999
mangrove	25.5	22.6	36.4	44.4	62.6
mixed	0	9.2	12.4	22.5	17.9
saltmarsh	181.7	151.9	140.6	107.1	79
terrestrial	89.7	105.9	113.8	124.1	130.9

Table A6.48: Areas of habitat change in Cararma Inlet, Jarvis Bay, 1948 to 1961.

change	Area (m²)	Area (ha)
casuarina-casuarina	183034.016	18.3
casuarina-saltmarsh	15274.446	1.5
catchment-catchment	3847156.662	384.7
catchment-melaleuca	10641.969	1.1
catchment-mixed	310.51	0.0
catchment-saltmarsh	12808.293	1.3
catchment-waterway	22638.489	2.3
eucalyptus-catchment	1242.039	0.1
eucalyptus-eucalyptus	354338.17	35.4
eucalyptus-melaleuca	35517.973	3.6
eucalyptus-saltmarsh	16961.405	1.7
mangrove-catchment	8098.543	0.8
mangrove-eucalyptus	2484.078	0.2
mangrove-mangrove	132524.308	13.3
mangrove-melaleuca	621.02	0.1
mangrove-mixed	29659.988	3.0
mangrove-saltmarsh	50745.923	5.1
mangrove-waterway	26400.839	2.6
melaleuca-catchment	37529.071	3.8
melaleuca-eucalyptus	7230.143	0.7
melaleuca-melaleuca	228852.428	22.9
melaleuca-saltmarsh	14760.643	1.5
saltmarsh-casuarina	91294.62	9.1
saltmarsh-catchment	95754.591	9.6
saltmarsh-eucalyptus	23041.063	2.3
saltmarsh-mangrove	60706.394	6.1
saltmarsh-melaleuca	122068.946	12.2
saltmarsh-mixed	54027.68	5.4
saltmarsh-saltmarsh	1371116.075	137.1
saltmarsh-waterway	621.02	0.1
waterway-catchment	11383.336	1.1
waterway-mangrove	25125.499	2.5
waterway-mixed	8383.763	0.8
waterway-saltmarsh	42530.214	4.2
waterway-waterway	456166.016	45.6

Table A6.49: Areas of habitat change in Cararma Inlet, Jervis Bay, 1961 to 1974.

change	Area (m²)	Area (ha)
casuarina-casuarina	220465.457	22.0
casuarina-melaleuca	2178.574	0.2
casuarina-mixed	2742.606	0.3
casuarina-saltmarsh	48666.561	4.9
catchment-catchment	3716882.493	371.7
catchment-mangrove	23817.301	2.4
catchment-melaleuca	70123.729	7.0
catchment-mixed	22130.908	2.2
catchment-saltmarsh	76848.619	7.7
catchment-waterway	16915.667	1.7
eucalyptus-eucalyptus	320333.998	32.0
eucalyptus-mangrove	1089.287	0.1
eucalyptus-melaleuca	46927.355	4.7
eucalyptus-saltmarsh	14269.995	1.4
mangrove-catchment	28853.569	2.9
mangrove-mangrove	159398.725	15.9
mangrove-melaleuca	3812.505	0.4
mangrove-mixed	6712.76	0.7
mangrove-saltmarsh	24803.84	2.5
melaleuca-catchment	16280.532	1.6
melaleuca-eucalyptus	11124.696	1.1
melaleuca-melaleuca	296174.175	29.6
melaleuca-saltmarsh	71833.724	7.2
mixed-catchment	544.644	0.1
mixed-mangrove	59169.802	5.9
mixed-mixed	26589.671	2.7
mixed-saltmarsh	1633.931	0.2
mixed-waterway	5112.491	0.5
saltmarsh-casuarina	37936.208	3.8
saltmarsh-catchment	21268.542	2.1
saltmarsh-eucalyptus	56651.607	5.7
saltmarsh-mangrove	85236.372	8.5
saltmarsh-melaleuca	67901.788	6.8
saltmarsh-mixed	58396.515	5.8
saltmarsh-saltmarsh	1170868.144	117.1
saltmarsh-waterway	17328.993	1.7
waterway-catchment	23844.494	2.4
waterway-mangrove	28664.248	2.9
waterway-mixed	5663.85	0.6
waterway-saltmarsh	3812.505	0.4
waterway-waterway	491255.239	49.0

Table A6.50: Areas of habitat change in Cararma Inlet, Jervis Bay, 1974 to 1981.

change	Area (m²)	Area (ha)
casuarina-casuarina	217581.977	21.8
casuarina-mangrove	7656.539	0.8
casuarina-melaleuca	9072.293	0.9
casuarina-mixed	10902.482	1.1
casuarina-saltmarsh	15755.272	1.6
catchment-casuarina	14799.179	1.5
catchment-catchment	3653294.017	365.3
catchment-mangrove	7203.745	0.7
catchment-melaleuca	24873.665	2.5
catchment-mixed	1166.296	0.1
catchment-saltmarsh	16399.045	1.6
catchment-waterway	8914.349	0.9
eucalyptus-eucalyptus	353600.622	35.4
eucalyptus-mangrove	777.531	0.1
eucalyptus-melaleuca	18780.029	1.9
eucalyptus-mixed	1319.936	0.1
eucalyptus-saltmarsh	13992.06	1.4
mangrove-catchment	14725.835	1.5
mangrove-eucalyptus	3110.122	0.3
mangrove-mangrove	267728.384	26.8
mangrove-mixed	20971.834	2.1
mangrove-saltmarsh	28562.485	2.9
mangrove-waterway	36728.978	3.7
melaleuca-casuarina	8625.732	0.9
melaleuca-catchment	62049.364	6.2
melaleuca-eucalyptus	36402.872	3.6
melaleuca-melaleuca	323215.61	32.3
melaleuca-mixed	1555.061	0.2
melaleuca-saltmarsh	56477.352	5.6
mixed-catchment	20022.277	2.0
mixed-eucalyptus	1804.022	0.2
mixed-mangrove	26359.233	2.6
mixed-mixed	54507.676	5.5
mixed-saltmarsh	14387.096	1.4
mixed-waterway	4249.473	0.4
saltmarsh-casuarina	143033.5	14.3
saltmarsh-catchment	64127.934	6.4
saltmarsh-eucalyptus	25480.812	2.5
saltmarsh-mangrove	70550.25	7.1
saltmarsh-melaleuca	48042.182	4.8
saltmarsh-mixed	126378.177	12.6
saltmarsh-saltmarsh	921828.317	92.2
saltmarsh-waterway	5372.013	0.5
waterway-catchment	8164.071	0.8
waterway-eucalyptus	1166.296	0.1
waterway-mangrove	55025.717	5.5
waterway-mixed	4973.234	0.5
waterway-saltmarsh	5555.268	0.6
waterway-waterway	482035.987	48.2

Table A6.51: Areas of habitat change in Cararma Inlet, Jervis Bay, 1981 to 1999.

change	Area (m²)	Area (ha)
casuarina-casuarina	368735.936	36.9
casuarina-catchment	10777.059	1.1
casuarina-mangrove	1943.826	0.2
casuarina-saltmarsh	3110.123	0.3
catchment-casuarina	3498.886	0.3
catchment-catchment	3756991.353	375.7
catchment-eucalyptus	4665.182	0.5
catchment-mangrove	777.53	0.1
catchment-melaleuca	12070.933	1.2
catchment-saltmarsh	8000.032	0.8
catchment-waterway	49386.979	4.9
eucalyptus-eucalyptus	342773.634	34.3
eucalyptus-mangrove	4276.416	0.4
eucalyptus-melaleuca	56286.67	5.6
eucalyptus-mixed	3110.122	0.3
eucalyptus-saltmarsh	15898.767	1.6
mangrove-casuarina	14627.33	1.5
mangrove-catchment	2097.466	0.2
mangrove-eucalyptus	1555.061	0.2
mangrove-mangrove	369712.246	37.0
mangrove-melaleuca	1166.296	0.1
mangrove-mixed	16353.591	1.6
mangrove-saltmarsh	6609.007	0.7
mangrove-waterway	24472.816	2.4
melaleuca-casuarina	10326.179	1.0
melaleuca-catchment	35290.7	3.5
melaleuca-eucalyptus	26039.167	2.6
melaleuca-mangrove	2332.592	0.2
melaleuca-melaleuca	336380.275	33.6
melaleuca-mixed	4665.183	0.5
melaleuca-saltmarsh	7582.515	0.8
mixed-casuarina	15855	1.6
mixed-catchment	8623.957	0.9
mixed-eucalyptus	1166.296	0.1
mixed-mangrove	117088.391	11.7
mixed-melaleuca	3110.12	0.3
mixed-mixed	43551.898	4.4
mixed-saltmarsh	30027.28	3.0
saltmarsh-casuarina	28243.63	2.8
saltmarsh-catchment	38660.013	3.9
saltmarsh-eucalyptus	10217.053	1.0
saltmarsh-mangrove	101857.549	10.2
saltmarsh-melaleuca	69245.726	6.9
saltmarsh-mixed	103484.562	10.3
saltmarsh-saltmarsh	717276.084	71.7
saltmarsh-waterway	2200.473	0.2
waterway-catchment	1555.061	0.2
waterway-mangrove	27624.455	2.8
waterway-saltmarsh	1943.827	0.2
waterway-waterway	484796.221	48.5

Table A6.52: Areas of habitat change in Cararma Inlet, Jervis Bay, 1948 to 1999.

change	Area (m²)	Area (ha)
casuarina-casuarina	198956.043	19.9
casuarina-mangrove	1394.364	0.1
catchment-catchment	9875.684	364.7
catchment-mangrove	83424.226	8.3
catchment-saltmarsh	1285.176	0.1
catchment-waterway	451372.106	45.1
eucalyptus-eucalyptus	297692.287	29.8
eucalyptus-mangrove	963.882	0.1
eucalyptus-melaleuca	100366.647	10.0
eucalyptus-mixed	963.882	0.1
eucalyptus-saltmarsh	5360.675	0.5
mangrove-casuarina	321.294	0.3
mangrove-catchment	4498.112	0.4
mangrove-eucalyptus	4176.819	0.4
mangrove-mangrove	177845.939	17.8
mangrove-melaleuca	4498.113	0.4
mangrove-mixed	17655.92	1.8
mangrove-saltmarsh	12731.055	1.3
mangrove-waterway	30452.614	3.0
melaleuca-casuarina	963.881	0.1
melaleuca-catchment	48096.947	4.8
melaleuca-eucalyptus	18215.274	1.8
melaleuca-mangrove	205.753	0.0
melaleuca-melaleuca	207288.227	20.7
melaleuca-mixed	7588.543	0.8
melaleuca-saltmarsh	3418.691	0.3
saltmarsh-casuarina	230900.153	23.1
saltmarsh-catchment	97166.21	9.7
saltmarsh-eucalyptus	66329.456	6.6
saltmarsh-mangrove	357218.418	35.7
saltmarsh-melaleuca	156145.608	15.6
saltmarsh-mixed	147640.822	14.8
saltmarsh-saltmarsh	763079.852	76.3
saltmarsh-waterway	2776.102	0.3
waterway-casuarina	8830.821	0.9
waterway-catchment	3647438.33	1.0
waterway-mangrove	3102.493	0.3
waterway-melaleuca	10569.264	1.1
waterway-mixed	1285.175	0.1
waterway-saltmarsh	16969.887	1.7
waterway-waterway	54963.057	5.5

Appendix 7: Raw Mean Elevational Data and Statistical Analyses

Table A7.1: Black Neds Bay, Lake Macquarie, mean habitat elevations (m).

mangrove to mangrove	saltmarsh to mangrove	saltmarsh to mixed	saltmarsh to saltmarsh
1.050	1.800	1.480	1.900
1.185	2.100		1.860
1.230	1.600		1.920
1.080	1.285		1.800
1.180	1.330		1.780
1.470	1.425		1.780
1.570	1.635		1.960
1.405	1.470		1.530
1.335	1.440		1.800
1.340	1.400		1.600
1.080	1.430		1.680
1.080			2.100
1.330			2.100
1.000			1.930
1.100			1.900
1.130			2.100
1.500			2.100
1.820			1.950
1.515			1.950
1.180			1.900
1.660			1.785
1.390			1.950
0.900			2.100
0.950			1.680
1.040			1.780
1.140			2.100
1.130			1.770
1.120			1.650
1.670			1.580
0.850			1.730
0.810			1.660
0.820			2.100
1.360			2.100
0.840			1.640
0.920			1.470
0.950			1.550
1.430			
1.230			
1.230			

Table A7.2: Habitat elevational changes (m) (to determine inundation depth) in Black Neds Bay, Lake Macquarie, 1950 to 1999.

change	Value	Count	Area	Min	Max	Range	Mean	Std	Sum
reclaimed-catchment	1	15	671.3602	2.0689	2.1	0.0311	2.0966	0.0089	31.4488
reclaimed-terrestrial	3	6	268.5441	2.0904	2.1	0.0096	2.0984	0.0036	12.5904
waterway-water	12	6	268.5441	1.6876	1.8278	0.1401	1.7629	0.0501	10.5773
waterway-saltmarsh	14	14	626.6028	1.6543	1.8978	0.2435	1.7247	0.0687	24.1457
coastal veg-waterway	20	96	4296.7051	0	2.1	2.1	1.0632	0.7805	102.0696
coastal veg-mixed	26	2	89.5147	1.8728	1.8797	0.0068	1.8763	0.0034	3.7525
coastal veg-mangrove	27	80	3580.5876	0.2575	2.1	1.8425	1.5824	0.4724	126.591
coastal veg-coastal veg	29	21	939.9042	0.4977	2.0863	1.5886	1.55	0.4856	32.5499
mangrove-waterway	30	16	716.1175	0	1.8627	1.8627	0.5947	0.4768	9.5157
mangrove-terrestrial	33	1	44.7573	2.0542	2.0542	0	2.0542	0	2.0542
mangrove-saltmarsh	34	6	268.5441	1.4362	1.8413	0.4051	1.6817	0.1475	10.0903
mangrove-mangrove	37	45	2014.0804	0.839	1.9424	1.1035	1.2253	0.1913	55.1405
mixed-terrestrial	43	261	11681.667	1.5721	2.1	0.5279	2.075	0.0657	541.5742
mixed-saltmarsh	44	901	40326.3672	1.1315	2.1	0.9685	1.6397	0.2223	1477.3438
mixed-reclaimed	45	9	402.8161	2.1	2.1	0	2.1	0	18.9
mixed-mixed	46	7	313.3014	1.4859	1.5524	0.0665	1.5154	0.02	10.6075
mixed-mangrove	47	372	16649.7324	1.1127	1.9835	0.8708	1.3319	0.1855	495.4496
saltmarsh-waterway	50	256	11457.8799	0	2.1	2.1	0.9392	0.7227	240.4363
saltmarsh-water	52	42	1879.8085	1.613	2.1	0.487	1.7584	0.1332	73.8533
saltmarsh-terrestrial	53	169	7563.9912	1.6681	2.1	0.4319	2.0522	0.0809	346.8178
saltmarsh-saltmarsh	54	4426	198096	0.463	2.1	1.637	1.7758	0.1706	7859.8657
saltmarsh-mixed	56	450	20140.8047	1.0854	1.9959	0.9105	1.5147	0.1007	681.6297
saltmarsh-mangrove	57	1959	87679.6406	0.0967	2.1	2.0033	1.4391	0.2324	2819.1628
saltmarsh-coastal veg	59	135	6042.2417	0.5421	2.1	1.5579	1.8939	0.3614	255.6743
terrestrial-waterway	60	108	4833.793	0	1.3678	1.3678	0.5455	0.4044	58.9126
terrestrial-catchment	61	240	10741.7627	1.9235	2.1	0.1765	2.0947	0.0196	502.734
terrestrial-water	62	19	850.3895	1.6704	2.1	0.4296	1.9655	0.1509	37.3446
terrestrial-terrestrial	63	2938	131497.0781	0.2447	2.1	1.8553	2.0765	0.1077	6100.7813
terrestrial-saltmarsh	64	1873	83830.5078	0.1598	2.1	1.9402	1.8262	0.2149	3420.4514
terrestrial-reclaimed	65	19	850.3895	2.1	2.1	0	2.1	0	39.9
terrestrial-mangrove	67	14	626.6028	1.3613	2.1	0.7387	1.6115	0.1859	22.5612
terrestrial-coastal veg	69	114	5102.3374	0.3453	2.1	1.7547	1.7314	0.4825	197.3769
catchment-waterway	70	2	89.5147	1.9046	1.9402	0.0356	1.9224	0.0178	3.8448
catchment-catchment	71	19	850.3895	1.7691	2.1	0.3309	2.0639	0.0843	39.2147
catchment-terrestrial	73	41	1835.0511	1.9633	2.1	0.1367	2.0814	0.0371	85.3364
catchment-saltmarsh	74	1	44.7573	1.9565	1.9565	0	1.9565	0	1.9565
catchment-mangrove	77	45	2014.0804	0.7654	2.0172	1.2517	1.6854	0.3175	75.8426
waterway-waterway	80	800	35805.875	0	2.1	2.1	0.648	0.6701	518.3663
waterway-water	82	19	850.3895	1.333	1.8306	0.4976	1.6197	0.1418	30.7739
waterway-terrestrial	83	4	179.0294	1.7956	1.9924	0.1969	1.8851	0.0702	7.5405
waterway-saltmarsh	84	346	15486.041	1.022	1.9824	0.9603	1.5865	0.1348	548.9461
waterway-mixed	86	28	1253.2057	1.3089	1.8265	0.5176	1.5706	0.1386	43.9764
waterway-mangrove	87	5880	263173.1875	0	2.1	2.1	1.1212	0.3175	6592.9014
waterway-coastal veg	89	84	3759.6169	0	2.1	2.1	1.8507	0.4697	155.4592

Table A7.3: Courangra Point, Hawkesbury River, mean habitat elevations (m).

mangrove to mangrove	saltmarsh to mangrove	saltmarsh to mixed	saltmarsh to saltmarsh
1.410	1.570	1.590	1.660
1.770	1.560	1.660	1.680
1.550	1.660	1.740	1.740
1.800			1.760
1.660			1.770
1.650			1.620
1.590			1.800
1.590			1.600
1.650			1.730
1.800			1.750
1.800			1.750
1.550			1.620
1.610			1.590
1.790			1.750
1.670			1.790
1.590			1.750
1.630			1.730
1.700			1.740
1.710			1.620
1.740			1.630
1.700			1.780
1.550			1.720
1.470			1.760
			1.790
			1.790
			1.800

Table A7.4: Habitat elevational changes (m) (to determine inundation depth) at Courangra Point, Hawkesbury River, 1954 to 1994.

change	Value	Count	Area	Min	Max	Range	Mean	Std	Sum
mangrove-saltmarsh	17	6	581.5089	1.6455	1.7789	0.1334	1.7061	0.0535	10.2364
mangrove-mixed	18	2	193.8363	1.7415	1.7435	0.002	1.7425	0.001	3.485
mangrove-mangrove	19	321	31110.7227	1.4169	1.7971	0.3801	1.6067	0.0682	515.7474
mixed-saltmarsh	27	7	678.4269	1.55	1.6662	0.1162	1.5936	0.0504	11.1553
mixed-mangrove	29	37	3585.9712	1.55	1.8955	0.3455	1.6013	0.0811	59.249
saltmarsh-catchment	45	3	290.7544	1.9145	2.0938	0.1794	2.0278	0.0805	6.0835
saltmarsh-terrestrial	46	9	872.2632	1.9444	2.1	0.1556	2.0361	0.0583	18.3249
saltmarsh-saltmarsh	47	761	73754.7031	1.55	2.1	0.55	1.7003	0.071	1293.9607
saltmarsh-mixed	48	208	20158.9727	1.5918	2.0602	0.4684	1.6961	0.0551	352.7844
saltmarsh-mangrove	49	401	38864.1719	1.55	2.1	0.55	1.6398	0.0893	657.5709
terrestrial-terrestrial	56	8	775.3451	1.9351	2.1	0.1649	2.0302	0.0605	16.242
terrestrial-saltmarsh	57	3	290.7544	1.8521	2.0462	0.1941	1.9188	0.0901	5.7563
terrestrial-mixed	58	2	193.8363	1.9714	2.0218	0.0504	1.9966	0.0252	3.9932
terrestrial-mangrove	59	11	1066.0995	1.59	2.1	0.51	1.7929	0.1715	19.7221
waterway-watway	74	12	1163.0177	1.4221	1.5887	0.1666	1.4844	0.0524	17.8126
waterway-mangrove	79	46	4458.2344	1.4135	1.6617	0.2482	1.5461	0.0684	71.119

Table A7.5: Careel Bay, Pittwater, mean habitat elevations (m).

mangrove to mangrove	saltmarsh to mangrove	saltmarsh to mixed	saltmarsh to saltmarsh
1.165	1.675	1.620	1.735
0.955			2.000
0.850			1.755
1.310			
1.100			
0.970			
0.940			
0.870			
0.985			
1.035			
1.120			
1.160			
1.245			
1.375			
1.495			
1.295			
1.270			
1.230			
1.190			
1.160			
1.170			
1.190			
1.160			
1.190			
1.170			
1.490			
1.380			
1.330			
1.320			
0.930			
1.710			
1.640			
1.590			
1.555			
1.510			
1.360			
1.270			
1.180			
0.970			
0.800			
1.220			
1.280			
1.375			
1.245			
1.415			
1.555			
1.590			
1.620			
1.615			

Table A7.6: Habitat elevational changes (m) (to determine inundation depth) in Careel Bay, 1940 to 1996.

Label	Value	Count	Area	Min	Max	Range	Mean	Std	Sum
waterway-waterway	13	26	520.2502	0	0.7486	0.7486	0.14	0.2427	3.64
waterway-terrestrial	15	8	160.077	1.153	2	0.847	1.5998	0.3032	12.7982
waterway-reclaimed	17	4	80.0385	1.9788	2	0.0212	1.9947	0.0092	7.9788
mangrove-mangrove	19	315	6303.0322	0	1.9585	1.9585	0.8561	0.3892	269.6815
mangrove-terrestrial	25	4	80.0385	1.7183	2	0.2817	1.9296	0.122	7.7183
mangrove-saltmarsh	26	4	80.0385	1.6431	1.9706	0.3275	1.875	0.1345	7.4999
mangrove-reclaimed	27	1	20.0096	1.6845	1.6845	0	1.6845	0	1.6845
mangrove-mangrove	29	621	12425.9775	0.0753	2	1.9247	1.0207	0.3536	633.8675
saltmarsh-waterway	33	158	3161.5208	0	0.9696	0.9696	0.234	0.2801	36.9686
saltmarsh-catchment	34	48	960.462	0	2	2	1.8071	0.5168	86.7397
saltmarsh-terrestrial	35	129	2581.2417	0.4484	2	1.5516	1.5434	0.4307	199.094
saltmarsh-saltmarsh	36	318	6363.061	0.7708	2	1.2292	1.7775	0.1704	565.2548
saltmarsh-reclaimed	37	67	1340.6449	1.3056	2	0.6944	1.9262	0.138	129.054
saltmarsh-mixed	38	1045	20910.0586	1.2182	1.9488	0.7306	1.6036	0.1189	1675.8044
saltmarsh-mangrove	39	4006	80158.5625	0	2	2	1.2659	0.4342	5071.1909

Table A7.7: Towra Point, Botany Bay, mean habitat elevations (m).

mangrove to mangrove	saltmarsh to mangrove	saltmarsh to mixed	saltmarsh to saltmarsh
0.780	1.020	1.625	1.640
0.810	2.000	1.560	1.610
0.990	1.670	1.580	1.570
1.550		1.570	1.600
1.540		1.585	1.620
1.550		1.590	1.755
1.520			1.660
1.500			1.675
1.465			1.790
1.350			1.830
1.450			1.750
1.510			1.730
1.535			1.690
1.590			1.720
1.620			1.690
1.265			1.630
1.010			1.580
0.870			1.500
0.840			1.420
1.180			
1.415			
1.240			
1.060			

Table A7.8: Habitat elevational changes (m) (to determine inundation depth) at Towra Point, Botany Bay, 1956 to 1999.

change	Value	Count	Area	Min	Max	Range	Mean	Std	Sum
mangrove-saltmarsh	5	4	2886.427	1.472	1.6358	0.1637	1.5559	0.0746	6.2236
mangrove-mixed	7	1	721.6068	1.5282	1.5282	0	1.5282	0	1.5282
mangrove-mangrove	8	163	117621.8984	0	1.5504	1.5504	0.8504	0.3099	138.6114
mixed-mangrove	18	62	44739.6172	1.3684	2.0676	0.6993	1.5517	0.1277	96.2044
mudflat-waterway	21	1	721.6068	0.4408	0.4408	0	0.4408	0	0.4408
mudflat-mangrove	28	5	3608.0337	0.184	1	0.816	0.5756	0.3584	2.8781
reclaimed-reclaimed	36	8	5772.854	1.9988	2.1	0.1012	2.0511	0.0412	16.4089
reclaimed-mangrove	38	3	2164.8203	1.9908	2.022	0.0313	2.0097	0.0136	6.0292
saltmarsh-saltmarsh	45	270	194833.8281	1.1027	2.0258	0.923	1.6867	0.0903	455.4122
saltmarsh-reclaimed	46	3	2164.8203	1.6483	2.0828	0.4344	1.8276	0.1853	5.4829
saltmarsh-mixed	47	77	55563.7188	1.2748	2.0394	0.7646	1.5944	0.0966	122.7666
saltmarsh-mangrove	48	117	84427.9922	0.9065	2.085	1.1784	1.5394	0.215	180.104
waterway-waterway	91	9	6494.4609	0	0.1829	0.1829	0.0302	0.0556	0.2716
waterway-mangrove	98	14	10102.4941	0	0.5717	0.5717	0.2079	0.1751	2.9105

Table A7.9: Replicate tidal inundation modelling for Towra Point, Botany Bay, over a four day period.

below tide:	2.0m	1.9m	1.4m	1.6m
Veg	06/06/00	07/06/00	08/06/00	09/06/00
Sarc	1.63	1.705	0	0
Av/sarc	1.658	1.65	0	0
sarc	1.64	1.75	0	0
sarc	1.67	1.75	0	0
spor	1.67	1.73	0	0
spor	1.68	1.72	0	0
Sarc	1.705	1.75	0	0
n.d.				
Avic	1.39	1.405	0	1.405
avic	1.24	1.29	0	1.29
avic	1.175	1.17	1.34	1.21
Avic	1.04	1.06	1.27	1.1
Avic	0.83	0.8	1.02	0.91
Avic (front)	0.7	0.6	0.9	0.735

Table A7.10: Currumbene Creek, Jervis Bay, mean habitat elevations (m).

mangrove to mangrove	saltmarsh to mangrove	saltmarsh to mixed	saltmarsh to saltmarsh
1.660	1.675	1.660	1.750
1.720		1.690	1.610
2.100		1.705	1.625
1.725		1.745	1.630
1.700		1.780	1.705
1.670		1.660	1.700
1.685		1.680	1.940
1.775		1.680	1.740
1.570		1.630	1.680
1.180		1.650	1.610
1.650		1.665	1.815
1.310		1.700	1.580
1.530		1.735	1.640
1.510		1.770	1.710
1.580		1.755	2.100
1.940		1.770	1.670
1.600		1.660	1.685
1.300			1.670
1.580			1.610
1.570			1.560
1.480			1.750
1.530			
1.680			
1.720			
1.760			
1.730			
1.475			
1.430			
1.410			
1.540			

Table A7.11: Habitat elevational changes (m) (to determine inundation depth) in Currumbene Creek, Jervis Bay, 1949 to 1993.

change	Value	Count	Area	Min	Max	Range	Mean	Std	Sum
casuarina-waterway	4	6	1393.8134	0	0.3099	0.3099	0.0944	0.1201	0.5661
cauarina-saltmarsh	5	9	2090.72	0.7427	2.0781	1.3355	1.7693	0.3701	15.9235
casuarina-mixed	6	7	1626.1156	1.6553	2.2283	0.573	1.9507	0.2382	13.6551
casuarina-mangrove	7	11	2555.3245	0.3285	1.8046	1.476	0.8674	0.3678	9.5416
casuarina-catchment	8	13	3019.929	1.398	2.4571	1.0592	1.8995	0.3255	24.6939
casuarina-saltmarsh	9	350	81305.7813	0	2.243	2.243	1.8525	0.4804	648.373
catchment-waterway	14	2	464.6045	0	0.0047	0.0047	0.0023	0.0023	0.0047
catchment-saltmarsh	15	19	4413.7422	1.7196	2.4558	0.7362	2.2182	0.1772	42.1453
catchment-mangrove	17	27	6272.1602	0	1.9188	1.9188	1.134	0.5291	30.6181
catchment-catchment	18	92	21371.8047	0.2298	2.5	2.2702	2.04	0.5565	187.6802
mangrove-waterway	24	3	696.9067	0	0.0331	0.0331	0.011	0.0156	0.0331
mangrove-saltmarsh	25	2	464.6045	1.6757	1.6995	0.0238	1.6876	0.0119	3.3752
mangrove-mixed	26	4	929.2089	1.4338	1.6743	0.2405	1.5693	0.0867	6.2771
mangrove-mangrove	27	142	32986.9141	0	1.8188	1.8188	1.0304	0.4484	146.3185
mangrove-casuarina	29	4	929.2089	1.8683	2.0151	0.1468	1.9274	0.0549	7.7094
mixed-waterway	34	2	464.6045	0.0409	0.151	0.11	0.096	0.055	0.1919
mixed-saltmarsh	35	45	10453.6006	0.4395	1.69	1.2505	1.2928	0.3744	58.1764
mixed-mixed	36	508	118009.5313	0.0416	1.8293	1.7877	1.5469	0.2502	785.8064
mixed-mangrove	37	503	116848.0156	0.0483	1.862	1.8137	1.2824	0.3761	645.0267
saltmarsh-waterway	44	2	464.6045	0	0.0224	0.0224	0.0112	0.0112	0.0224
saltmarsh-saltmarsh	45	574	133341.4844	0.1445	2.4184	2.2739	1.6956	0.2747	973.2547
saltmarsh-mixed	46	397	92223.9844	0.9261	2.3135	1.3873	1.6972	0.1291	673.7963
saltmarsh-mangrove	47	206	47854.2578	0.3104	2.4487	2.1382	1.7572	0.2261	361.9933
saltmarsh-catchment	48	35	8130.5776	1.187	2.5	1.313	2.1129	0.2946	73.9528
saltmarsh-casuarina	49	63	14635.04	1.1069	2.4576	1.3507	1.9103	0.2515	120.352
waterway-waterway	54	69	16028.8535	0	1.0944	1.0944	0.1626	0.2207	11.2202
waterway-saltmarsh	55	4	929.2089	0.4463	0.8945	0.4482	0.6117	0.1706	2.4469
waterway-mixed	56	16	3716.8357	0.108	0.8067	0.6987	0.4127	0.202	6.6039
waterway-mangrove	57	68	15796.5518	0	1.2502	1.2502	0.4787	0.3101	32.5516

Statistical Analyses

Oneway for ALL sites for the whole period of mapping

ANOVA

Elevation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.904	2	3.952	84.110	.000
Within Groups	18.043	384	4.699E-02		
Total	25.947	386			

Post Hoc Tests

Homogeneous Subsets

Elevation

Student-Newman-Keuls^{a,b}

Vegetation	N	Subset for alpha = .05		
		1	2	3
Mangrove to mangrove	52	1.31823		
saltmarsh to mangrove/mixed	165		1.54268	
saltmarsh to saltmarsh	170			1.73794
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

- Uses Harmonic Mean Sample Size = 96.235.
- The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Univariate Analysis of Variance

Between-Subjects Factors

	Value Label	N
Vegetation	1 Mangrove to mangrove	52
	2 saltmarsh to mangrove/mixed	165
	3 saltmarsh to saltmarsh	170
SITE	1 Black Neds Bay	40
	2 Couranga Point	66
	3 Careel Bay	73
	4 Towra Point	67
	5 Currambene Creek	141

Descriptive Statistics

Dependent Variable: Elevation

Vegetation	SITE	Mean	Std. Deviation	N
Mangrove to mangrove	Couranga Point	1.65800	.13592	15
	Careel Bay	1.28500	.32609	10
	Towra Point	1.07059	.27317	17
	Currambene Creek	1.26280	.21056	10
	Total	1.31823	.33209	52
saltmarsh to mangrove/mixed	Couranga Point	1.66591	6.7093E-02	22
	Careel Bay	1.40724	.23218	58
	Towra Point	1.56309	8.6560E-02	22
	Currambene Creek	1.65850	.10153	50
	Black Neds Bay	1.45846	.14575	13
	Total	1.54268	.19529	165
saltmarsh to saltmarsh	Couranga Point	1.71379	6.3943E-02	29
	Careel Bay	1.72800	.16600	5
	Towra Point	1.66714	9.3228E-02	28
	Currambene Creek	1.72864	.23362	81
	Black Neds Bay	1.86704	.16678	27
	Total	1.73794	.19097	170
Total	Couranga Point	1.68515	8.8635E-02	66
	Careel Bay	1.41247	.25825	73
	Towra Point	1.48161	.29045	67
	Currambene Creek	1.67073	.22699	141
	Black Neds Bay	1.73425	.25028	40
	Total	1.59830	.25927	387

Tests of Between-Subjects Effects

Dependent Variable: Elevation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13.505 ^a	13	1.039	31.143	.000
Intercept	515.067	1	515.067	15441.140	.000
VEG	4.897	2	2.449	73.404	.000
SITE	2.051	4	.513	15.375	.000
VEG * SITE	2.888	7	.413	12.369	.000
Error	12.442	373	3.336E-02		
Total	1014.559	387			
Corrected Total	25.947	386			

a. R Squared = .520 (Adjusted R Squared = .504)

Post Hoc Tests

Vegetation

Homogeneous Subsets

Elevation

Student-Newman-Keuls^{a,b,c}

Vegetation	N	Subset		
		1	2	3
Mangrove to mangrove	52	1.31823		
saltmarsh to mangrove/mixed	165		1.54268	
saltmarsh to saltmarsh	170			1.73794
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on Type III Sum of Squares

The error term is Mean Square(Error) = 3.336E-02.

- Uses Harmonic Mean Sample Size = 96.235.
- The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
- Alpha = .05.

Site

Homogeneous Subsets

Elevation

Student-Newman-Keuls^{a,b,c}

SITE	N	Subset		
		1	2	3
Careel Bay	73	1.41247		
Towra Point	67		1.48161	
Currambene Creek	141			1.67073
Couranga Point	66			1.68515
Black Neds Bay	40			1.73425
Sig.		1.000	1.000	.113

Means for groups in homogeneous subsets are displayed.

Based on Type III Sum of Squares

The error term is Mean Square(Error) = 3.336E-02.

- Uses Harmonic Mean Sample Size = 65.904.
- The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
- Alpha = .05.

Black Neds Bay**Oneway****Warnings**

Post hoc tests are not performed for Elevation because there are fewer than three groups.

Univariate Analysis of Variance**Warnings**

Post hoc tests are not performed for Vegetation because there are fewer than three groups.

Courangra Point**Oneway****ANOVA**

Elevation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.299E-02	2	2.150E-02	2.896	.063
Within Groups	.468	63	7.423E-03		
Total	.511	65			

Post Hoc Tests**Homogeneous Subsets****Elevation**Student-Newman-Keuls^{a,b}

Vegetation	N	Subset for alpha = .05
		1
Mangrove to mangrove	15	1.65800
saltmarsh to mangrove/mixed	22	1.66591
saltmarsh to saltmarsh	29	1.71379
Sig.		.104

Means for groups in homogeneous subsets are displayed.

- a. Uses Harmonic Mean Sample Size = 20.463.
- b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Careel Bay**Oneway****ANOVA**

Elevation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.662	2	.331	5.595	.006
Within Groups	4.140	70	5.914E-02		
Total	4.802	72			

Post Hoc Tests**Homogeneous Subsets****Elevation**Student-Newman-Keuls^{a,b}

Vegetation	N	Subset for alpha = .05	
		1	2
Mangrove to mangrove	10	1.28500	
saltmarsh to mangrove/mixed	58	1.40724	
saltmarsh to saltmarsh	5		1.72800
Sig.		.278	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 9.457.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Towra Point**Oneway****ANOVA**

Elevation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.982	2	1.991	80.342	.000
Within Groups	1.586	64	2.478E-02		
Total	5.568	66			

Post Hoc Tests

Homogeneous Subsets

Elevation

Student-Newman-Keuls^{a,b}

Vegetation	N	Subset for alpha = .05		
		1	2	3
Mangrove to mangrove	17	1.07059		
saltmarsh to mangrove/mixed	22		1.56309	
saltmarsh to saltmarsh	28			1.66714
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

- Uses Harmonic Mean Sample Size = 21.430.
- The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Currambene Creek

Oneway

ANOVA

Elevation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.943	2	.972	25.441	.000
Within Groups	5.270	138	3.819E-02		
Total	7.213	140			

Post Hoc Tests

Homogeneous Subsets

Elevation

Student-Newman-Keuls^{a,b}

Vegetation	N	Subset for alpha = .05	
		1	2
Mangrove to mangrove	10	1.26280	
saltmarsh to mangrove/mixed	50		1.65850
saltmarsh to saltmarsh	81		1.72864
Sig.		1.000	.227

Means for groups in homogeneous subsets are displayed.

- Uses Harmonic Mean Sample Size = 22.668.
- The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Site-Specific Analyses of Mean Sea-Level Versus Mangrove Incursion

Mean Sea-level Versus Mangrove Incursion

Black Neds Bay

Table A7.12: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.533525	7.1895E-02	4
Mean sea-level	.95650	2.5619E-02	4

Table A7.13: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	-.870
	Sig. (2-tailed)	.	.130
	N	4	4
Mean sea-level	Pearson Correlation	-.870	1.000
	Sig. (2-tailed)	.130	.
	N	4	4

Table A7.14: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.535800	7.48319E-02	4
Mean sea-level	.95650	1.3401E-02	4

Table A7.15: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	-.280
	Sig. (2-tailed)	.	.720
	N	4	4
Mean sea-level	Pearson Correlation	-.280	1.000
	Sig. (2-tailed)	.720	.
	N	4	4

Courangra Point

Table A7.16: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.668750	1.28778E-02	4
Mean sea-level	.94450	9.3274E-03	4

Table A7.17: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	-.646
	Sig. (2-tailed)	.	.354
	N	4	4
Mean sea-level	Pearson Correlation	-.646	1.000
	Sig. (2-tailed)	.354	.
	N	4	4

Table A7.18: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.668763	1.28994E-02	4
Mean sea-level	.94000	1.1776E-02	4

Table A7.19: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	-.628
	Sig. (2-tailed)	.	.372
	N	4	4
Mean sea-level	Pearson Correlation	-.628	1.000
	Sig. (2-tailed)	.372	.
	N	4	4

Careel Bay

Table A7.20 Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.600925	.150696	4
Mean sea-level	.93950	1.6902E-02	4

Table A7.21: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	.993**
	Sig. (2-tailed)	.	.007
	N	4	4
Mean sea-level	Pearson Correlation	.993**	1.000
	Sig. (2-tailed)	.007	.
	N	4	4

** . Correlation is significant at the 0.01 level (2-tailed).

Table A7.22: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.600925	.150696	4
Mean sea-level	.93550	1.9841E-02	4

Table A7.23: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	.997**
	Sig. (2-tailed)	.	.003
	N	4	4
Mean sea-level	Pearson Correlation	.997**	1.000
	Sig. (2-tailed)	.003	.
	N	4	4

** . Correlation is significant at the 0.01 level (2-tailed).

Towra Point

Table A7.24: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.499613	.113714	4
Mean sea-level	.93875	1.0308E-02	4

Table A7.25: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	.149
	Sig. (2-tailed)	.	.851
	N	4	4
Mean sea-level	Pearson Correlation	.149	1.000
	Sig. (2-tailed)	.851	.
	N	4	4

Table A7.26: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.499613	.113714	4
Mean sea-level	.94275	6.3443E-03	4

Table A7.27: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	.213
	Sig. (2-tailed)	.	.787
	N	4	4
Mean sea-level	Pearson Correlation	.213	1.000
	Sig. (2-tailed)	.787	.
	N	4	4

Currambene Creek

Table A7.28: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currambene Creek, 1949 to 1993.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.623463	8.44853E-02	4
Mean sea-level	.94375	1.1927E-02	4

Table A7.29: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currambene Creek, 1949 to 1993.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	.126
	Sig. (2-tailed)	.	.874
	N	4	4
Mean sea-level	Pearson Correlation	.126	1.000
	Sig. (2-tailed)	.874	.
	N	4	4

Table A7.30: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currambene Creek, 1949 to 1993, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Elevation of mangrove incursion	1.623463	8.44853E-02	4
Mean sea-level	.93475	1.4315E-02	4

Table A7.31: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currumbene Creek, 1949 to 1993, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Elevation of mangrove incursion	Pearson Correlation	1.000	.589
	Sig. (2-tailed)	.	.411
	N	4	4
Mean sea-level	Pearson Correlation	.589	1.000
	Sig. (2-tailed)	.411	.
	N	4	4

Black Neds Bay

Table A7.32: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999.

	Mean	Std. Deviation	N
Range of mangrove incursion	.387225	.111264	4
Mean sea-level	.95650	2.5619E-02	4

Table A7.33: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.638
	Sig. (2-tailed)	.	.362
	N	4	4
Mean sea-level	Pearson Correlation	-.638	1.000
	Sig. (2-tailed)	.362	.
	N	4	4

Table A7.34: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Range of mangrove incursion	.387225	.111264	4
Mean sea-level	.93675	1.3401E-02	4

Table A7.35: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Black Neds Bay, 1950 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.803
	Sig. (2-tailed)	.	.197
	N	4	4
Mean sea-level	Pearson Correlation	-.803	1.000
	Sig. (2-tailed)	.197	.
	N	4	4

Courangra Point

Table A7.36: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996.

	Mean	Std. Deviation	N
Range of mangrove incursion	5.08E-02	2.57836E-02	4
Mean sea-level	.94450	9.3274E-03	4

Table A7.37: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	.070
	Sig. (2-tailed)	.	.930
	N	4	4
Mean sea-level	Pearson Correlation	.070	1.000
	Sig. (2-tailed)	.930	.
	N	4	4

Table A7.38: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Range of mangrove incursion	5.08E-02	2.57836E-02	4
Mean sea-level	.93475	1.4315E-02	4

Table A7.39: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Courangra Point, 1954 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.402
	Sig. (2-tailed)	.	.598
	N	4	4
Mean sea-level	Pearson Correlation	-.402	1.000
	Sig. (2-tailed)	.598	.
	N	4	4

Careel Bay

Table A7.40: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996.

	Mean	Std. Deviation	N
Range of mangrove incursion	.5000650	5.29425E-02	4
Mean sea-level	.93950	1.6902E-02	4

Table A7.41: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.379
	Sig. (2-tailed)	.	.621
	N	4	4
Mean sea-level	Pearson Correlation	-.379	1.000
	Sig. (2-tailed)	.621	.
	N	4	4

Table A7.42: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Range of mangrove incursion	.5000650	5.29425E-02	4
Mean sea-level	.93550	1.9841E-02	4

Table A7.43: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Careel Bay, 1940 to 1996, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.253
	Sig. (2-tailed)	.	.747
	N	4	4
Mean sea-level	Pearson Correlation	-.253	1.000
	Sig. (2-tailed)	.747	.
	N	4	4

Towra Point

Table A7.44: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999.

	Mean	Std. Deviation	N
Range of mangrove incursion	.624075	5.92852E-02	4
Mean sea-level	.93875	1.0308E-02	4

Table A7.45: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.819
	Sig. (2-tailed)	.	.181
	N	4	4
Mean sea-level	Pearson Correlation	-.819	1.000
	Sig. (2-tailed)	.181	.
	N	4	4

Table A7.46: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Range of mangrove incursion	.624075	5.92852E-02	4
Mean sea-level	.94275	6.3443E-03	4

Table A7.47: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Towra Point, 1956 to 1999, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	-.618
	Sig. (2-tailed)	.	.383
	N	4	4
Mean sea-level	Pearson Correlation	-.618	1.000
	Sig. (2-tailed)	.383	.
	N	4	4

Currambene Creek

Table A7.48: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currambene Creek, 1949 to 1993.

	Mean	Std. Deviation	N
Range of mangrove incursion	.598875	.143485	4
Mean sea-level	.94375	1.1927E-02	4

Table A7.49: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currambene Creek, 1949 to 1993.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	.063
	Sig. (2-tailed)	.	.937
	N	4	4
Mean sea-level	Pearson Correlation	.063	1.000
	Sig. (2-tailed)	.937	.
	N	4	4

Table A7.50: Descriptive statistics of the correlation between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currambene Creek, 1949 to 1993, with vegetation data lagging 5 years behind mean sea-level data.

	Mean	Std. Deviation	N
Range of mangrove incursion	.598875	.143485	4
Mean sea-level	.93475	1.4315E-02	4

Table A7.51: Correlations between the mean elevation of mangrove incursion, and changes in mean sea-level, for Currumbene Creek, 1949 to 1993, with vegetation data lagging 5 years behind mean sea-level data.

		Elevation of mangrove incursion	Mean sea-level
Range of mangrove incursion	Pearson Correlation	1.000	.616
	Sig. (2-tailed)	.	.384
	N	4	4
Mean sea-level	Pearson Correlation	.616	1.000
	Sig. (2-tailed)	.384	.
	N	4	4

Appendix 8: Raw Datasets for Assessment of Other Considerations

Table A8.1: Raw data for analyses of the relationship between mean sea-level and rainfall at each site.

year	mean sea-level (mm) (Fort Denison)	rainfall							
		Ukerebagh Island	Tilligerry Creek	Black Neds Bay	Brisbane Water	Courangra Point	Careel Bay	Towra Point	Jervis Bay
1915	960	858.2		829.9		494.9			1179.9
1916	878	1402.3		882.3		707.1			1437.5
1917	936	1679.8		1177.6	959.4	825			1297.1
1918	894	1241		770.4	951.4				1626.9
1919	908	1360.5		998.7	1106.5				1406.1
1920	900	1679.2		990.4	1098.8				910.5
1921	938	2422.5		1224.9	1688.7	1211.9			1340.7
1922	924	1262.3		907.8	1086.3	724.4			1206
1923	886	1381.6		773.9	1027.9	756.8			1055.7
1924	880	1709.9		934.3	1420.3	519.1			1033.9
1925	858	2044.8		985.4	1156.3				1371.4
1926	877	1387.1		1108	1211.4				957.9
1927	855	2145.9		1279.1	1334				937.4
1928	874	1837		949.6	991.8				1323.1
1929	886	1635.7		1315	1664.1				1363.9
1930		1886.9		1193.2	1400.9			1129.2	864.5
1931	898	2349		1389.2	1743.1			1152.9	1180.1
1932	874	1145.4		826.6	896.9	886.4	1007.9		936.5
1933	894	1663.7		1035.4	1195.6	1173.3	1149.1		833.1
1934	913	2242.7		1355.2	1674.7	1608.5	1785.4		2250.1
1935	917	1221.1		813.7	740.6	833.3	779.8		957.2
1936	887	1076.2		807.5	876.6	874.4	704		931.3
1937	894	2050.8		1048.4	1199.7	1166.2	1176.4		1174.8
1938	910	1664.5		990.5	930.3	1010.8	836.3		888
1939	903	1681		868	908.5	884.2	770		865.1
1940	876	1093.1		903.6	930.7	944.3	870.6		585.9
1941		1418.4		693.3	778.6	625.9	553.4		847
1942	884	1716.9		829.3	1351.7	1107.4	990.3		774.6
1943	886	1647.1		1052.8	1337.6	1053.7	1146.4		1267.8
1944	863	1303.4	784	763.8	630.2	790.3	629.9		656.4
1945	886	1866.9		986.5	1176.5	1124.4	1045.3		1001.2
1946	892	1253.5		1178.8	1265.3	978.8	707.6		686.6
1947	873	1972.2		946	1239.5	1041.2	842.7		1045.4
1948	891	1899.4		1063.5	1056.5	885.8	754.8		987.9
1949	912	1294.8		1737.4	2199.4	1932.8	1087.4		1390
1950	938	2107.1		1745.4	2190.8	2189.9	1770.5		2170.5
1951	951	1600.2	1140.8	1265.8	1409.3	1317.7	1073.4		1537.4
1952	933	1603.2	1143.1	1287.4	1847.7	1638.4	1422.2		1921.5
1953	914	2056.2	941.6	1005.8	1280.4	1575.2	916		996.9
1954	912	2609.5	1075.9	1014.4	1344.5	1185.3	947.8		1000.1
1955	960	1783.9	1496.7	1576	1925.9	1651.6	1721.9		1420.1
1956	977	1978	1346.5	1126.6	1895.8	1754.2	1621.7		1751.2
1957	922	1089.7	703.7	668.2	845.7	744	836.1		782
1958	947	1485.4	1072.2	842.6	1249.5	1464.3	1238.4		1705.2
1959	921	1772.7	1436.2	1447.4	1540.2	1443.9	1357.3		2137
1960	927	1015	1244.7	1302.1	1571.2	1184	1091.5		1641.1
1961	897	1730.5	988.7	1090.4	1548.8	1326.4	1205.5		2493.6
1962	932	1862.5	1329.2	1325.6	1592.3	1266.3	1114.3		1273.8
1963	922	1981.6	1793.7	1801.2	2232	1434.1	1846		2198.7
1964	977	1352	758.4	789.6	1492.5	744.2	962.6		932.2
1965	924	1263.2	686.5	714.3	961.3	530.7	922.6		847.1
1966	927	1377.5	997.8	1046.8	1191.9	564.4	956.7		1073.5
1967	919	2364	1500.5	1313.4	1724.4	1061.1	1357.7		1226.5
1968	951	1028.4	956.3	967.7	1033.1	700.8	699.6		522.9
1969	907	1631.5	1120.3	1215.1	1406.5	965.5	1370.4		1323.4
1970	924	1653.5	925.1	1034.2	1098.7	762.4	749.5		1029.9
1971	943	1293.3	1228.1	1228	1272	858.7	1017.3		990
1972	922	2631.6	1264.4	1249.4	1404.8	923.8	1478.3		1308.7
1973	959	1934.6	875.9	995.6	1240.5	1101.4	1458.9		1389.4
1974	988	2809.9	1458.7	1407.1	1629.7	804.7	1619.1		1453.7
1975	959		1108.5	1247.7	1180.3	934	1045.6		1294.8
1976	992		1382.6	1309.9	1703.8	1001.5	1467		1767.9
1977	939	1293.6	1032.2	909.4	1211.2	809	1079.9		879.4
1978	974	1942.4	1666.4	1545.7	1887.1	1442	1844.2		1525.8
1979	919	1195.5	788.6	871.8	884.3	672	727.7		760.7
1980	948	1339.1	541	596.9	818.3	610	572.6		606
1981	961	1278	1096.6	964.8	1449.1	837	703.7		958.8
1982	912	1209.3	994.2	1046.1	917.5	615			773.1
1983	908	2495	1018.6	1233	1401.8	800.5	1361.9		1184.5

Table A8.2: Raw data for correlations between (a) mean annual rainfall for the 10 years previous to the mapping date, and corresponding mangrove and saltmarsh habitat areas, and (b) 10 year mean annual rainfall and a 5-year lag in mangrove and saltmarsh habitat areas.

Site	Year	Mangrove Area (ha)	Saltmarsh Area (ha)	Mean Rainfall (mm) 10 yr period leading up to each mapping date	Mean Rainfall (mm) for 10 yr period 5 yrs previous to period of analysis
Ukerebagh Island	1948	47.1	13.3	1957	1581
	1961	37.7	13.8	1712	2202
	1975	43.7	12.4	1858	1624
	1983	42.8	13.2	2014	1519
	1998	45.2	11.1	1437	2108
Tilligerry Creek	1954	113.8	222.5	-	-
	1961	132.3	195.2	1191	1191
	1975	131.7	206.6	1106	1106
	1983	149.6	149.9	1452	1206
	1996	177.4	134.6	1129	1129
Black Neds Bay	1950	0.4	38.5	1100	894
	1961	23.3	43.5	1136	1395
	1974	25.5	44.4	1117	1157
	1987	33.1	33.9	1065	1090
	1999	40.0	33.9	1137	1094
Brisbane Water	1954	51.9	44.3	1501	1197
	1965	54.2	34.6	1493	1491
	1975	65.2	16.2	1318	1428
	1986	63.9	13.5	1249	1341
	1998	64.0	13.0	1385	1196
Courangra Point	1954	34.6	47.7	-	-
	1966	41.0	37.5	818	-
	1975	54.5	32.1	868	676
	1986	50.9	31.6	755	914
	1994	54.0	29.5	948	921
Careel Bay	1940	2.0	21.6	989	-
	1965	8.3	8.6	1232	1381
	1974	8.7	1.0	1215	1137
	1986	10.3	0.8	1184	1150
	1996	10.3	0.7	1209	1477
Towra Point	1956	351.6	229.3	1216	1005
	1961	401.8	238.6	1236	1216
	1970	377.7	194.3	1130	1227
	1983	395.2	141.0	1120	1296
	1999	470.5	88.1	1071	1133
Currambene Creek	1949	9.7	51.0	924	895
	1961	13.5	43.3	1585	1422
	1975	21.6	31.6	1290	1358
	1987	31.4	33.9	1138	1386
	1993	38.4	26.4	1363	1096
Cararma Inlet	1948	25.5	181.7	872	1054
	1961	22.6	151.9	1585	1422
	1974	36.4	140.6	1223	1419
	1981	44.4	107.1	1484	1387
	1999	62.6	79.0	1260	1208

Table A8.3: Raw data for correlations between (a) mean annual rainfall and corresponding mangrove habitat gain and saltmarsh habitat loss, and (b) mean annual rainfall and a 5-year lag in mangrove habitat gain and saltmarsh habitat loss.

Site	Year	Mangrove Habitat Areal Increase (ha)	Saltmarsh Habitat Areal Decline (ha)	Saltmarsh Habitat Loss specifically to mangrove incursion during study period (%)	Mean Rainfall (mm) During the Corresponding Period	Mean Rainfall (mm) 5 yrs Previous to Period of Analysis
Ukerebagh Island	1948-1961	-9.4	-0.5	16	1716	1784
	1961-1971	6.0	1.4	16	1594	1537
	1971-1983	-0.9	-0.8	17	1494	1535
	1983-1998	2.4	2.1	28	1642	1588
Tilligerry Creek	1954-1961	18.5	30.3	17	1148	1145
	1961-1975	-0.6	-11.4	10	1144	1106
	1975-1983	17.9	56.7	33	1070	1216
	1983-1996	27.8	15.3	25	1096	1099
Black Neds Bay	1950-1961	22.9	-5.0	7	1198	1244
	1961-1974	2.2	-0.9	17	1244	1118
	1974-1987	7.6	10.5	13	1109	1116
	1987-1999	6.9	0	5	1153	1139
Brisbane Water	1954-1965	2.3	9.7	20	1517	1608
	1965-1975	11.0	18.4	35	1286	1441
	1975-1986	-1.3	2.7	31	1284	1315
	1986-1998	0.1	0.5	25	1430	1455
Courangra Point	1954-1966	6.4	10.2	32	818	-
	1966-1975	13.5	5.4	31	868	845
	1975-1986	-3.6	0.5	12	862	896
	1986-1994	3.1	2.1	12	948	960
Careel Bay	1940-1965	6.3	13.0	38	1268	1208
	1965-1974	0.4	7.6	13	1163	1189
	1974-1986	2.6	0.2	38	1089	1164
	1986-1996	0	0.1	14	1244	1192
Towra Point	1956-1961	50.2	-9.3	9	1225	1284
	1961-1970	-24.1	44.3	8	1130	1227
	1970-1983	17.5	53.3	22	1137	1188
	1983-1999	75.3	52.9	31	1139	1087
Currambene Creek	1949-1961	3.8	7.7	15	1611	1274
	1961-1975	8.1	-0.7	26	1395	1439
	1975-1987	9.8	5.6	27	1259	1286
	1987-1993	7.0	1.9	27	1357	1192
Cararma Inlet	1948-1961	-2.9	29.8	6	1611	1274
	1961-1974	13.8	11.3	10	1395	1439
	1974-1981	8.0	33.5	14	1259	1286
	1981-1999	18.2	28.7	20	1357	1192

Table A8.4: Raw data for correlations between (a) population total and corresponding mangrove and saltmarsh habitat areas, and (b) population total and a 5-year lag in mangrove and saltmarsh habitat areas.

Site	Year	Mangrove Area (ha)	Saltmarsh Area (ha)	Population	Population 5 yrs Previous to Period of Analysis
Ukerebagh Island	1948	47.1	13.3	14000	-
	1961	37.7	13.8	22248	21270
	1975	43.7	12.4	24650	23310
	1983	42.8	13.2	42500	30550
	1998	45.2	11.1	68816	57190
Tilligerry Creek	1954	113.8	222.5	9590	7000
	1961	132.3	195.2	15350	12146
	1975	131.7	206.6	18500	17040
	1983	149.6	149.9	32400	22450
	1996	177.4	134.6	52281	45128
Black Neds Bay	1950	0.4	38.5	51708	36008
	1961	23.3	43.5	91962	70780
	1974	25.5	44.4	127920	116240
	1987	33.1	33.9	159400	156950
	1999	40.0	33.9	182750	173632
Brisbane Water	1954	51.9	44.3	25312	20700
	1965	54.2	34.6	42578	32500
	1975	65.2	16.2	67470	52500
	1986	63.9	13.5	116450	96350
	1998	64.0	13.0	155144	140100
Courangra Point	1954	34.6	47.7		
	1966	41.0	37.5		
	1975	54.5	32.1		
	1986	50.9	31.6		
	1994	54.0	29.5		
Careel Bay	1940	2.0	21.6	-	-
	1965	8.3	8.6	126000	90000
	1974	8.7	1.0	169180	141530
	1986	10.3	0.8	181550	178150
	1996	10.3	0.7	185757	184250
Towra Point	1956	351.6	229.3		
	1961	401.8	238.6		
	1970	377.7	194.3		
	1983	395.2	141.0		
	1999	470.5	88.1		
Currambene Creek	1949	9.7	51.0	13962	-
	1961	13.5	43.3	20262	18390
	1975	21.6	31.6	33570	27370
	1987	31.4	33.9	59950	51750
	1993	38.4	26.4	74560	62260
Cararma Inlet	1948	25.5	181.7	0	0
	1961	22.6	151.9	0	0
	1974	36.4	140.6	0	0
	1981	44.4	107.1	0	0
	1999	62.6	79.0	0	0

Table A8.5: Raw data for correlations between (a) mean annual rainfall and saltmarsh loss to mangrove incursion, and (b) mean annual rainfall and a 5-year lag in saltmarsh loss to mangrove incursion.

Site	Year	% Saltmarsh Habitat Loss to Mangrove Incursion (mangrove or mixed)	Mean Rainfall (mm) During the Corresponding Period	Mean Rainfall (mm) 5 yrs Previous to Period of Analysis
Ukerebagh Island	1948-1961	16	1716	1784
	1961-1971	16	1594	1537
	1971-1983	17	1494	1535
	1983-1998	28	1642	1588
Tilligerry Creek	1954-1961	17	1148	1145
	1961-1975	10	1144	1106
	1975-1983	33	1070	1216
	1983-1996	25	1096	1099
Black Neds Bay	1950-1961	7	1198	1244
	1961-1974	17	1244	1118
	1974-1987	13	1109	1116
	1987-1999	5	1153	1139
Brisbane Water	1954-1965	20	1517	1608
	1965-1975	35	1286	1441
	1975-1986	31	1284	1315
	1986-1998	25	1430	1455
Courangra Point	1954-1966	32	818	-
	1966-1975	31	868	845
	1975-1986	12	862	896
	1986-1994	12	948	960
Careel Bay	1940-1965	38	1268	1208
	1965-1974	13	1163	1189
	1974-1986	38	1089	1164
	1986-1996	14	1244	1192
Towra Point	1956-1961	9	1225	1284
	1961-1970	8	1130	1227
	1970-1983	22	1137	1188
	1983-1999	31	1139	1087
Currambene Creek	1949-1961	15	1611	1274
	1961-1975	26	1395	1439
	1975-1987	27	1259	1286
	1987-1993	27	1357	1192
Cararma Inlet	1948-1961	6	1611	1274
	1961-1974	10	1395	1439
	1974-1981	14	1259	1286
	1981-1999	20	1357	1192

Table A8.6: Raw data for correlations between (a) population total and saltmarsh habitat loss to mangrove incursion, and (b) population total and a 5-year lag in mangrove and saltmarsh habitat areas.

Site	Year	% Saltmarsh Habitat Loss to Mangrove Incursion (mangrove or mixed)	Population Growth During Corresponding Period	Population Growth During Corresponding Period 5 yrs Previous to Period of Analysis
Ukerebagh Island	1948-1961	16	8248	-
	1961-1971	16	2402	2040
	1971-1983	17	17850	7240
	1983-1998	28	26316	26640
Tilligerry Creek	1954-1961	17	5760	5146
	1961-1975	10	3150	4894
	1975-1983	33	13900	5410
	1983-1996	25	19881	22678
Black Neds Bay	1950-1961	7	40254	34772
	1961-1974	17	35958	45460
	1974-1987	13	31480	40710
	1987-1999	5	23350	16682
Brisbane Water	1954-1965	20	17266	11800
	1965-1975	35	24892	20000
	1975-1986	31	48980	43850
	1986-1998	25	38694	43750
Courangra Point	1954-1966	32		
	1966-1975	31		
	1975-1986	12		
	1986-1994	12		
Careel Bay	1940-1965	38	-	-
	1965-1974	13	43180	51530
	1974-1986	38	12370	36620
	1986-1996	14	4207	6100
Towra Point	1956-1961	9		
	1961-1970	8		
	1970-1983	22		
	1983-1999	31		
Currambene Creek	1949-1961	15	6300	-
	1961-1975	26	13308	8980
	1975-1987	27	26380	24380
	1987-1993	27	14610	10510
Cararma Inlet	1948-1961	6	0	0
	1961-1974	10	0	0
	1974-1981	14	0	0
	1981-1999	20	0	0

Appendix 9: Previous Publications

Saintilan, N. and Wilton, K. (2001); Changes in the distribution of mangroves and saltmarshes in Jervis Bay, Australia. *Wetlands Ecology and Management*, 9(5):409-420.

Wilton, K.M. (2001); Changes in Coastal Wetland Habitats in Careel Bay, Pittwater, N.S.W. from 1940 to 1996. *Wetlands (Australia)*, 19(2):72-86.

Saintilan, N., Wilton, K. and Rogers, K. (2001); Regional environmental change and mangrove proliferation: science and policy implications. *Conference Abstracts*. Thailand. August 27-31, 2001.

Saintilan N., and Wilton, K.M. (2001); Comparison of methods for the estimation of flooding frequencies in mangrove forests. *Mangroves and Saltmarshes* (in prep.).

Wilton, K.M. and Saintilan, N. (2000); *Protocols for Mangrove and Saltmarsh Habitat Mapping*. Australian Catholic University Coastal Wetlands Unit Technical Report 2000/01, produced for the Estuaries Branch, NSW Department of Land and Water Conservation, Sydney. March 2000.

Wilton, K.M., Saintilan, N. and Coates, B.P. (2000); Mangrove Transgression into Saltmarsh in Southeastern Australia and its Management Implications. *Conference Abstracts, Australian Marine Sciences Association Inc. Annual Conference*, 11th-14th July, 2000, Sydney.

Wilton, K.M. and Saintilan, N. (1999); Mangrove Transgression into Saltmarsh in Southeastern Australia. *Conference Abstracts, Estuarine Research Federation's 15th Biennial International Conference 'Where the River Meets the Sea'*, September 25-30, 1999, Hotel Inter-Continental, New Orleans, U.S.A.

Saintilan, N., Hashimoto, T. and Wilton, K.M. (1999); Environmental Change and Vegetation Dynamics in Temperate Australasian Coastal Wetlands. *Printed Abstracts, Institute of Australian Geographers National Conference, University of Sydney, 27th September to 1st October, 1999.*

Saintilan N., and Wilton, K.M. (1999); *Changes in the Distribution of Mangroves and Saltmarshes in Jervis Bay*. ACU Technical Report 99/02 prepared for the Shoalhaven Catchment Management Committee. Final Report, September, 1999. 57p.

Wilton, K.M. (1998); *Changes in the mangrove and saltmarsh habitats of Careel Bay, Pittwater, NSW*. Master of Science Thesis, School of Earth Sciences, Macquarie University. 216p.

Wilton, K.M. (1997); Changes in mangrove (*Avicennia marina*) and saltmarsh (*Sarcocornia quinqueflora*) habitats in the Sydney area, with specific reference to Careel Bay, Pittwater. *Published Abstracts, Conference on the Ecology of Estuaries and Soft Sediment Habitats, Deakin University, Warrnambool, Victoria, January, 1997.*



Changes in the distribution of mangroves and saltmarshes in Jervis Bay, Australia

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Abstract

The decline of saltmarsh in Currumbene Creek and Cararma Inlet, in Jervis Bay, eastern Australia, in the period 1944–1999 has been documented through photogrammetric analysis. The area of saltmarsh has declined in Currumbene Creek by approximately 52.5% and in Cararma Inlet by approximately 35%. In Currumbene Creek the decline of saltmarsh is primarily due to the landward encroachment of mangroves, while in Cararma Creek the seaward encroachment of *Melaleuca* and *Casuarina* have more significantly contributed to losses of saltmarsh. Regional sea-level rise is excluded as a primary cause of this transgression. A more plausible hypothesis involves an increase in the delivery of freshwater and nutrients to the intertidal environments in response to higher rainfall and catchment modifications.

Introduction

A landward incursion of mangroves into saltmarsh environments in the estuaries of southeastern Australia over the last five decades has been established as a widespread trend in a review of photogrammetric surveys (Saintilan and Williams, 1999, 2000). In many places the invasion of saltmarshes by mangroves has led to a serious decline in the areal extent of saltmarsh (McTainsh et al., 1988; Mitchell and Adam, 1989a; Williams et al., 1999). Many estuaries on the south coast of New South Wales have been affected, including Currumbene Creek, Jervis Bay (CSIRO, 1994).

In a review of this phenomenon, Saintilan and Williams (1999) identified seven key hypotheses which might explain mangrove transgression into saltmarsh in southeast Australia. Briefly, these hypotheses were:

- i) sea-level rise has allowed the colonisation of the saltmarsh by mangroves,
- ii) an increase in rainfall has freshened the upper intertidal environment,
- iii) increases in nutrient loads in estuaries and the subsequent fertilisation of the saltmarsh plain has facilitated landward colonisation by mangroves,

- iv) mangroves are recolonising areas from which they have been cleared,
- v) modifications to the estuarine channel or entrance have altered tidal patterns in the estuary,
- vi) the intertidal flat has subsided,
- vii) saltmarsh is a pioneer species and is subsequently replaced by mangrove.

Many of these hypotheses can be tested by examining historical records and present-day environmental conditions. Hypothesis (i) can be tested by comparing the vertical extent of change with the extent of sea-level rise in the period. Hypothesis (ii) can be examined by comparing rainfall trends with the timing of change and the response of glycophytes in the upper saltmarsh fringe. Hypothesis (iii) can be tested by comparing the nutrient content of soils from affected and unaffected areas. If hypothesis (iv) were true, mangrove stumps should be observable. The remaining hypotheses are more difficult to test *post hoc*, though a combination of elevational modelling and stratigraphic analysis can provide some insights, particularly in relation to hypothesis (vii).

This paper quantifies the rate of change in the intertidal communities of the two principal creeks of Jervis Bay over the period of air photographic records and,

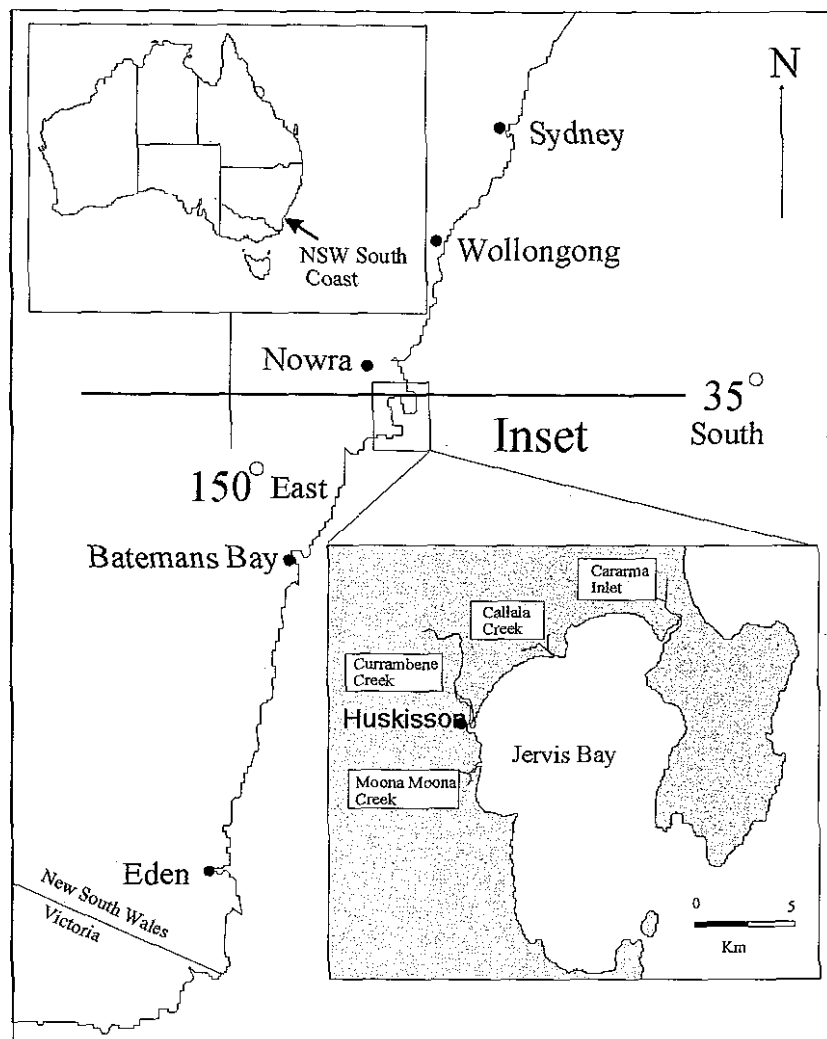


Figure 1. Location of Currambene Creek and Carama Inlet, Jervis Bay.

in some instances, over a longer time period with the use of mangrove palaeosols. The change in position of these communities is assessed in relation to the extent of mean annual rainfall and sea-level change.

Methods

Study sites

Currambene Creek and Carama Inlet, Jervis Bay (Figure 1), were chosen for detailed analysis of mangrove-saltmarsh dynamics in the context of these hypotheses. The south coast of NSW is tectonically stable, and the intertidal zones consist primarily of reworked marine sands of Holocene and Pleistocene origin, suggest-

ing a minimum of deep or shallow subsidence. Both creeks have been the site of detailed vegetation surveys (Adam and Hutchings, 1987; Clarke, 1993; Clarke and Jacoby, 1994), and the creeks provide an interesting contrast in geomorphic setting and degree of modification.

A high stationary barrier blocks the northern half of Jervis Bay, and includes buried Pleistocene humate impregnated sand outcropping at both the northern and southern end (Thom, 1987). The backbarrier flat is cut by Carama Inlet, a tidal creek which drains into the low-energy Hare Bay. Here there has been some wave and aeolian reworking of backbarrier sands enclosing the swamps. Carama has little fluvial input and little development in the relatively small catch-

ment area. However, the saltmarsh plain is extensive, and relatively undisturbed.

By contrast, Currumbene Creek has a relatively large catchment draining agricultural and urban land, and the saltmarsh environments have been grazed in the past. The town of Huskisson is situated at the mouth of the creek, and the creek is a popular site for boating. There is evidence of Pleistocene inner barrier sands occurring in a small area 0.5 km west of the mouth of Currumbene Creek (Paterson, 1975; Thom, 1987). The mangrove and saltmarsh environments of Currumbene occur on both flooded Pleistocene and prograded Holocene material.

Stratigraphic analysis

Longer-term changes in the extent of mangroves can be gauged through stratigraphic analysis of upper-intertidal soils (Mitchell and Adam, 1989b; Saintilan and Hashimoto, 1999). The occurrence of fossil mangrove root systems beneath the saltmarsh plain is an indication of a vegetation succession from mangrove to saltmarsh with fluvial and/or marine accretion of the intertidal flat. Such data can place historic observations of mangrove-saltmarsh dynamics in the context of changes over centuries and millennia (Saintilan and Hashimoto, 1999).

A hand auger was used to retrieve cores from the saltmarsh plain along two transects extending from the mangrove-saltmarsh boundary to the saltmarsh-*Casuarina* boundary in Cararma Inlet and Currumbene Creek (Figures 2, 3).

In both transects preserved root material of the grey mangrove, *Avicennia marina* was retrieved from 0.2–0.5 metres below the contemporary saltmarsh surface. At Cararma Inlet, a dense layer of estuarine shells was found at approximately 0.7 metres beneath the upper intertidal saltmarsh plain.

Shells were washed and submitted to acid etch before standard radiometric dating. Sands containing preserved mangrove roots were excavated, and roots retrieved individually from the mud matrix. Roots were then given an acid/alkali/acid pre-treatment before undergoing standard radiometric dating. The measured age of shell and root material was converted into the conventional C14 age after applying $^{13}\text{C}/^{12}\text{C}$ corrections.

Photogrammetry

Photogrammetric analysis in this survey was undertaken using the Wild Aviolyt AC3 stereo plotter. This

instrument produces high resolution digital spatial data from stereo pairs of aerial photograph diapositives (Hanslow et al., 1997). The stereo plotter has the advantage of rectifying distortion in photo scale and differences in scale between photographs, as well as allowing high resolution magnification of images, assisting in interpretation. Ground control was based on Integrated Survey Grid (ISG) control points provided by the NSW Lands Department. Data output was downloaded to a CADD system for analysis and presentation.

Photographic runs of Currumbene Creek used in the photogrammetry were Jervis Bay Run 1, 1949; Jervis Bay Run 1, 1961; Jervis Bay Run 1, 1975; 1986 Huskisson/Callala Beaches 1993 and NSW4126 for 1997. Photographic runs of Cararma Inlet were Jervis Bay-Nowra Run C 1948; Jervis Bay Run 1, 1961; NSW Coastal Wetlands Run 60 1981; and NSW4474 Cabbage Tree Swamp for 1999.

Pure mangrove habitat was defined as mangrove with less than 10 m canopy gaps. A mixed or ecotone category was identified as areas of mangrove and saltmarsh where the gap between mangrove canopy was between 10 and 20 metres. Saltmarsh was defined as vegetated intertidal areas with a greater than 20 m canopy gap between mangroves, though *Casuarina* and *Melaleuca* were identified as separate categories. Only mangrove and saltmarsh areas common to all photographs were included in the analysis.

Topographic analysis

The method for measuring inundation frequency in intertidal environments is a modification of that described in English et al. (1997). Rods marked with water-soluble dye were inserted along transects placed at equal intervals across the intertidal plain before a night Spring tide. A total of 120 rods were used in each of Cararma Inlet and Currumbene Creek for this purpose. The tide acts as a level, the depth of inundation at each pole was recorded. The species composition of the surrounding vegetation was recorded for each rod position, providing a basis for the description of the elevation at which each species was observed.

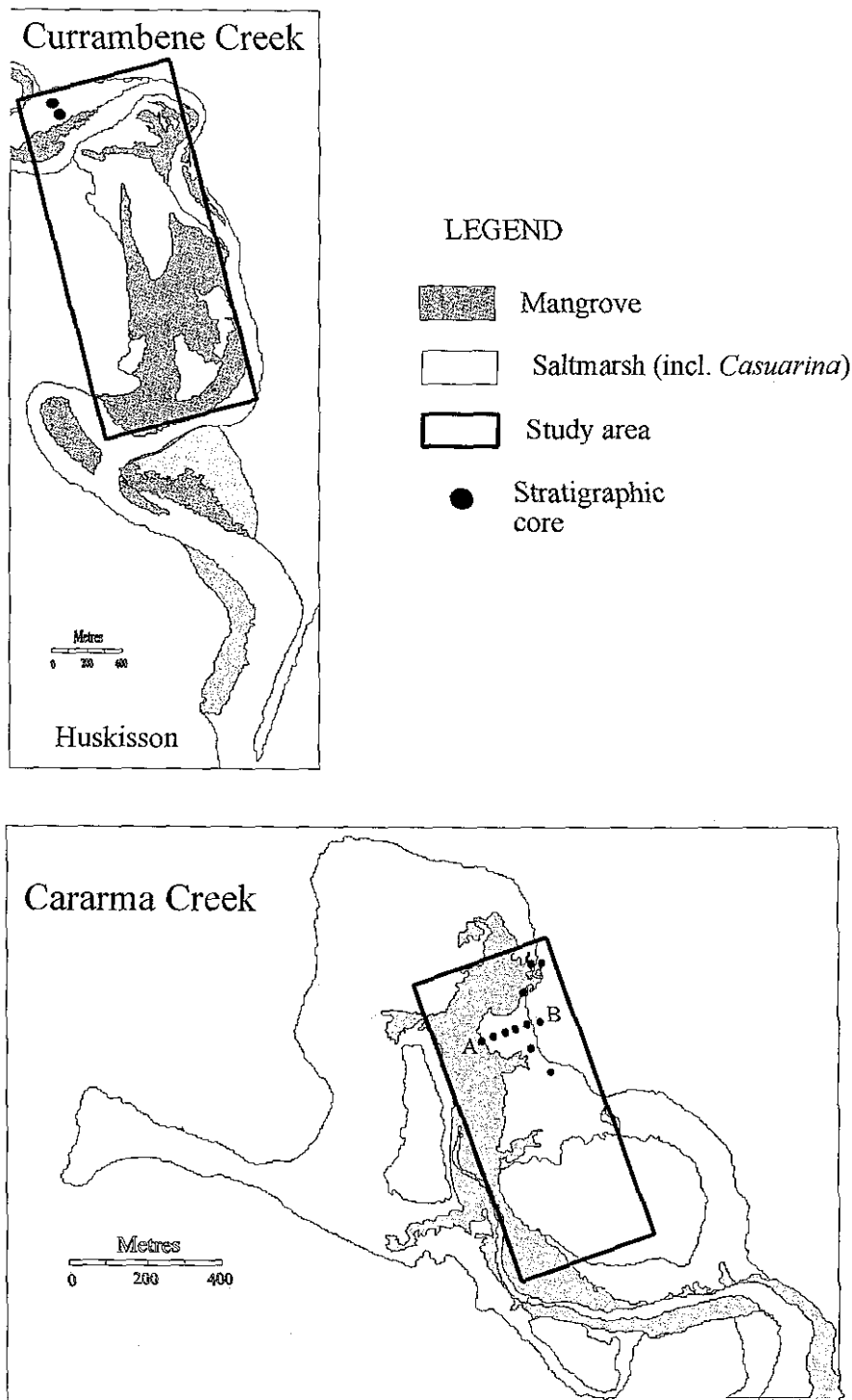


Figure 2. Location of study areas and stratigraphic cores.

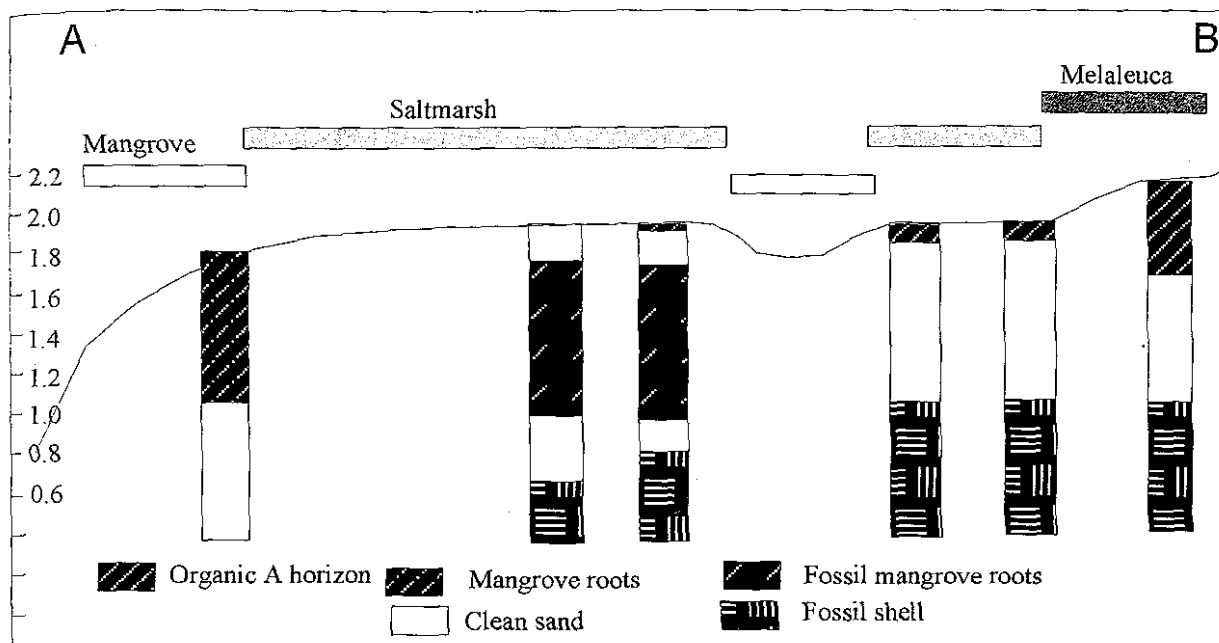


Figure 3. Stratigraphic profile within Carama Creek, Jervis Bay, from the creek edge 'A' to the landward edge of the saltmarsh 'B' as in Figure 2.

Results

Stratigraphic analysis and C14 dating

Mangrove roots found beneath *Juncus* saltmarsh in the Currumbene saltmarsh core dated to 1320 ± 70 C14 yrs BP. Shell deposited at the base of the intertidal unit in Carama Inlet dated to 3200 ± 60 C14 yrs BP, and the mangrove roots within the same Carama Inlet core dated to 1920 ± 90 C14 yrs BP.

Changes in the area of mangroves and saltmarshes

The areal extent of 'pure' saltmarsh in the Currumbene Creek study area declined from 48 hectares in 1949 to 27.2 hectares in 1993 (Figure 4). Further, the area of mixed mangrove and saltmarsh habitat declined from 26.7 hectares in 1949 to 12 hectares in 1993. Overall the habitat of saltmarsh declined by 52.5% from 74.7 hectares in 1949 to 39.2 hectares in 1993.

Areas of pure mangrove habitat increased from 34.1 hectares to 44.9 hectares in 1993. Since 1975 in particular, the area of pure mangrove habitat has expanded substantially at the expense of the mixed mangrove and saltmarsh habitat.

The area of saltmarsh in Carama Inlet has declined by 35% from 176.5 hectares in 1949 to 114.2 hectares in 1999. The trend is that of a steady decline with little

sign of attenuation (Figures 5 and 6). In contrast to Currumbene Creek, the mangrove-saltmarsh boundary in Carama Inlet has been relatively stable, with little overall increase in the area of mangrove. Most saltmarsh loss has been due to the expansion of terrestrial species at the landward edge of the saltmarsh (*Casuarina*, *Melaleuca*, *Eucalyptus* and miscellaneous) which increased in area from a combined 80 hectares in 1961 to 128 hectares in 1999.

Tidal inundation

The longest period of sea-level data for the region is Fort Denison, Sydney Harbour, 150 km to the north. Five-year running means of sea-level for this data set (Figure 7) indicate sea-levels approximately 4 cm higher for the period 1950–2000 compared to the first half of the century. This provides a benchmark against which changes in the vertical position of mangroves in the intertidal zone may be gauged. Topographic maps were generated on the basis of flooding depths measured using marker poles (Figure 8).

Single factor analysis of variance was performed with a *post hoc* Student-Newman-Kuels test to determine the elevational associations of species encountered in the elevation survey. At Carama Inlet, where the saltmarsh plain was widest, *Avicennia marina* was consistently found in the lowest elevation, forming

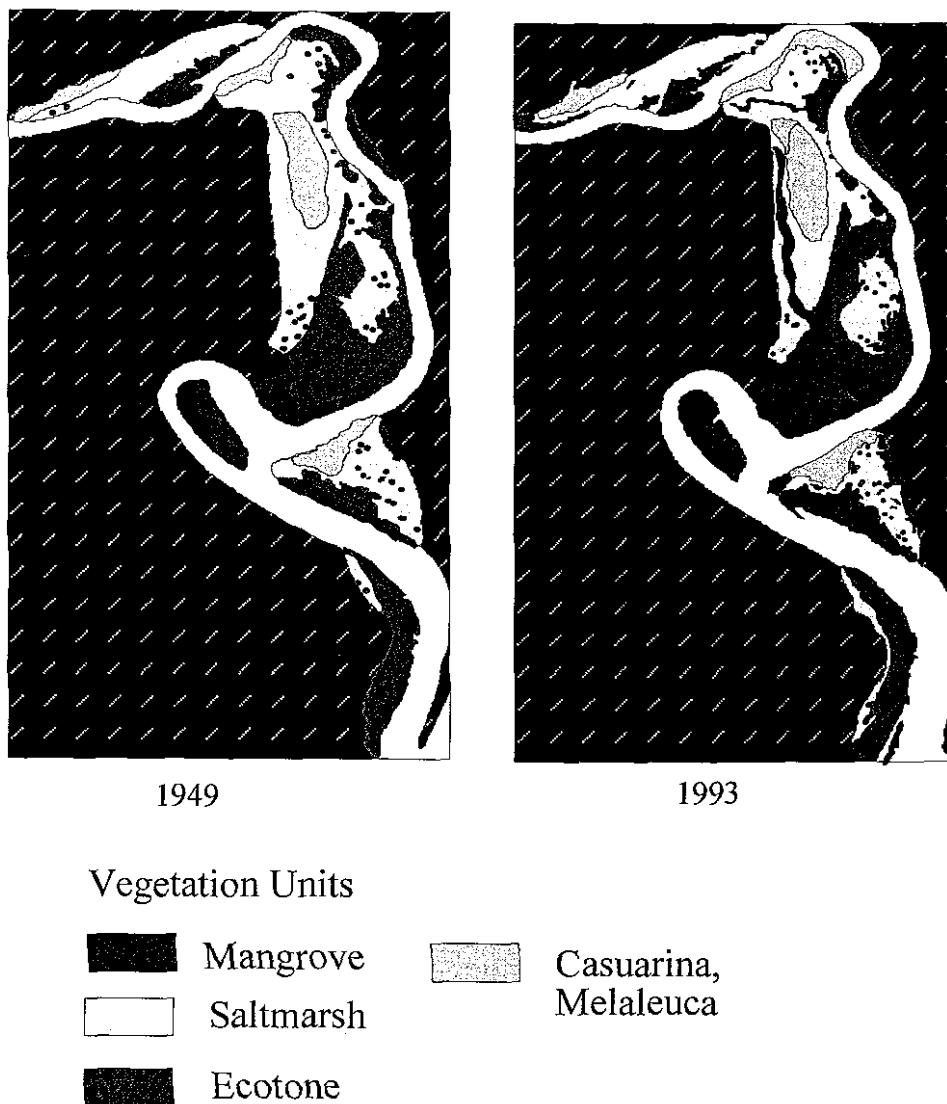


Figure 4. The distribution of intertidal wetland communities, Currambene Creek, 1949 and 1993.

an association with *Samolus repens* at its landward edge. *Sporobolus virginicus* forms a group at intermediate elevation. *Halosarcia pergranulata*, *Sarcocornia quinqueflora* and *Gahnia filum* form an upper saltmarsh association, with *Juncus kraussii* and *Casuarina glauca* occurring at a level rarely inundated by Spring tides.

Within Currambene Creek the elevation of the species was less distinct. *Avicennia marina*, *Samolus repens*, *Sporobolus virginicus* and *Sarcocornia quinqueflora* could not be statistically differentiated on the basis of elevation. Only *Juncus kraussii* and

Casuarina glauca occurred at significantly higher elevations.

The elevation at which *Juncus kraussii* and *Sarcocornia quinqueflora* were found growing in Currambene Creek with respect to tidal inundation was lower than that at Cararma Inlet. *Samolus repens*, *Sporobolus virginicus* and *Avicennia marina* grew at comparable elevations within the two creeks with respect to tidal inundation.

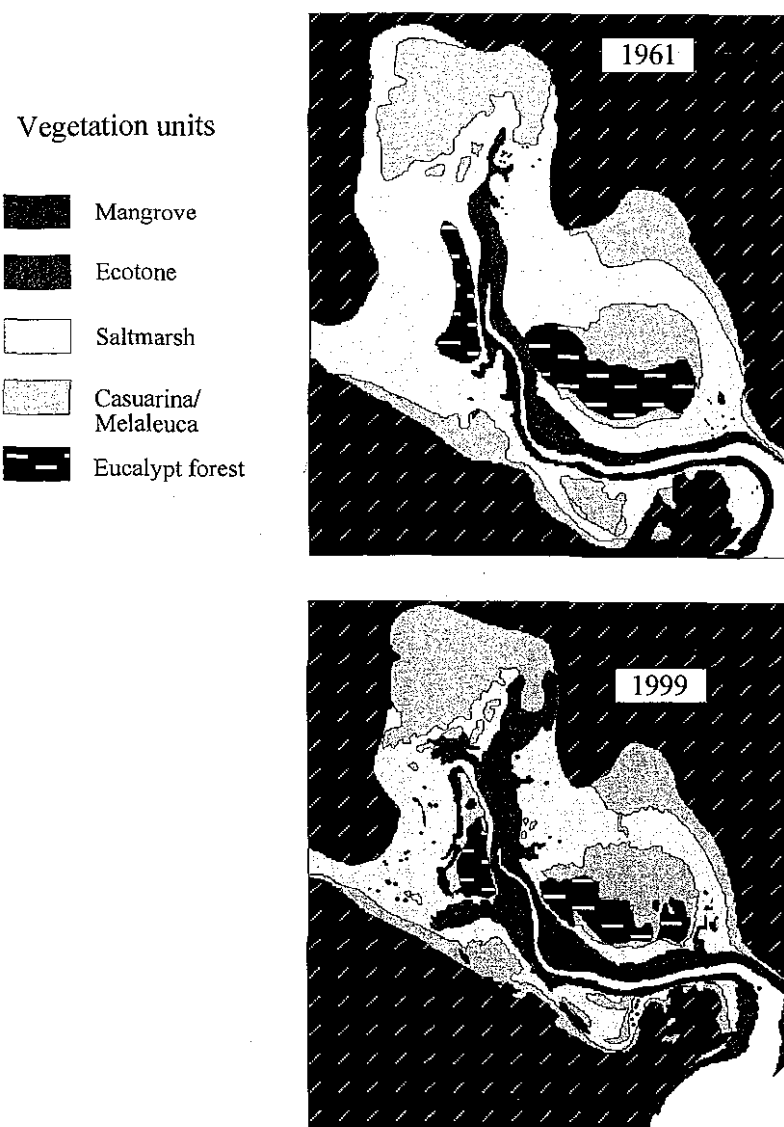


Figure 5. The distribution of intertidal wetland communities, Cararma Inlet. 1949 and 1993.

Discussion

Reconstruction of vegetation history in Cararma Inlet and Currambene Creek

At circa 3000 BP Cararma Inlet appears to have been a shallow estuarine lake sheltered behind a complex Pleistocene-Holocene barrier. The lake must have been highly productive source of shellfish, gauging from the thick, dense deposits of intact estuarine bivalves which have been located at 0.7 m below at least ten hectares of the upper saltmarsh surface.

Tidal reworking of aeolian and wash-over deposits has gradually infilled the lake, creating an intertidal wetland, dominated circa 2000 BP by mangroves. Continued accretion has seen the gradual replacement of mangroves with saltmarsh, so that mangroves now form a fringe to the tidal creek, and the inlet is dominated by one of the most extensive saltmarsh plains on the south coast of New South Wales. Rates of vertical accretion over the previous 2000 years have averaged approximately 0.5–0.8 mm per year.

Currambene Creek has a more complex history, given the greater extent of probable Pleistocene material and the involvement of both fluvial and tidal sedi-

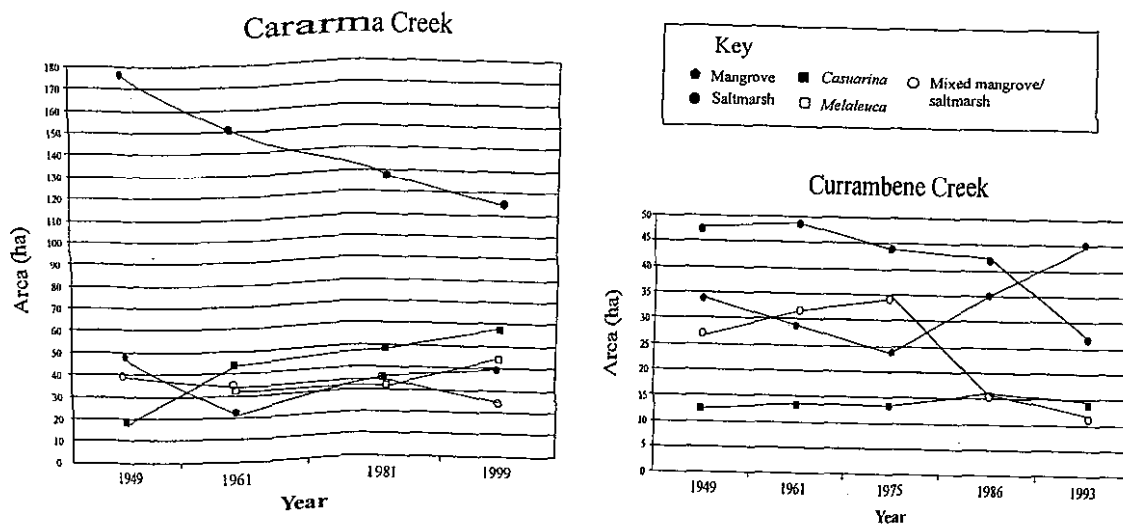


Figure 6. Changes in the area of intertidal wetland communities, Currumbene Creek and Carrarma Inlet between 1949 and 1999.

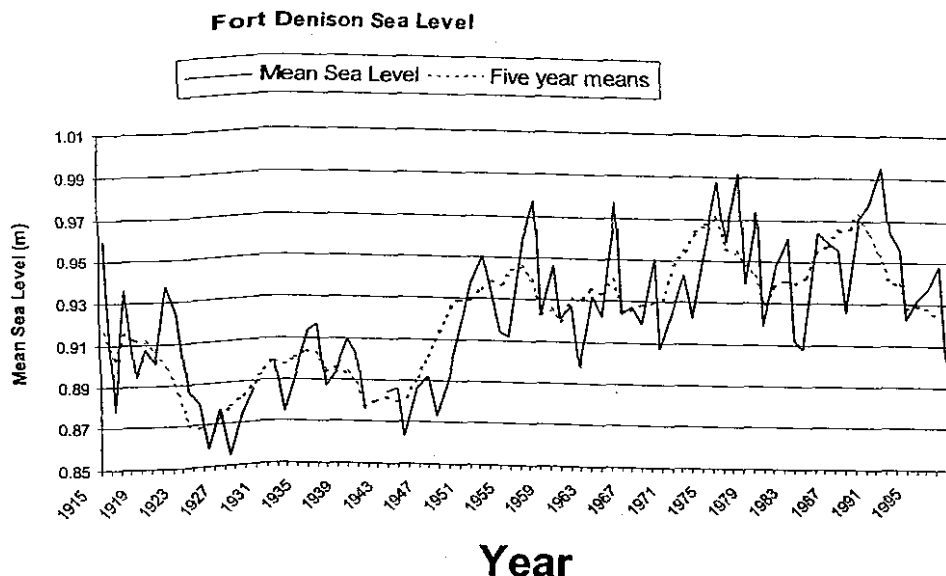


Figure 7. Sea-level trends at Fort Denison, 1915–1998.

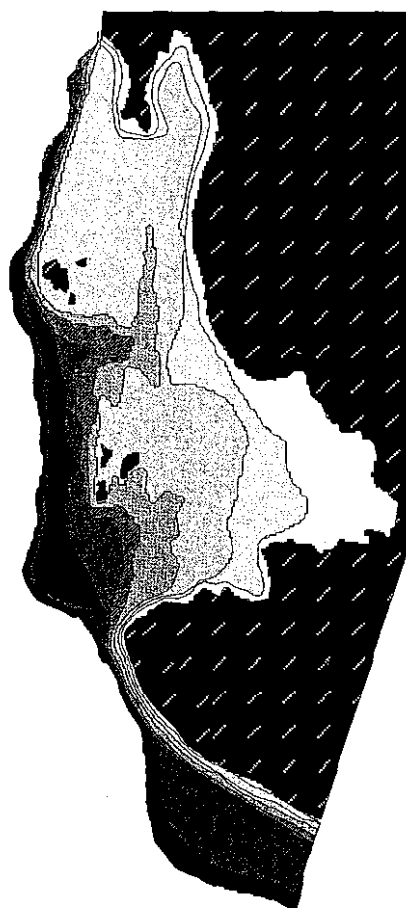
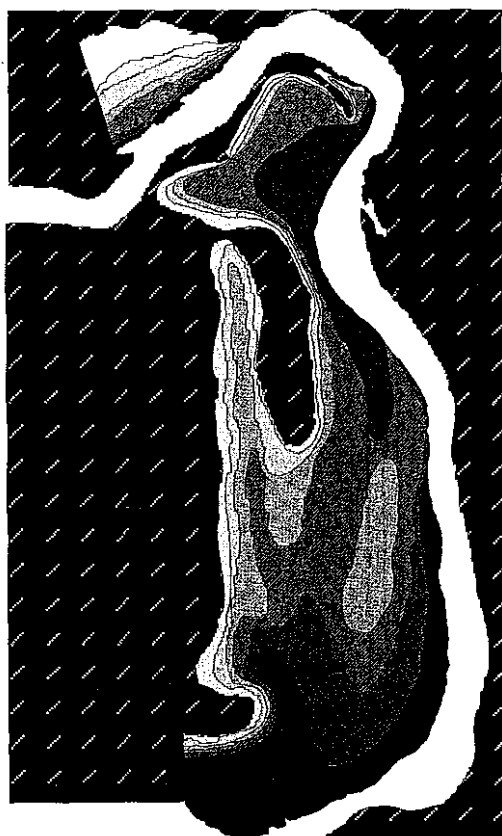
mentation through the latter Holocene. On the main intertidal flat immediately upstream of Huskisson, there is no stratigraphic evidence of prior occupation of the upper intertidal flat by mangroves, nor is there evidence of the marine bivalves so prominent in the profile at Carrarma Inlet. However, mangrove roots were found beneath the *Juncus* plain 2 kilometres upstream, suggesting that some, though not all, of the current point bars have accreted in the previous two thousand years, and a succession from mangrove to saltmarsh has occurred. The C14 age of this man-

grove material suggests a rate of accretion slightly more rapid than that found at Carrarma Inlet, of approximately 1 mm per year. These results are comparable to rates of accretion established using the same technique in the Hawkesbury River estuary (Saintilan and Hashimoto, 1999).

The more sporadic occurrence of mangrove palaeo-material in the intertidal plains of Currumbene Creek may reflect the more important contribution of channel meandering and horizontal accretion in the creation of point bars. Cut-off meanders are obvious

Currambene Creek

Carama Inlet



Legend

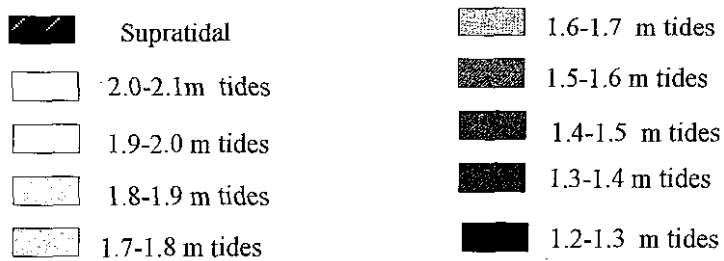


Figure 8. Elevation of selected intertidal environments in Currambene Creek and Carama Inlet.

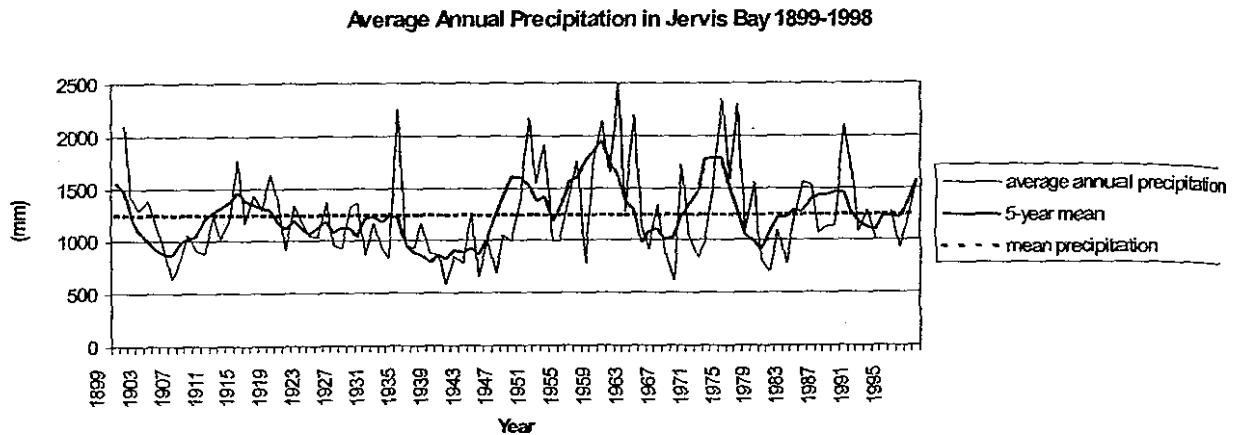


Figure 9. Rainfall for Point Perpendicular, Jervis Bay; 1889–1998. Data from the Bureau of Meteorology.

in the upper tidal reaches, and some are currently occupied by relict mangroves. With continued accretion these will presumably be replaced by saltmarsh.

Recent changes in the distribution of mangroves and saltmarsh

Mangrove has increased in area in Currumbene Creek at the expense of saltmarsh. The distance over which mangrove transgression has occurred on the largest intertidal flat in Currumbene Creek in some places exceeds 700 metres. The loss of saltmarsh to mangrove incursion in Currumbene Creek is of similar magnitude to that described in many NSW estuaries (Saintilan and Williams, 1999).

The mangrove-saltmarsh boundary in Cararma Inlet has been more stable. Within this system a considerable proportion of saltmarsh loss has been due to the encroachment of *Casuarina* and *Melaleuca* onto the saltmarsh plain. The seaward encroachment of *Casuarina* onto the saltmarsh plain has also been described for the nearby Minamurra estuary by Chafer (1998), and suggests an alteration in the hydrology of the upper intertidal plain unrelated to fluctuations in the tidal prism.

Inferences regarding sea-level rise and mangrove transgression

Within Currumbene Creek, the vertical range transgressed by mangroves in the photographic period (1949–1993) far exceeds the degree of regional sea-level rise. Judging by the position of the mangrove-saltmarsh boundary in Currumbene Creek in 1949, the position of the boundary in 1993, and the difference

in inundation depth between poles at both locations, mangroves have extended their vertical range in some places within Currumbene Creek by up to 30 cm. This is likely to be a conservative estimate in that inundation frequency, and hence vertical accretion, is higher in lower elevation environments (Stoddart et al., 1989).

At both Currumbene Creek and Cararma Inlet the elevation at which saltmarsh replaces mangrove is approximately the position of the mean highest diurnal tide. The implication is that mangroves in Currumbene Creek have moved to the position with respect to tidal inundation that they have been consistently occupying in Cararma Inlet. The result is consistent with the supposition that biotic and/or physio-chemical factors had excluded mangroves from sections of the Currumbene intertidal flat in the first half of the century.

A further factor telling against a simple translation of vegetation communities in response to sea-level rise is the stability of the saltmarsh-terrestrial boundary. The only instances of *Casuarina* dieback in Currumbene Creek are clearly fire-related, and in Cararma Inlet the terrestrial species are advancing onto the saltmarsh plain.

Inferences regarding rainfall, nutrients and mangrove encroachment

Higher rainfall in the second half of the century has been a regional trend for southeastern Australia (Hennessey et al., 1999), and rainfall patterns at Point Perpendicular, Jervis Bay, follow this trend (Figure 9). Mean annual rainfall for the period 1899–1949 was 1150 mm/yr., compared to 1360 mm/yr for the period

1950–1998. A landward encroachment of mangroves with increased rainfall is consistent with the observation of Saenger (1995) that the relative proportion of mangroves and saltmarsh within Australian estuaries is significantly related to average annual precipitation.

The encroachment of both mangrove and terrestrial glycophytes onto the saltmarsh plain would be consistent with the freshening of the intertidal environment which would result from increased precipitation. However, rainfall is also an important source of nitrogen. Nitrogen has been found to be limiting to mangrove growth (Boto and Wellington, 1983). Decreased salt marsh may be due to increased rainfall both freshening the intertidal environment and contributing nitrogen.

Increases in nutrient levels within estuaries following urbanisation is well established for the region (Zann, 1995), as is the proportion of rainfall reaching the estuary from urbanised catchments. This study has shown a contrast between the high degree of mangrove incursion in Currumbene Creek, with a highly modified catchment, and the stable mangrove/saltmarsh boundary in Carama Inlet, with an unmodified catchment. This trend is consistent with that emerging from a review of twenty-eight photogrammetric surveys (Saintilan and Williams, 2000), which showed the highest level of mangrove incursion to be in modified, and in particular urbanised catchments. The suggestion by Wilton (2000) that the degree of mangrove incursion may be related to the degree of urbanisation warrants an examination of the potential role of nutrient and sediment inputs in urbanised catchments in altering the balance between mangrove and saltmarsh.

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References

- Adam, P. and Hutchings, P. 1987. The saltmarshes and mangroves of Jervis Bay. *Wetlands (Australia)* 6(2): 58–64.
- Boto, K.G. and Wellington J.T. 1983. Phosphorus and nitrogen nutritional status of a northern Australian mangrove forest. *Marine Ecology Progress Series* 11: 63–69.
- Chafer C.J. 1998. A spatio-temporal analysis of estuarine vegetation change in the Minnamurra River 1938–1997. Minnamurra Estuary Management Committee.
- Clarke, P.J. 1993. Mangroves, saltmarsh and peripheral vegetation of Jervis Bay. *Cunninghamia* 3(1): 231–254.
- Clarke, P.J. and Jacoby, C.A. 1994. Baseline studies of saltmarsh plants in south-eastern Australia: biomass and productivity. *Australian Journal of Freshwater and Marine Research* 45: 1521–28.
- CSIRO, 1994. Jervis Bay Baseline Studies, Final Report, May 1994. CSIRO Division of Fisheries, Marmion Research Laboratories.
- English, S., Wilkinson, C. and Baker, V. 1997. Survey Manual for Tropical Marine Resources. (2nd edition) Australian Institute of Marine Science, Townsville.
- Hanslow, D.J., Clout, B., Evans, P. and Coates, B. 1997. Monitoring Coastal Change Using Photogrammetry. *In*: Bliss E. (ed.) Islands: Economy, Society and Environment. Conference Proceedings, Second Joint Conference, Institute of Australian Geographers and New Zealand Geographical Society, University of Tasmania.
- Hennessy, K.J., Suppiah, R. and Page, C.M. 1999. Australian Rainfall Changes 1910–1995. *Australian Meteorological Magazine* 48: 1–13.
- McTainsh G., Iles B. and Saffigna P. 1988. Spatial and temporal patterns of mangroves at Oyster Point Bay, south east Queensland, 1944–83. *Proc. R. Soc. Qld.* 99: 83–91.
- Mitchell, M.L. and Adam, P. 1989a. The decline of saltmarsh in Botany Bay. *Wetlands (Australia)* 8: 55–60.
- Mitchell, M.L. and Adam, P. 1989b. The relationship between mangrove and saltmarsh communities in the Sydney Region. *Wetlands (Australia)* 8: 37–46.
- Paterson I.B.L. 1975. The Geology and low-cost extractive resources of the Nowra-Jervis Bay area. Geological Survey of NSW Report GS 1974/208.
- Saenger P. 1995. The status of Australian estuaries and enclosed marine waters. *In*: Zann, L. and Kailola P. (eds.), State of the Marine Environment Report for Australia: Technical Annex 1, The Marine Environment. GBRMPA/Ocean Rescue 2000, pp. 53–73.
- Saintilan, N. and Hashimoto, T.K. 1999. Mangrove-saltmarsh dynamics on a prograding bayhead delta, Hawkesbury River, New South Wales, Australia. *Hydrobiologia* 413: 95–102.
- Saintilan, N. and Williams, R.J. 1999. Mangrove transgression into saltmarsh environments in southeast Australia. *Global Ecology and Biogeography* 8: 117–124.
- Saintilan N. and Williams R.J., 2000. Short note: the decline of saltmarsh in southeastern Australia: results of recent surveys. *Wetlands (Australia)* 18(2): 49–54.
- Stoddart D.R., Reed D.J. and French J.R. 1989. Understanding saltmarsh accretion, Scolt Head Island, Norfolk, England. *Estuaries*: 228–236.
- Thom, B.G. 1987. Geomorphology of the Jervis Bay area. *Wetlands (Australia)* 6(2): 19–21.
- Williams R.J., Watford F.A. and Balashov V. 1999. Kooragang Wetland Rehabilitation Project: Changes in wetland fish habitats of the lower Hunter River. NSW Fisheries Office of Conservation, Fisheries Research Institute, Cronulla, NSW.

Wilton K. 2000. Changes in the distribution of mangroves and saltmarshes in Careel Bay, Pitwater. Wetlands (Australia) in press.

Zann L.P. 1997. Our Sea, Our Future. Major findings of the State of the Marine Environment Report for Australia. Ocean Rescue 2000, Department of Environment, Sport and Territories, Canberra.