BELOW-GROUND BIOMASS IN SOME INTERTIDAL WETLANDS IN NEW SOUTH WALES

W. LICHACZ* S. HARDIMAN** R.T. BUCKNEY

School of Biological and Biomedical Sciences
New South Wales Institute of Technology
PO Box 123 Broadway NSW 2007

*Present Address: NSW National Parks and Wildlife Service
PO Box 351 Muswellbrook NSW 2333

**Present Address: State Pollution Control Commission
117 Bull Street Newcastle NSW 2300

INTRODUCTION

Few, if any, data exist on below-ground biomass for most plant communities. Nevertheless, the proportion of plant productivity devoted to root growth may be substantial. The major difficulties in obtaining representative measures of root biomass are:

i) obtaining samples which are representative of the root zone, especially with respect to depth;
ii) adequate separation of the root material from soil minerals without loss of live material; and
iii) the discrimination between live and dead material.

Wetland soils tend to be poorly consolidated so that some of the above problems are partially alleviated.

This paper reports on the determination of below-ground biomass in parts of the intertidal wetlands at Pelican Point near Sydney, and on Kooragang Island near Newcastle.

Among Australian intertidal wetlands, root biomass estimates are available for mangrove stands in the Lane Cove River, New South Wales (Briggs, 1977) and in Westernport Bay, Victoria (Clough and Attiwill, 1975) and a *Juncus kraussii* wetland in Western Australia (Congdon and McComb, 1980). In this paper we present data for similar sites and for adjacent *Casuarina glauca* woodlands and *Sarcocornia quinqueflora* saltmarshes.

STUDY SITES AND METHODS

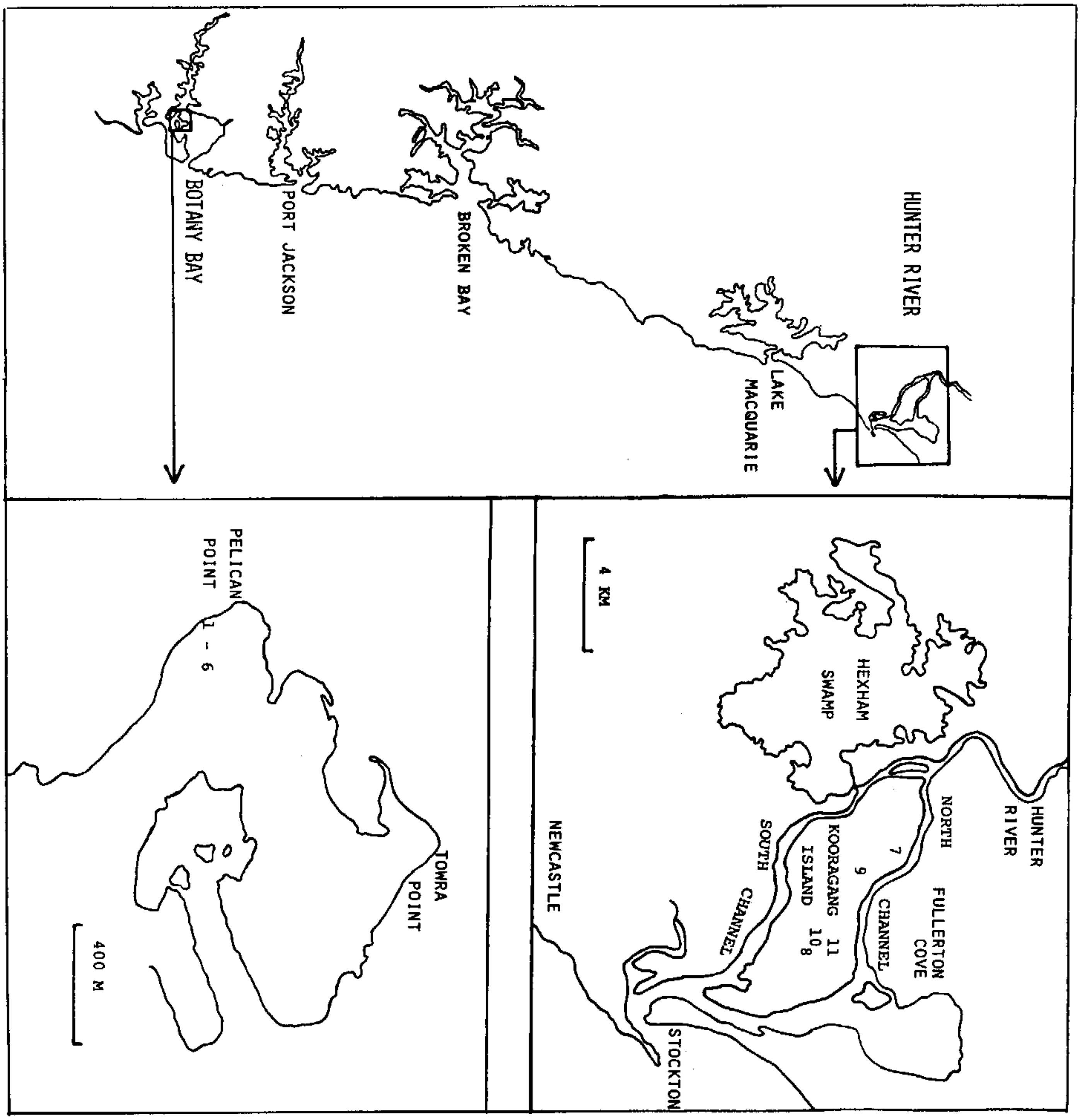
1. <u>Pelican Point</u>
Pelican Point is part of the Towra Point wetland complex on the southern side of Botany Bay near Sydney; its vegetation has been described by Clarke (1983). A number of soil samples were taken from each of Clarke's six sample areas; the main features of the vegetation at each of these is given in Table 1.

2. <u>Kooragang Island</u>
Outhred and Buckney (1983) have classified the vegetation of the island. Core samples were taken in two healthy mangrove areas (type M1b, Outhred and Buckney, 1983) — one bordering the North Channel of the Hunter River and one near the eastern centre of the island. Samples were also taken in a deteriorating mangrove forest (type M2a) near the western end of the island and in two *Sarcocornia quinqueflora* saltmarsh areas (type SM1a) near the eastern end of the island.

All sample sites are shown in Figure 1.

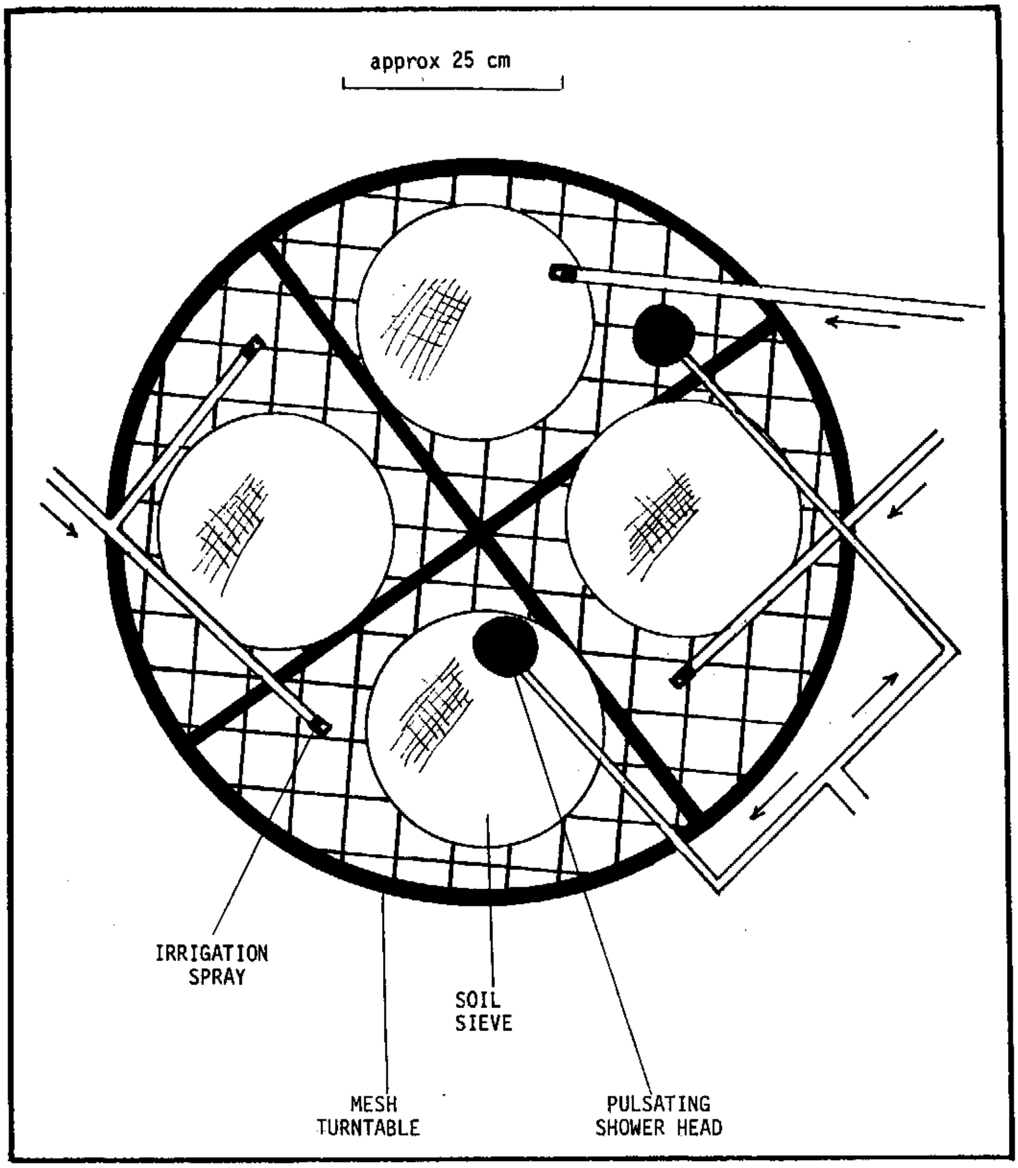
3. <u>Sampling and core treatment</u>
Samples were taken to a depth of 0.50 m using a robust mild steel cylindrical corer of 0.056 m diameter with

Figure 1 Locations of study sites.



a sharpened end to allow the cutting of large roots. Each sample was sub-divided into sections corresponding to the top 0.1 m, and middle and bottom 0.2 m of the core.

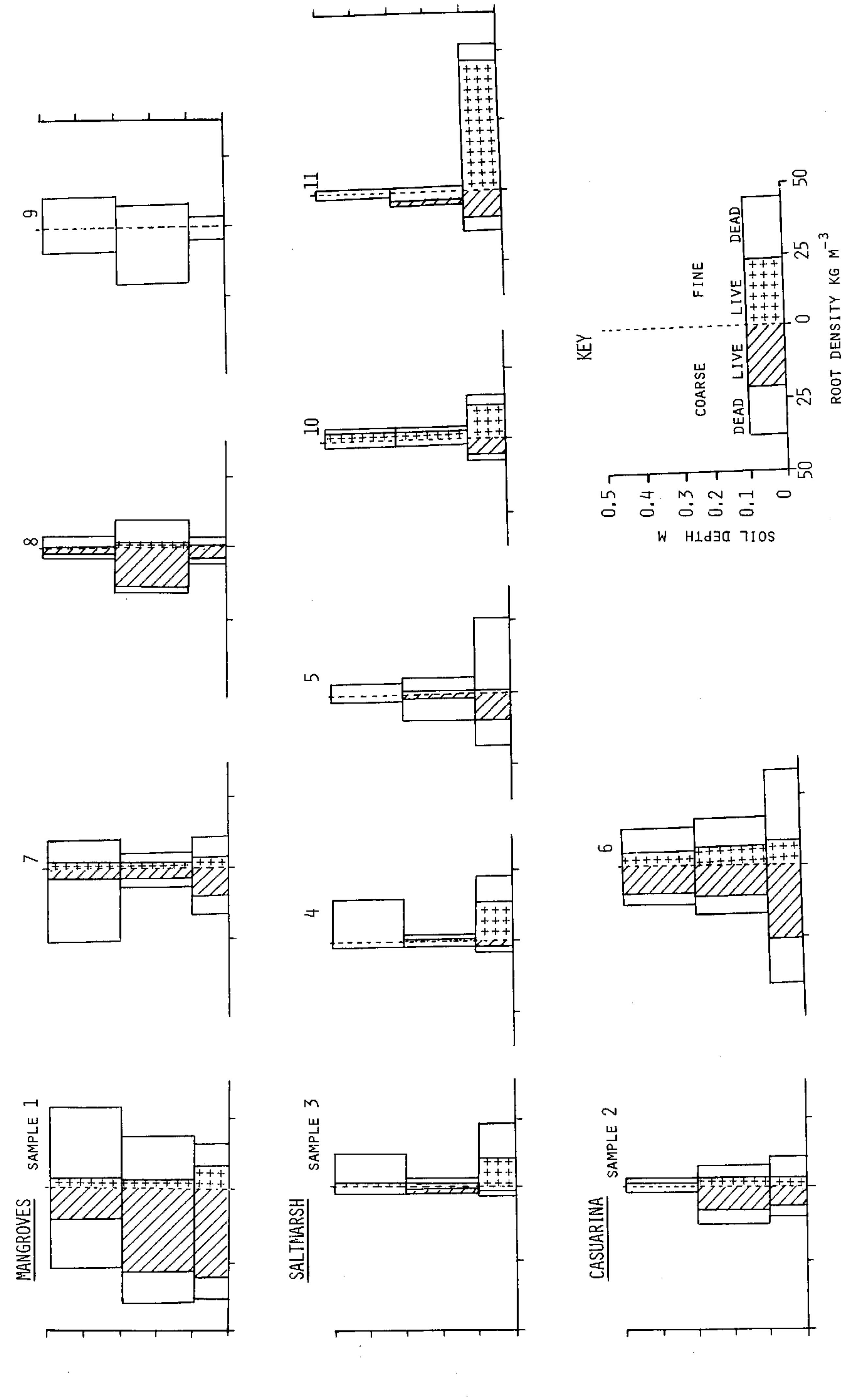
Each sub-sample was soaked in an 0.27% (w/v) solution of sodium pyrophosphate for 48 hours to aid in the dispersion of mineral matter. Separation of root material was then achieved by successive washing and decanting (the roots float when free of most soil) into a stacked pair of sieves of mesh size 1 mm and 0.25 mm. The collected root material was then washed in the sieves on a water-driven turntable to separate 'coarse' (>1 mm) and 'fine' (0.25-1 mm) fractions (see diagram).



Plan diagram of root washing apparatus. Arrows show water flow. Spray heads are angled to cause rotation of the turntable.

Percentage live root material was estimated by microscopic inspection for root colour, branching and the presence of root hairs (Bohm, 1979). Dry weight was determined after oven drying at 70°C and loss on ignition after heating at 600°C for four hours.

Figure 2 (opposite) Distribution of root biomass components with soil depth. Data from sites with broadly similar vegetation have been grouped together. Sample numbers correspond with those of Tables 1 and 2.


MANGROVES
SAMPLE 1
7
8
9
SALTMARSH
SAMPLE 3
4
5
10
11
CASUARINA
SAMPLE 2
6
KEY
COARSE
FINE
DEAD
LIVE
LIVE
DEAD
0.5
0.4
0.3
0.2
0.1
0
SOIL DEPTH M
50
25
0
25
50
ROOT DENSITY KG M-3

RESULTS

Results for Pelican Point and Kooragang Island are summarised in Tables 1 and 2 respectively. Root density (here defined as dry weight of recovered material per unit volume of soil) and its distribution with depth is shown diagramatically in Figure 2.

TABLE 1

Means of root biomass estimates for samples from Pelican Point. Numbers in parentheses are standard errors. Three cores were taken for samples 3 and 5, four for all others

Sample Number	Vegetation Type (see Clarke, 1983)	Root Fraction	Dry Weight kg.m^{-2}		% Loss on Ignition
			Total	Live	
1	A				
	Avicennia marina	coarse	16.9 (1.5)	10.8 (0.6)	77.3
	woodland	fine	10.8 (1.2)	2.5 (0.3)	51.6
2	B -strand dune				
	Casuarina glauca	coarse	4.0 (1.7)	2.5 (1.0)	52.9
	woodland	fine	2.9 (0.7)	1.2 (0.1)	50.0
3	C				
	Sarcocornia-Suaeda	coarse	1.0 (0.3)	0.3 (0.1)	72.9
	saltmarsh	fine	5.7 (0.5)	1.5 (0.5)	58.9
4	D				
	as for C, with	coarse	1.1 (0.2)	0.1 (0.1)	77.4
	Sporobolus	fine	5.3 (1.0)	1.6 (0.5)	64.4
5	E				
	Juncus kraussii	coarse	2.9 (0.3)	1.1 (0.7)	90.9
	saltmarsh	fine	4.5 (1.2)	0.7 (0.2)	75.8
6	F				
	Casuarina glauca	coarse	10.0 (2.3)	6.7 (1.5)	89.6
	woodland	fine	10.1 (2.9)	2.9 (0.8)	71.7

TABLE 2

Mean root biomass estimates for samples from Kooragang Island. Numbers in parentheses are standard errors for two cores; only one core taken for sample 11

Sample Number	Vegetation Type (see Outhred & Buckney, 1983)	Root Fraction	Dry Weight kg.m^{-2}		% Loss on Ignition
			Total	Live	
7	Type M1b				
	Vigorous mangroves	coarse	13.0 (8.3)	4.6 (2.2)	82.9
	without *Aegiceras*	fine	6.7 (1.1)	2.1 (0.7)	57.3
8	M1b				
	Vigorous mangroves	coarse	5.0 (2.4)	3.5 (2.1)	79.8
	without *Aegiceras*	fine	4.1 (2.0)	0.9 (0.7)	42.0
9	M2a				
	Tall mangroves	coarse	5.5 (2.2)	0	79.0
	lacking vigour	fine	3.3 (1.7)	0	67.3
10	SM1a				
	Sarcocornia	coarse	1.2 (0.2)	1.0 (0.2)	61.6
	saltmarsh	fine	3.4 (0.2)	2.8 (0.2)	38.9
11	SM1a				
	Sarcocornia	coarse	2.7	2.2	64.4
	saltmarsh	fine	6.4	5.9	52.2

DISCUSSION

Below-ground biomass estimates, even for sites with grossly similar vegetation (e.g. mangroves: samples 1, 7, 8; saltmarsh: samples 3, 4, 10, 11 — see Tables 1 and 2), vary greatly. This may reflect variations in soil type: Pelican Point soils are sandy, while those on Kooragang Island are light to medium clays, but variations in the relative importance of fine and coarse root material might also be important.

Although the mangroves sampled on Kooragang Island are larger than those at Pelican Point, their below-ground biomass estimates are smaller. Similar observations have been made by Whittaker (1975), Briggs (1977) and Saenger (1982). Above-ground biomass estimates are available for several of our sample areas — the sites of Clarke (1983) and two of those used by Burchett and Pulkownik (1983) have been used for this study — and a similar trend, though less marked, for below-ground biomass to be lower for larger above-ground biomass is apparent in the saltmarshes. Root: shoot ratios are discussed below.

Root density data (Figure 2) show that root development is most intense in the uppermost 0.1 m of soil in almost all samples, the exceptions being the fringing mangroves of Kooragang Island and the *Casuarina* woodland on the strand dune at Pelican Point. This tendency is especially marked in the saltmarsh sites where it is clear that fine root material is very important in producing this trend. Fine material has not always been specifically sought by other workers, the most usual strategy being to collect root matter on sieves with mesh sizes of 1 mm or greater. Lauff (1967, cited by Briggs, 1977) asserted that mangrove roots were most developed in the 0.2-0.3 m zone; most of our data show a more superficial development, though one site on Kooragang Island supports Lauff's contention. The shallow proliferation of saltmarsh roots is not unusual (see Good *et al.*, 1982).

Below-ground to above-ground biomass (root to shoot) ratios are presented in Table 3 with some other Australian data. The high value for the Pelican Point mangroves could reflect the relative youth of the trees (see above), but remains exceptionally high even if the fine root material is ignored. The remaining values are within reported ranges. Good *et al.* (1982) summarised root to shoot ratios for several saltmarsh plants; their data include one value of nearly 50 for *Spartina*.

TABLE 3

Below-ground to above-ground biomass ratios (B/A) for a number of Australian intertidal wetland sites. Above-ground data for Pelican Point and Kooragang Island from Clarke (1983) and Burchett and Pulkownik (1983) respectively

Dominant Plants	Site	B/A	Source
Avicennia marina	Lane Cove (NSW)	1.02	Briggs (1977)
	" " "	1.41	" "
	Westernport Bay (Vic.)	1.74	Clough & Attiwill (1975)
	Pelican Point	4.74	This study
	Kooragang Island	0.71	" "
Sarcocornia quinqueflora	Pelican Point	2.54*	" "
	" "	3.41*	" "
	Kooragang Island	9.41	" "
Juncus kraussii	Blackwood R (WA)	2.23	Congdon & McComb (1980)
	Pelican Point	2.47	This study
Casuarina glauca	" "	0.89*	" "
	" "	2.63*	" "

*values presented in the same order as in Table 1

Most root to shoot ratios found in this study exceed unity. This fact and the high levels of dead matter in the cores (Tables 1 and 2) raise the question of how much of the primary productivity in the systems is apportioned to the roots. Burchett and Pulkownik (1983) provide a number of above-ground productivity estimates for saltmarshes; these values have a mean of 1.1 kg $m^{-2}yr^{-1}$. In comparison, below-ground productivity estimates for saltmarsh plants (Good *et al.*, 1982) provide a mean of 2.0 kg $m^{-2}yr^{-1}$. No similar comparison is, as yet, possible for mangroves.

It is clear that the subterranean component of mangrove and saltmarsh vegetation represents a quantitatively important part of these systems. Despite this, there is little information available on the factors which affect root development and activity in these areas. An understanding of these factors may well be essential to an appreciation of the nutrient and energy dynamics of intertidal wetlands.

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