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Contents

Introduction

In September 1988, MAF Fisheries was contracted to survey the surf clam populations of Cloudy Bay and Clifford Bay, Marlborough, to determine the species present and their distribution and abundance. Cloudy Bay was surveyed in January 1989 (Cranfield *et al.* 1994b) and Clifford Bay (White Bluffs to Cape Campbell) in October 1989. This report contains information on the physical characteristics of the survey area in Clifford Bay (climate and beach profile) and on the abundance (density by weight and numbers, and biomass), distribution, and species composition of surf clams there.

Methods

Field sampling

A stratified random survey was designed to estimate biomass with minimal bias and sample variance and to allow post-stratification of areas if high catches were made. Depth, substrate type, freshwater input, beach profile, and wave action strongly influence surf clam distribution. To reduce sampling variance, Clifford Bay was stratified into 1 m depth contours from 1 m below chart datum to 7 m (all depths in this report are corrected for state of the tide to depth below chart datum). To minimise any differences in species composition and density along the beach, Clifford Bay was further stratified into four blocks (Figure 1). The coast between Mussel Point and Cape Campbell was not surveyed as the substrate was mainly exposed papa rock which could not be sampled by dredging.

The depth profile of the subtidal beach was surveyed at 11 transects along the shore (transects A–K, Figure 1). Two optical range finders and a 200 m measuring tape were used to measure the distance of each 1 m contour from the shore. The areas between the contours in each block were estimated by summing the areas of the quadrilaterals formed from the intersection of the transects and the depth contours. Each stratum (block multiplied by depth) was subdivided into 10 equal sections to give 280 quadrilaterals. In each depth stratum in each block, four of these sections were randomly selected and sampled with a hydraulic dredge (Michael *et al.* 1990). Dredge tows began at the midpoint of each quadrilateral, with the vessel towing the dredge parallel to the shore. The 0.8 m wide dredge was towed for a standard distance of 50 m and sampled 40 m^2 of the sea bed. The dredge and towing technique were described by Cranfield *et al.* (1994b).

Data collection and analysis

The surf clams taken in each dredge tow were identified, counted, and weighed to the nearest 0.1 kg on a Salter dial balance. The dredge retained small bivalves over 20 mm long (Cranfield *et al.* 1994b). Lengths of individual surf clams were measured on an electronic measuring board with a precision of ± 1% of the measurement.

Biomass was estimated from the usual formula for stratified random sampling (Snedecor & Cochran 1980, pp. 444–445). The variance of the estimate of the biomass includes the variances from dredge efficiency and from sampling. A non-parametric bootstrap simulation determined the variance of dredge efficiency from data collected previously; a parametric bootstrap simulation determined sampling variance (*see* Cranfield *et al.* 1994b).

Results and discussion

Beach gradient

The intertidal and aerial beach profiles are steep with a maximum gradient of 1 in 5. The tidal amplitude is 1.3 m and the littoral zone ranges from 10 to 20 m wide. The subtidal beach in blocks 1, 2, and 3 continues to shelve steeply (between 1 in 10 and 1 in 20) to 2 m. Both the aerial and subtidal beaches shelve more gently in block 4 (particularly in the south). The gradient of the beach in all blocks becomes gentle (1 in 100 to 1 in 150) beyond 2 m.

The area of each depth stratum in each block is shown in Table 1.

Sampling

Because of the steepness of the beach profile close to shore, the first stratum was in the breaker zone at all stages of the tide in blocks 1 and 4, as were the first three strata in block 2. These strata could not be dredged. Fine papa mud off shore prevented the dredging of stratum 7 of blocks 1 and 4 and strata 6 and 7 of block 3. Hence only 190 quadrilaterals covering 7.5 km^2 could be surveyed from the original 280. These 190 quadrilaterals were randomly selected with replacement for sampling and 75 were sampled by 92 tows.

Distribution of species

The seven species of surf clams caught were *Paphies subtriangulata*, *P. donacina*, *Spisula aequilatera*, *Mactra murchisoni*, *M. discors*, *Dosinia anus*, and *Bassina yatei*. Each occurs in a unique depth zone (Figure 2), and so can be readily targeted by fishers. Too few *B. yatei* were caught for the depth distribution to be determined.

Biomass

The percentage composition of the six most abundant species by block is shown in Figure 3. Zonation of species by depth was not as clearly defined as elsewhere around New Zealand (*see* Cranfield *et al.* 1994a). The north to south trend in distribution changes may be related to changes in substrate composition. Offshore, species found in fine sediments (*M. murchisoni* and *M. discors*) were dominant in the northern blocks where the substrate contained a large proportion of papa mud. Inshore, species of coarser sediments (*S. aequilatera* and *P. donacina*) were dominant in the mainly sandy southern blocks.

Mean biomass estimates from the distributions of simulated biomasses for each species and their 95% confidence intervals are shown in Table 2. The biomasses of the mactrid species *S. aequilatera* and *M. discors* were higher and the biomasses of the venerids *D. anus* and *B. yatei* were lower in Clifford Bay than in Cloudy Bay 20 km to the north (*see* Cranfield *et al.* 1994b). The distribution of the biomass of the seven species combined by strata (Figure 4) suggests that block 3 is the most productive portion of the beach.

The mean biomass of each species by stratum is shown in Figure 5. The highest biomass of *P. donacina* was found in strata 2, 3, and 4 in blocks 3 and 4; block 3 supported four times the biomass of the next highest block, block 4. There were few *P. donacina* in the northern blocks, 1 and 2. The highest biomass of *S. aequilatera* was in stratum 4 in block 3 and in strata 5 and 6 in block 2. The depth of maximum biomass changed from the deeper strata in the north to shallower strata in the south. The greatest biomass of *M. murchisoni* was in strata 3 and 4 in block 1. The biomass decreased rapidly to the south and the depth of maximum biomass also became shallower in this direction. The biomass of *M. discors* and *D. anus* was low throughout the area surveyed.

Acknowledgments

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Table 1: Area (m^2) of each depth stratum in each block

	Block			
	1	2	3	4
Stratum				
1	–	–	159 550	186 375
2	258 070	–	297 450	338 375
3	870 630	–	526 850	311 000
4	757 325	288 695	414 750	451 625
5	388 015	257 993	422 250	335 875
6	359 460	352 745	–	–
7	–	485 220	–	–
Total	2 633 490	1 384 653	1 820 850	1 623 250
Total area surveyed				7 462 173

– = not measured.

Table 2: The mean biomass, standard deviation (*s.d*), and 95% confidence interval for each species, all blocks combined

	Mean biomass (t)	*s.d*	95% confidence interval	
			Lower	Upper
Paphies subtriangulata	22	9	9	45
P. donacina	284	123	111	606
Spisula aequilatera	358	152	162	764
Mactra murchisoni	192	79	90	390
M. discors	89	3	44	172
Dosinia anus	5	3	1	11
Bassina yatei	0.2	0.2	0	1

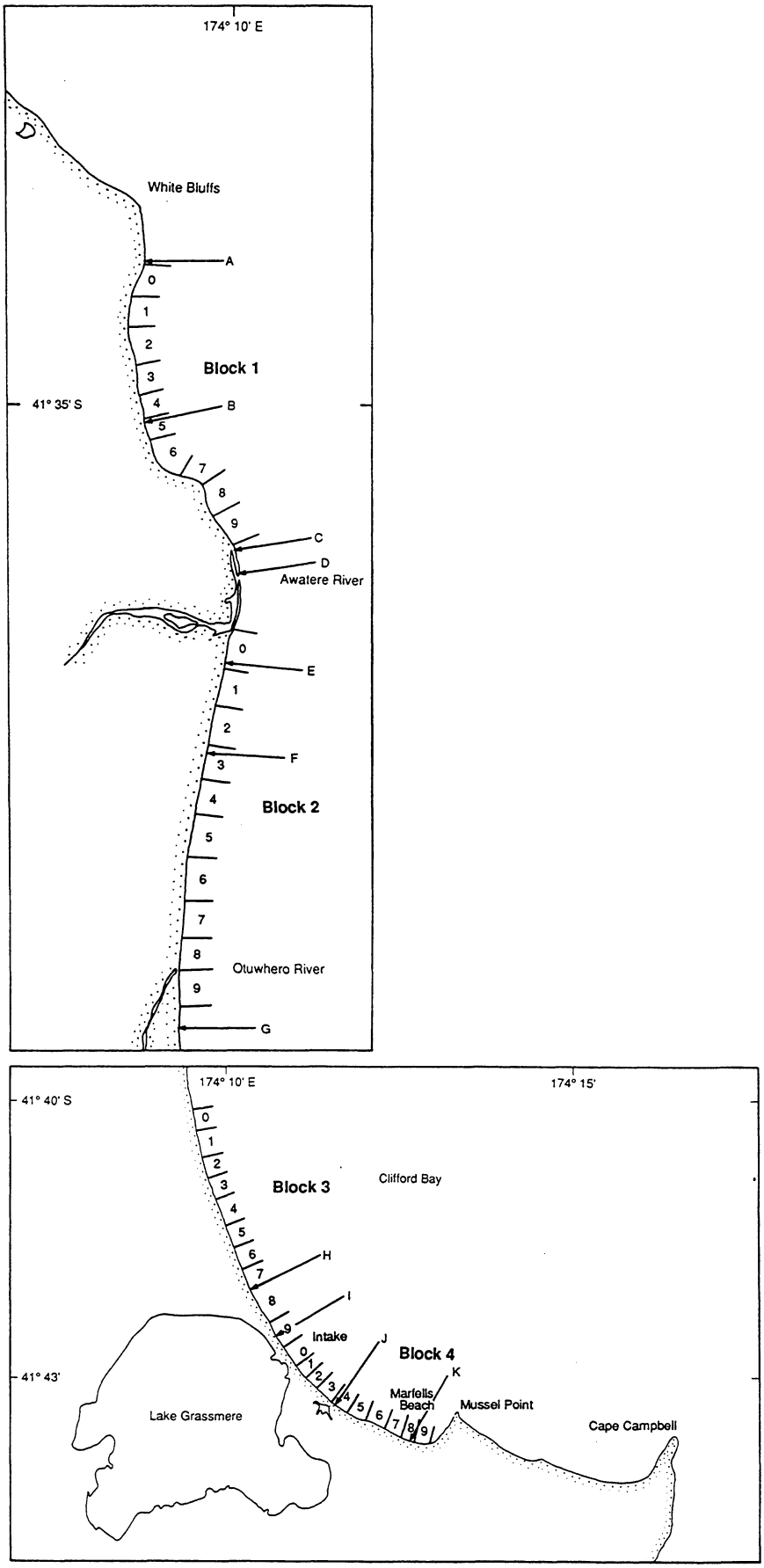

Figure 1: Survey area, showing the four blocks, the 10 grid sections in each area (0–9), and the location of the bathymetric survey transects (A–K).

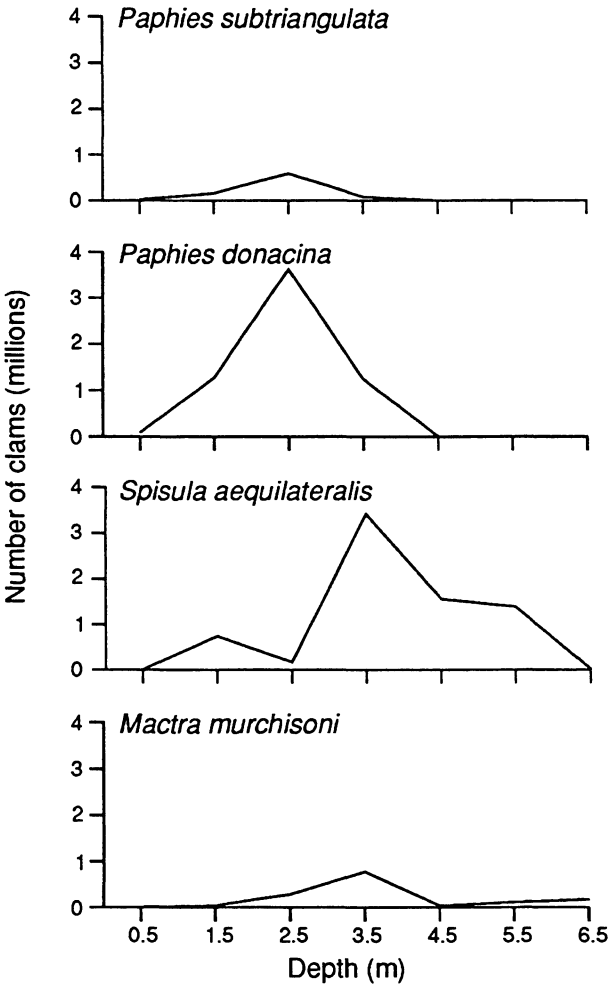

Figure 2: Depth distribution of the four most abundant species, all blocks combined.

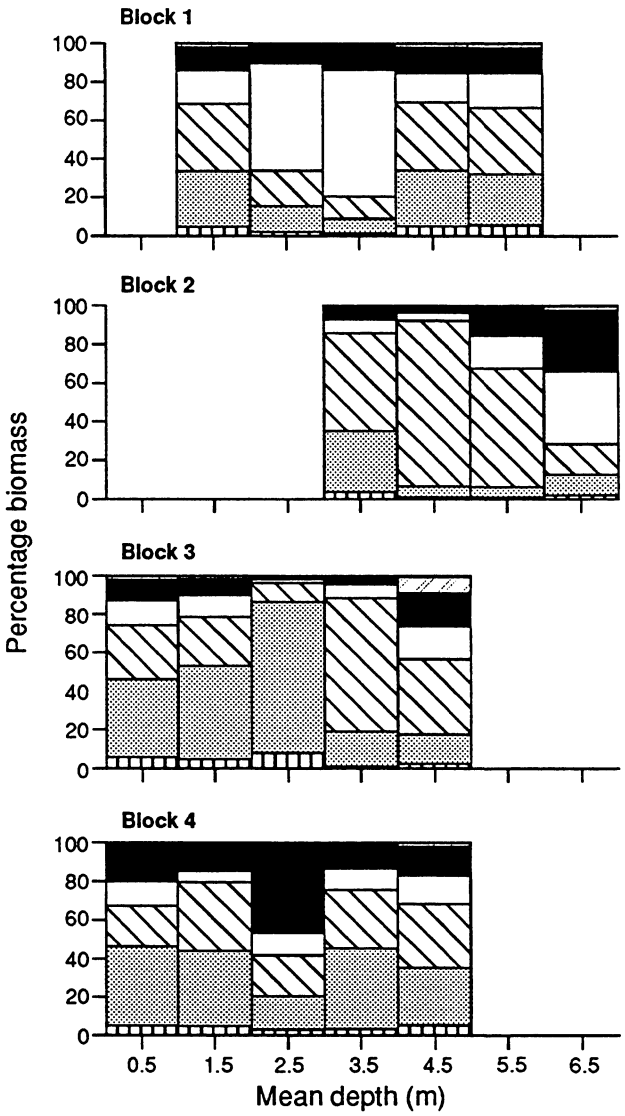

Figure 3: Percentage composition of the six most abundant species by depth and by block.

- *Paphies subtriangulata*
- *P. donacina*
- *Spisula aequilateralis*
- *Mactra murchisoni*
- *M. discors*
- *Dosinia anus*
- *Bassina yatei*

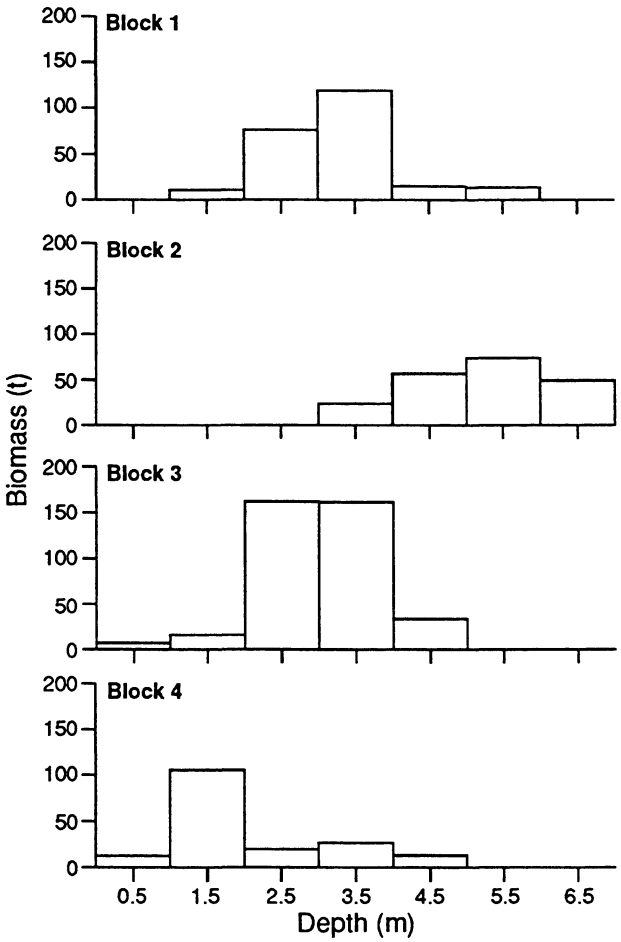

Figure 4: Distribution of biomass of all species combined, by depth and by block.

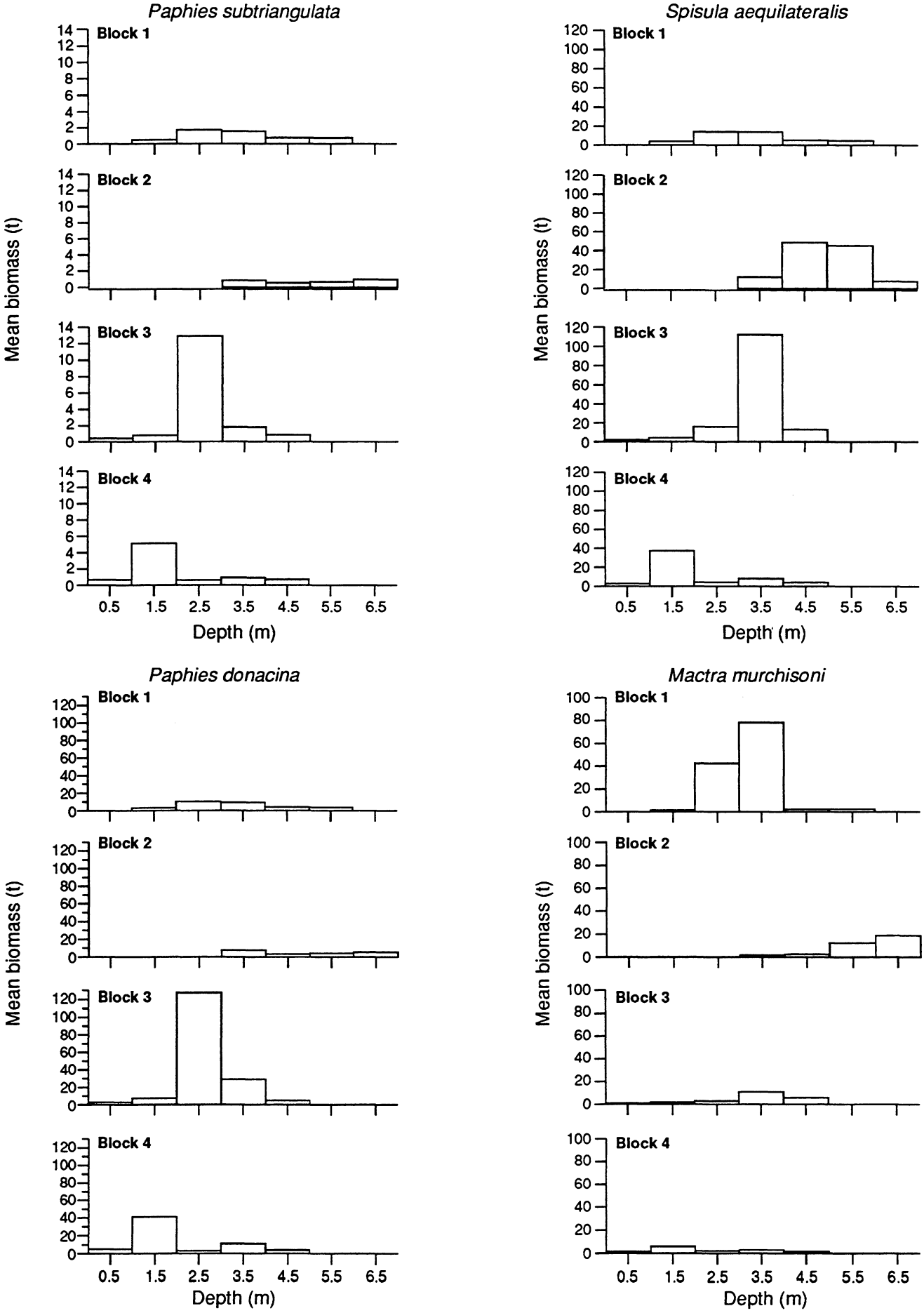

Figure 5: Distribution of biomass of each species by depth and block.

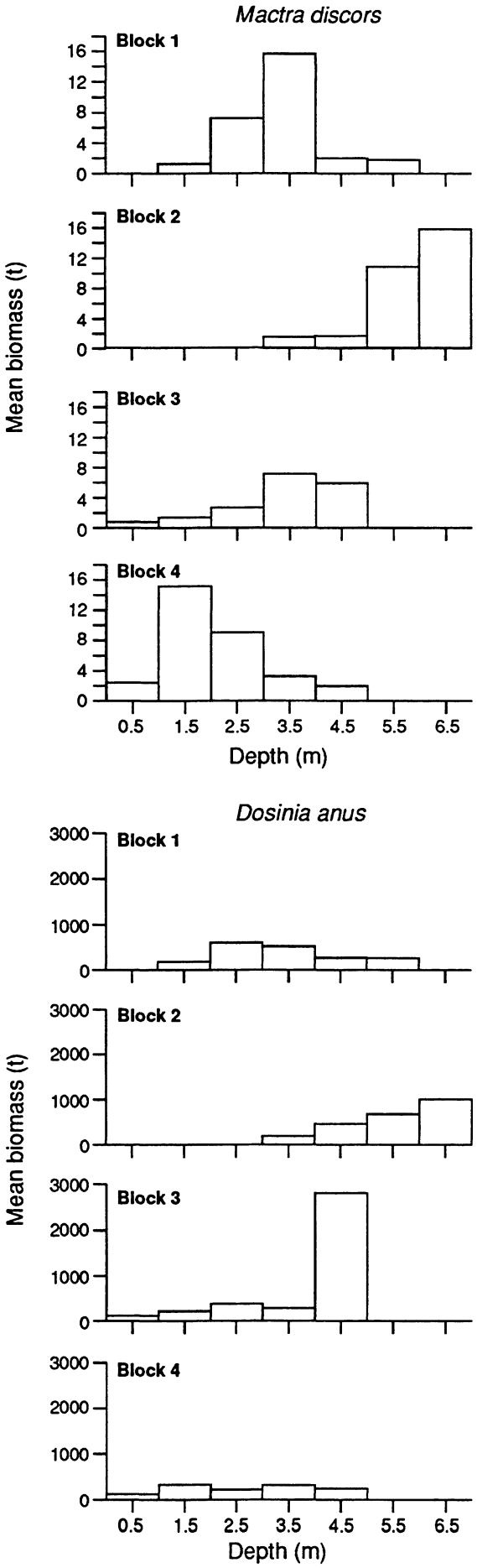

Figure 5—*continued*

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