ABORIGINAL SHELL MIDDENS AT THE MOUTH OF THE MAROOCHY RIVER, SOUTHEAST QUEENSLAND

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INTRODUCTION

This paper examines a series of shell midden and stone artefact sites located at the mouth of the Maroochy River, southeast Queensland. It represents the first detailed archaeological research undertaken on the Sunshine Coast since Jackson (1939) investigated a series of middens near Point Cartwright in the 1930's. The present study details the results of survey and excavation work, with a number of tentative hypotheses concerning late Holocene shellfishing behaviour, bevel-edged tool use, and "regionalization" of societal groupings.

THE STUDY AREA AND ENVIRONMENTAL SETTING

The study area is situated on the northern bank of the mouth of the Maroochy River (Figure 1). It is located 70km north of Brisbane and 30km south of Noosa. Most of the area is less than 5m a.s.l. and the watertable is often at or just below the surface. A number of narrow ridges less than 10m wide and averaging less than 1m a.s.l. extend across the water-logged flats. Inland, particularly to the northwest of the study area, the land gently rises through a series of ridges to some 5m a.s.l. Both the low lying and higher ridged areas consist of Holocene marine sands and silts (Caloundra 1:100,000 Industrial rock and mineral resources map 1984, see also Thompson 1975). Fronting both the riverine and oceanic beaches, situated to the south and east of the study area respectively, is a zone of sand dunes generally less than 30m wide. Along the Maroochy River these dunes are less than 1m high, while along the ocean beach they attain elevations of 3-4m.

Most of the study area is covered by permanently or seasonally inundated swamp vegetation and mangrove forest (Figure 1). The swamp vegetation mostly consists of sedgeland. On the narrow ridges extending across the low lying areas there is woodland and shrubland including Casuarina sp., Acacia sp., and Pandanus sp.

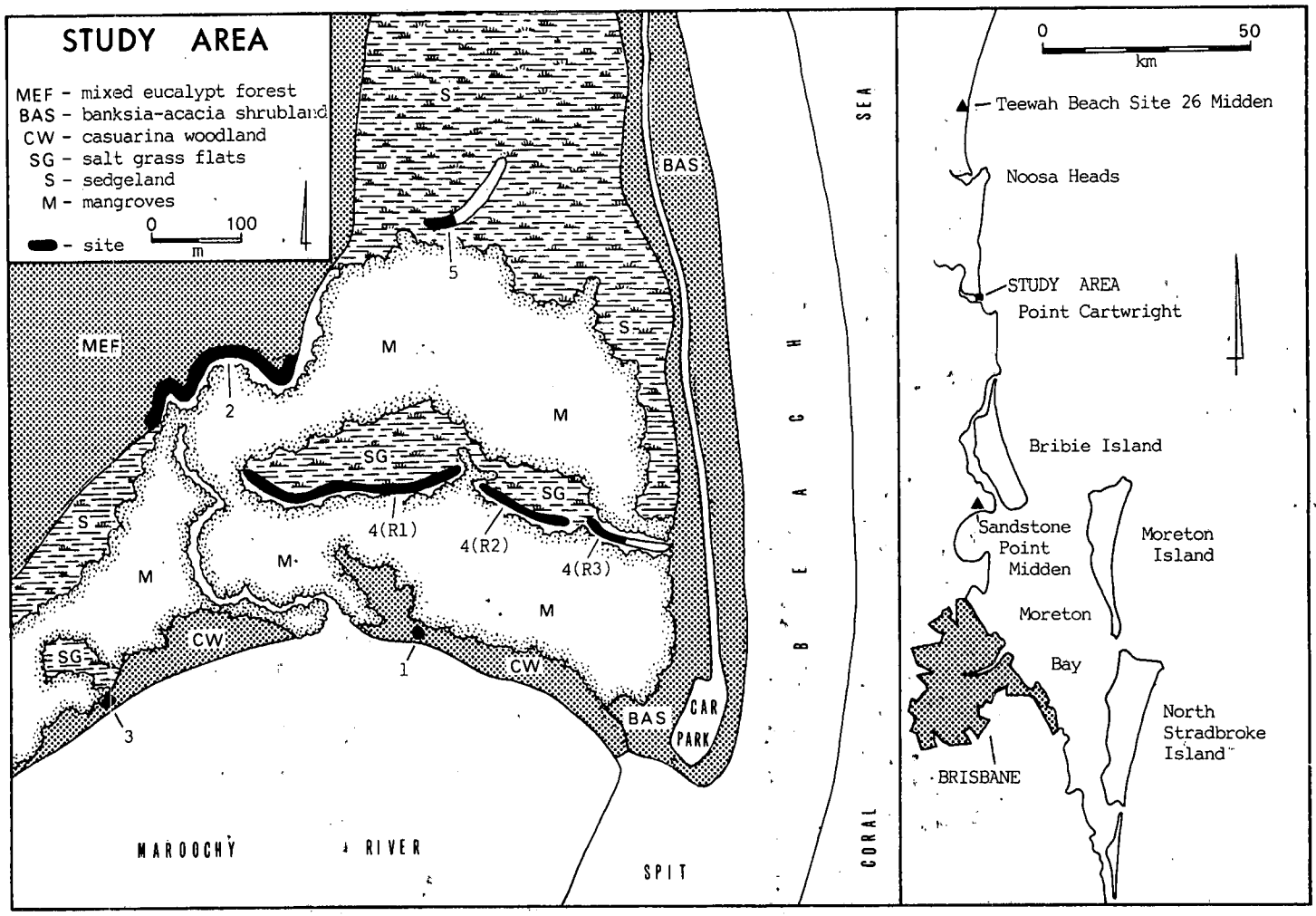

Figure 1. The study area showing location of sites and areas mentioned in the text.

The more elevated ridged areas inland from the swamp and mangroves carry mixed eucalypt forest with a dense grass ground cover. On the dunes fronting the Maroochy River there is open casuarina woodland with grass ground cover of varying density. On the higher foredunes fronting the ocean beach very dense banksia-acacia shrubland occurs.

No specific mammal studies have been published for the study area. From research undertaken in similar coastal lowlands elsewhere in southeast Queensland however, it is probable the mammal fauna in the lower lying areas is depauperate (see Dwyer, Hockings and Willmer 1979, Dwyer, Kikkawa and Ingram 1979). On the higher eucalypt forest areas, the diversity and abundance of mammals may be greater. For most of the study area therefore, the mammal food resource potential is only slight.

The lack of terrestrial faunal resources is compensated for by the productivity of the adjacent marine environments. The Maroochy River and Coral Sea (Pacific Ocean) provide a rich suite of shellfish and fish resources. Shellfish range from pipis (Donax deltoides) on the ocean beach to oyster (Saccostrea commercialis), cockle (Anadara trapezia), club whelk (Pyrazus ebeninus) and mud whelk (Velacumantus australis) on tidal mudflats flanking the Maroochy River. Major fish types available include bream (Acanthopagrus australis), whiting (Sillago sp.) and flathead (Platycephalus sp.) (Young 1977). The only major Aboriginal plant food identified was bungwall (Blechnum indicum), located within paperbark (Melaleuca sp.) forest immediately north of the study area (see Gillieson and Hall 1982).

SITE SURVEY

The study area was surveyed using a stratified sampling strategy. The area was divided into two sampling strata in order to increase the speed and efficiency of the survey. Stratification was based upon the results of detailed survey work undertaken in environmentally similar areas in Moreton Bay to the south (e.g. Hall 1982, Robins 1984) and Cooloola to the north (McNiven 1985). Stratum 1 consisted of mangrove forest and sedgelands. The site location potential of these areas is extremely low. Stratum 2 consisted of the following four higher elevation zones:

Zone 1. low sand dunes fronting Maroochy River

Zone 2. narrow ridges traversing low lying areas

Zone 3. inland ridge areas with mixed eucalypt forest

Zone 4. foredunes fronting ocean beach

The site location potential of these zones was considered high.

Differential sampling fractions were employed for each stratum owing to differences in site location potential. Most (>95%) of the survey concentrated on Stratum 2. Survey coverage of this stratum ranged from 80-100% for Zones 1 and 2 to less than 10% for Zones 3 and 4. The small survey coverage of Zones 3 and 4 resulted from the large areal extent of Zone 3 and the impenetrable vegetation in Zone 4.

The sampling units were transects, which have proved to be most efficient and informative in recent archaeological surveys in southeast Queensland (McNiven 1985, J. Hall pers. comm. 1989).

Ground visibility over the study area was generally poor. It ranged from good (>80%) for much of Zone 1 to extremely poor (<10%) in many sections of Zones 3 and 4. In order, to compensate for this, major areas of ground disturbance such as vehicular/pedestrian tracks and erosion faces were examined in detail.

SURVEY RESULTS

The survey found five sites (Figure 1). All sites consist of varying proportions of shell and stone artefacts. A brief description of the location and content of each site follows.

Site 1

Site 1 is a small estuarine shell midden located on a low (0.5m) sand dune fronting the Maroochy River. It is mostly vegetated by grass with casuarina and mangrove trees flanking its western boundary. Cultural remains are dominated by estuarine shells with a small number of stone artefacts. The midden extends along the dune for some 8m and spans its entire width (i.e. up to 10m). An in-situ shell layer extends from the ground surface down 15-20cm. Dark brown organic matrix which surrounds the shells continues below the main shell layer for at least another 10-20cm.

Site 2

Site 2 is eroding from a 0.2-2.0m-high erosion face flanking the southern periphery of the higher ground supporting mixed eucalypt forest. The site is approximately 100m long, at least 20m wide and is flanked to the south by mangrove forest. Cultural remains mostly consist of estuarine shells and stone artefacts. They are most visible on a compound alluvial fan fronting the erosion face. Very little in-situ material was observed in section.

Site 3

Site 3 is an estuarine shell midden located on a low (0.5m) sand dune fronting the Maroochy River. The midden is covered by dense shrubland. Cultural remains are dominated by estuarine shells with a small number of stone artefacts. The midden extends along the dune for 10m. The in-situ shell layer extends 10-20cm below the ground surface.

Site 4

Site 4 is located on three separate sand ridges. The ridge system is oriented on a east-west axis and parallels the Maroochy River at a distance of 80-120m. The ridges increase in length westwards, from approximately 100m (Ridges 2 and 3) to about 240m (Ridge 1), and average less than 10m in width and only 0.5-1.0m in elevation. Mangroves flank the entire southern periphery of the ridge system while

extensive salt grass flats separate the northern boundaries of Ridges 1 and 2 from further mangroves. Vegetation on the ridges is dominated by Casuarina sp. and Acacia sp. woodland/shrubland. Cultural remains consist mostly of estuarine shells and stone artefacts. Ridges 1 and 2 numerically exhibited over 99.0% of all artefacts recorded on Site 4. Moreover, faunal remains were only observed on these ridges.

Site 5

Site 5 lies at the southwestern end of a sandy ridge measuring 80m in length and less than 1m in elevation. The ridge is vegetated by Banksia sp., Acacia sp. and paperbark (Melaleuca sp.) woodland, and is flanked to the west and south by mangroves and to the east and north by sedge swamp. Surface finds consist of a low density scatter of 10 stone artefacts located along a 40m section of tidal mudflats adjacent to the low (<30cm) erosion face of the sandy ridge. No faunal remains or in-situ cultural remains are visible.

EXCAVATION AIMS AND PROCEDURES

Comprehensive collections of stone artefacts and shells were obtained from Sites 2 and 4 (Ridges 1 and 2). They were recovered through extensive surface excavations and a number of small test pits. The major aim of surface excavations was to obtain a large representative sample of stone artefacts for analysis. The test pits aimed to provide insights into the original in-situ stratigraphic context of eroded cultural remains recovered in the surface excavations. A brief description of the methods employed for the surface and pit excavations follows.

Surface excavations

Most cultural remains observed on Sites 2 and 4 (Ridges 1 and 2) were collected from 2m x 2 m grid units (GUs). These grid units were positioned over exposed stone artefacts and shell midden material and aligned parallel to the adjacent erosion face. Most units spanned the width of the compound alluvial fan flanking the erosion face and included up to 20-30cm of mudflat. The units were placed according to the distribution and density of artefacts. Single collection squares were used for discrete clusters of cultural material while contiguous squares were used for extensive artefact and shell scatters. The archaeological contents of each grid unit were removed by shovel excavation of the top 2-3cm of sediment. The excavated sediment was taken into the adjacent mangroves for wet-sieving with salt water through 3mm mesh. All sieve residue was placed into labelled plastic bags.

Pit excavation

A number of 50cm x 50cm test pits were excavated mostly using two bucket (ca. 5cm thick) excavation units (XUs) (cf. Johnson 1979). Acidity (pH) and colour (Munsel) determinations, as well as sediment samples, were obtained for all excavation units. The majority of excavated material was wet-sieved owing to recent rain which had saturated sediments and made dry-sieving difficult and inefficient.

Wet-sieving was carried out in a similar fashion to that described above. All sieve residues were sealed in labelled plastic bags. As with surface collected materials, all finds were subsequently rinsed with fresh water, dried and sorted. All sieve residues from the excavation pits were retained. Only stone and faunal remains were retained from the surface excavations.

SITE 2

Surface excavations

Twelve surface grid units were distributed along the entire length of the site (Figure 2). A total of 116 stone artefacts was recovered from these grid units (Table 1). The number of artefacts per grid unit ranges from 2 to 21 with a mean of 9.7. The maximum density of artefacts recorded was 12/m^2 from GU11. Variations in the density of artefacts recorded along the site appear to represent variations in stone artefact discard patterns. From the high density of artefacts recovered from the eastern and western ends of the site it may be inferred that these two areas were major foci for activities employing stone artefacts (Table 1).

Table 1. Stone artefact frequencies and densities for surface collection grids from Site 2.

Grid Unit No.	Grid Unit area (m^2)	stone artefacts (n)	artefact density n/m^2
1	4	15	3.8
2	4	14	3.5
3	4	21	5.3
4	4	3	0.8
5	4	3	0.8
6	5	9	1.8
7	4	6	1.5
8	4	4	1.0
9	4	2	0.5
10	2	12	6.0
11	1	12	12.0
12	4	15	3.8
Total:	44	116	

Stone artefacts are made from at least nine raw materials, the most common being sandstone and silcrete (Table 2). Numerically and by weight, sandstone and silcrete together represent 64.7% and 67.5% respectively of all stone artefacts recovered from the site. Stone artefact fracture types represented include cores, flakes, retouched flakes and flaked pieces. Ten stone artefacts were classed as bevel-edged implements (McNiven, in press) (cf. bevelled pounders - Gillieson and Hall 1982). These bevelled artefacts constitute 47.0% by weight of all artefacts recovered. No other implement types were recorded.

Table 2. Stone artefact raw materials for surface collection grids from Sites 2 and 4.

Raw material	Site 2		Site 4	
	n	wt (g)	n	wt (g)
sandstone	40	1330.8	770	9979.6
silcrete	35	882.2	369	2733.1
quartz	6	1.0	97	1933.9
quartzite	14	219.5	78	509.9
trachyte	1	596.0	1	1.4
rhyolite	1	10.7	18	377.2
volcanic*	16	208.8	287	3310.4
chert	0	0.0	7	20.8
ochre	1	1.1	33	6.0
other	2	26.2	52	15.8
Total:	116	3276.3	1712	18888.1

* = unidentified volcanic rock

Only eight grid units contained shell midden material. A total of 97.6g of shell was recovered, the bulk (73.1%) from GU6. Most shell derives from the adjacent mangroves, the important species including oyster, cockle and club whelk. A small amount (4.7g) of ocean beach pipi shell was also recovered. Two small fragments of mammal bone weighing less than 0.1g were recovered from GU11. Whether these bones represent part of the cultural assemblage of the site or were deposited naturally is unknown. Future taphonomic research may clarify this problem.

Pit excavations

Pit A

A test pit was dug to a depth of 68cm behind the erosion face adjacent to GU6 (Figure 2). The deposit consists largely of dark gray (10YR-4/1) sand grading to gray (10YR-6/1) sand in the lower section of the pit. An area of faint mottled dark gray sand and brown organic matter was found some 30-40 cm below the surface. None of the subtle colour changes through the deposit were identified as stratigraphic changes.

At least 85% (by weight) of shell and stone artefacts was found in XUs 6 and 7 at a depth of 25-35cm below surface (Table 3). It is likely that all cultural remains recovered from the pit derive from a single cultural layer located in the vicinity of XU6 (Figure 3). This layer probably represents the original in-situ stratigraphic context for eroded stone artefacts and shell found on the adjacent alluvial slope.

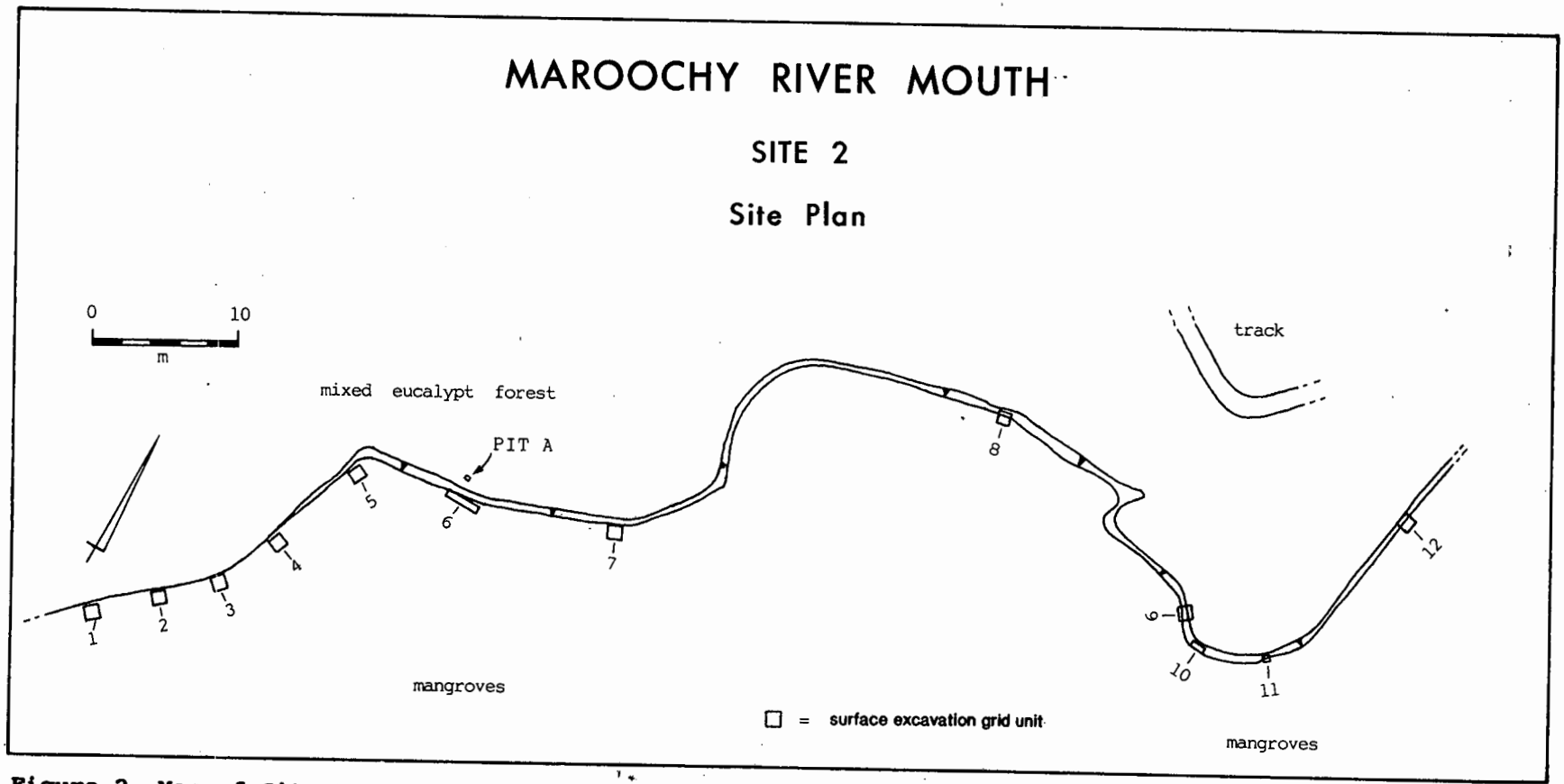

Figure 2. Map of Site 2.

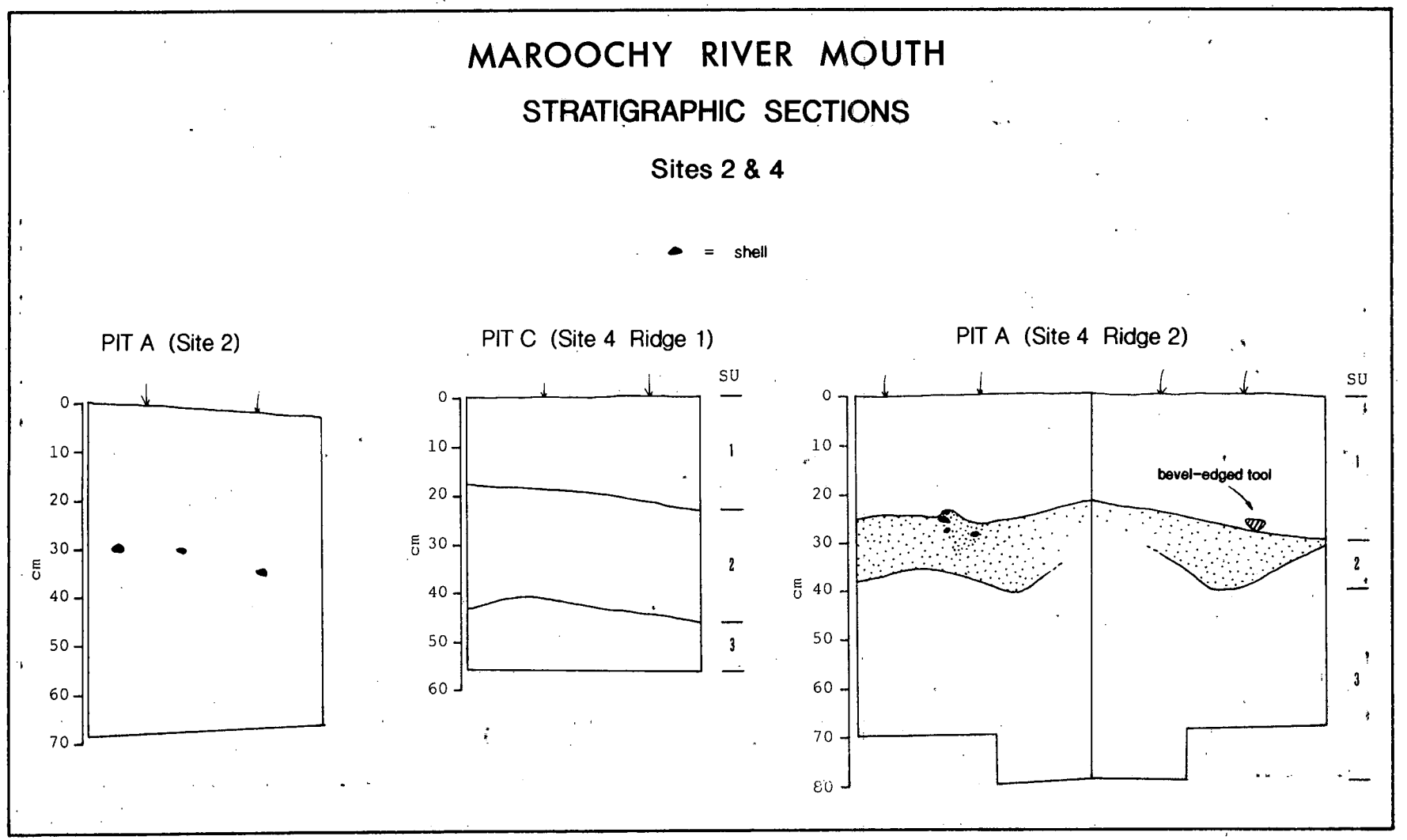

Figure 3. Stratigraphic sections of Sites 2 and 4.

Table 3. Maroochy River Mouth Site 2 Pit A - weights and components.

Excavation Unit (XU) (no.)	Mean XU thickness (cm)	Mean XU depth (cm)	XU weight (kg)	shell weight (g)	artefact weight (g)	pH
1	5	5	11.7	0.0	0.0	4.5
2	5	10	13.6	0.7	0.0	6.0
3	4	14	16.0	1.7	0.2	5.0
4	6	20	20.1	4.8	4.7	6.0
5	5	25	19.0	7.6	0.4	5.5
6	5	30	18.3	91.5	46.0	6.0
7	5	35	19.8	27.1	9.2	5.5
8	4	39	18.5	4.1	1.6	5.5
9	6	45	21.7	0.8	0.1	5.5
10	6	51	21.5	0.1	0.0	6.5
11	7	58	23.3	0.1	0.1	6.0
12	7	65	36.1	0.0	0.0	6.0
Total:				138.5	62.3	

A 40g sample of cockle shell fragments was submitted for radiocarbon age determination to Beta Analytic Inc. through the NWG Macintosh Centre for Quaternary Dating, University of Sydney. The shell was obtained from XU6 and was used to establish the antiquity of the major shell layer. The resulting age in radiocarbon years is 610 ±70 b.p. (Beta-27085) (Table 4). This gives calibrated ages of 148 and 207 BP (Stuiver and Reimer 1986) and indicates that the major shell layer was deposited around the time of initial European contact in the mid- to late 18th century (Table 4).

Table 4. C14 age determinations for Maroochy River mouth middens.

Lab. No.	Site No.	Pit-XU	Depth (cm)	C-14 age (years bp)	Cal. age (years BP)	Cal. age 2 sigmas
Beta-27085	2	A-6	25-30	610±70 bp	148, 207*	310-0
Beta-27086	4(R1)	C-7	27-29	840±60 bp	482	511-327
Beta-27087	4(R2)	A-5	23-28	170±60 bp	modern	modern

* = both dates are of equally high probability (other lower probability dates are 0, 12, 271)

NB. Dates calibrated using CALIB computer program (Stuiver and Reimer 1986) and the 450 year marine reservoir correction factor (Gillespie and Temple 1977).

Most (95.0% by weight) shell recovered from the pit is oyster, cockle and club whelk. The remainder is pipi (0.3%) and land snail (4.7%). Eight individual shells were identified using MNI for each XU. No vertebrate remains were recovered.

A total of 41 stone artefacts weighing 62.0g was recovered. As with the surface excavations, the two most common raw materials are silcrete and sandstone (Table 5). Most (n=36) of the artefacts are flakes or flaked pieces, the remainder (n=5) being manuports. Two small flakes exhibit fragments of bevels from bevelled pounders. No other formal implement types or fragments thereof were identified.

Table 5. Stone artefact raw materials from Site 2, Pit A.

raw material	n	wt (g)
sandstone	10	16.8
silcrete	22	36.5
quartzite	6	5.8
rhyolite	1	1.9
volcanic*	2	1.0
Total:	41	62.0

* = unidentified volcanic rock

SITE 4

Surface excavations

Surface remains were collected from 35 collection units (2x2m) on Ridges 1 and 2 (Figures 4 and 5). A total of 1723 stone artefacts weighing 21.25kg was recovered, the bulk (n=1712, 18.89kg) of which came from Ridge 1. The number of grid units containing stone artefacts ranges from 1 to 207 with a mean of 49. The maximum artefact density is $52/m^2$ in GU17 (Ridge 1), while the mean artefact density for both ridges is $12/m^2$. Artefact fracture types represented include cores, flakes, flaked pieces and retouched flakes. Ninety-seven artefacts are bevel-edged tools and constitute approximately 60.0% (by weight) of all artefacts recovered. No other implement types were recorded.

Shell dominated the faunal assemblage. A total of 8826g of shell was recovered. All grid units contained shell in amounts ranging from 0.1g (GUs 30 and 31 Ridge 1) to 4253.8g (GU26 Ridge 1). Most (98.5%) of the shell is estuarine (i.e. oyster, cockle, club whelk, mud whelk and scallop), with small amounts of pipi (0.4%) and land snail (1.1%). Only 4.0g of fragmented mammal, reptile and fish bone was recovered, most from Ridge 1. The only identifiable bones include a rodent incisor (GU12), a brush-tail possum (Trichosurus vulpecula) molar cap (GU19), a broken dasyurid mandible and a lizard vertebra (GU22), three broken fish vertebrae (GUs18, 24 and 26), two whiting (Sillago sp.) otoliths and 16 tarwhine (Rhabdosargus sarba) teeth (GUs 25 and 26). As with the Site 2 surface bone, it is unknown whether these bones were deposited by human or non-human agents.

The spatial distribution of stone artefacts and shells along the southern side of Ridge 1 (GUs 1-26) and Ridge 2 (GUs 1-4) exhibits two main patterns. First, there is a positive association between the distribution of shell and stone artefacts (Figure 6), indicating that the discard of both occurred in the same place. Second, cultural remains on each ridge fall into four major clusters, three on Ridge 1 and one on Ridge 2 (Figures 4, 5 and 6). Clusters 1-3 on Ridge 1 are represented by GUs 3-10, 13-21 and 24-26 respectively and Cluster 1 on Ridge 2 is represented by GUs 1-4. Between the major clusters on Ridge 1 there is a number of minor clusters of shell and stone artefacts. At present, the significance of the difference between major and minor clusters is unknown. Future research will be directed towards isolating the relative effects of group size, occupational duration and site function upon cluster size (see Schacht 1981).

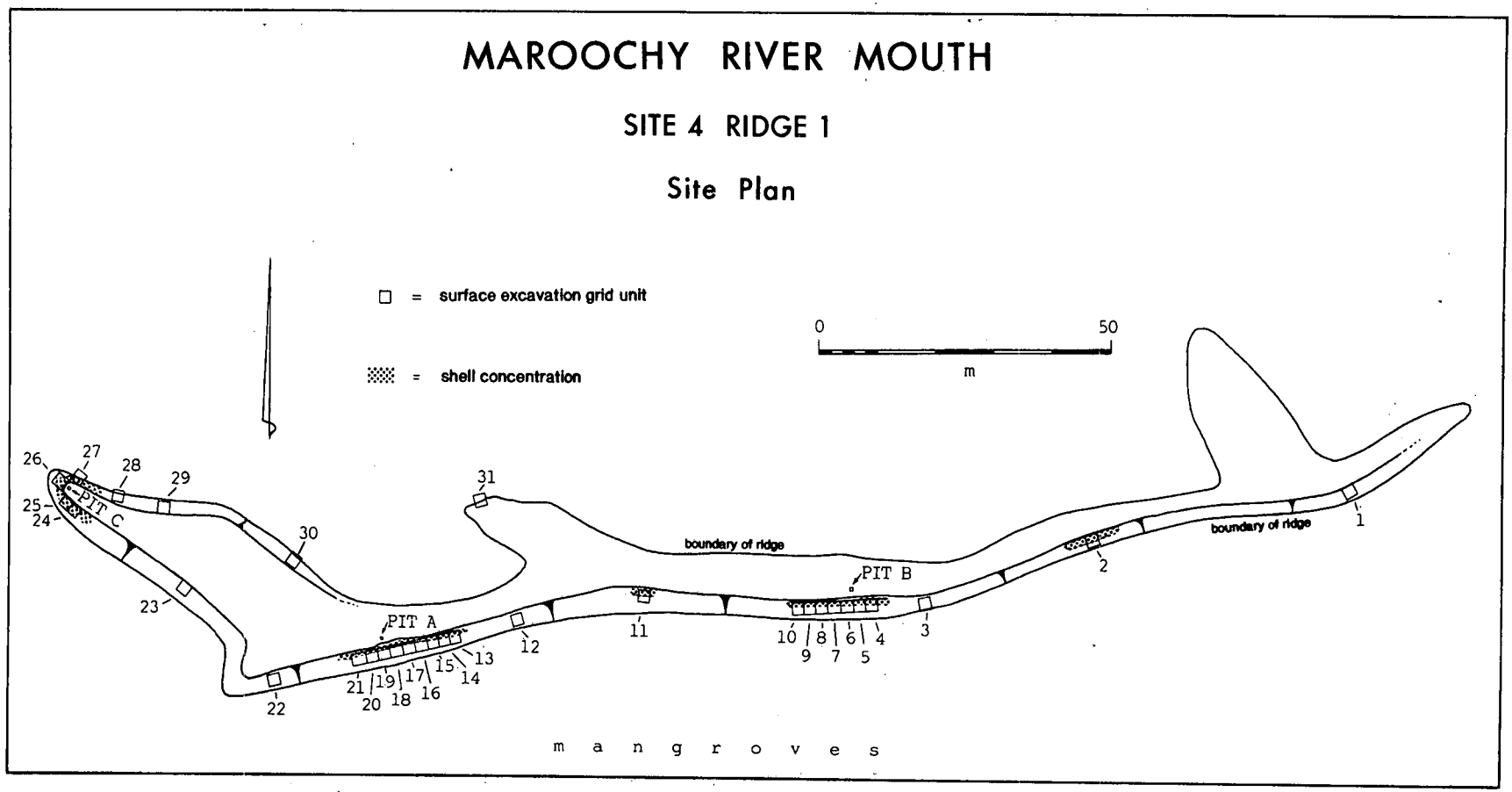

Figure 4. Map of Site 4 (Ridge 1).

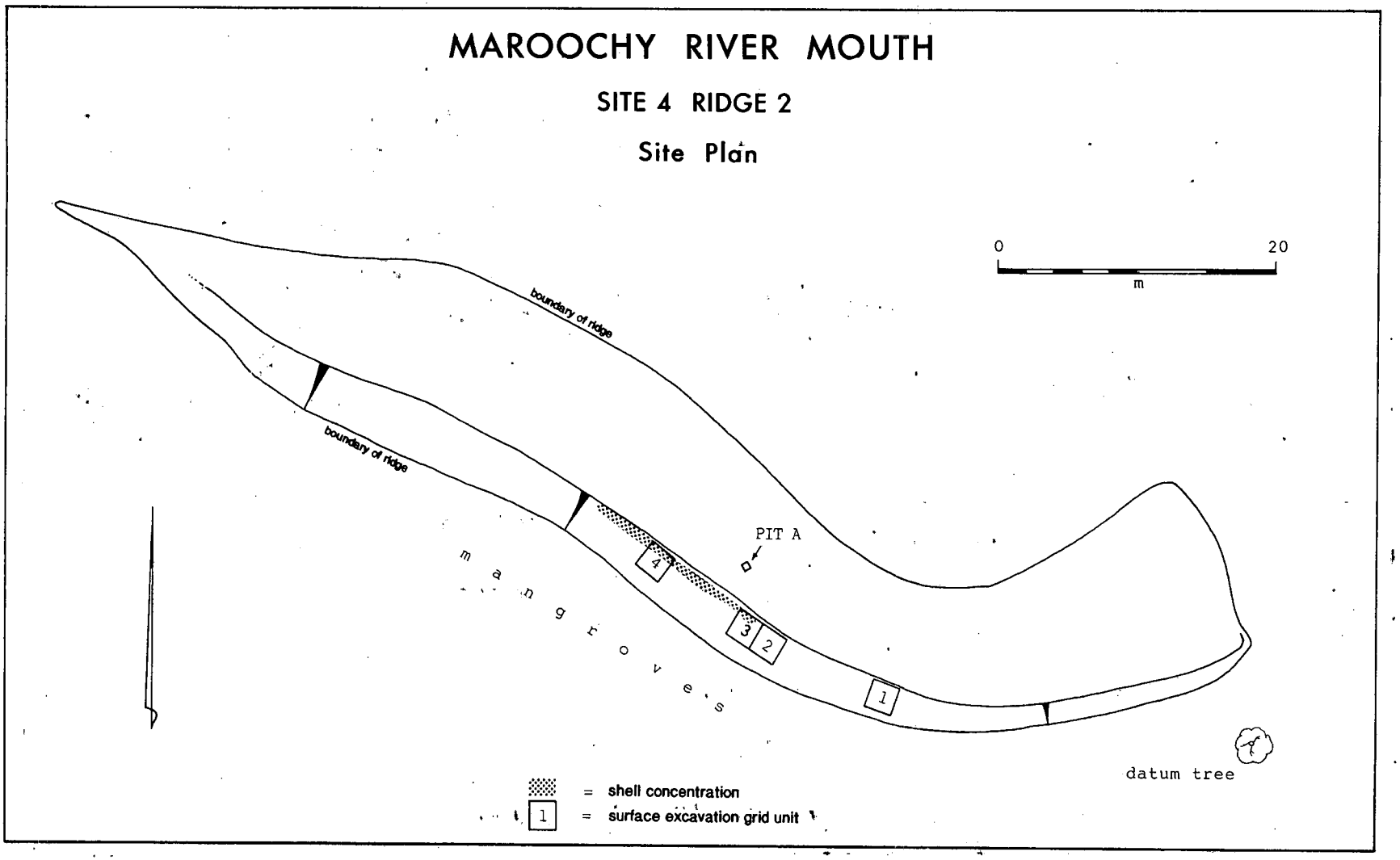

Figure 5. Map of Site 4 (Ridge 2).

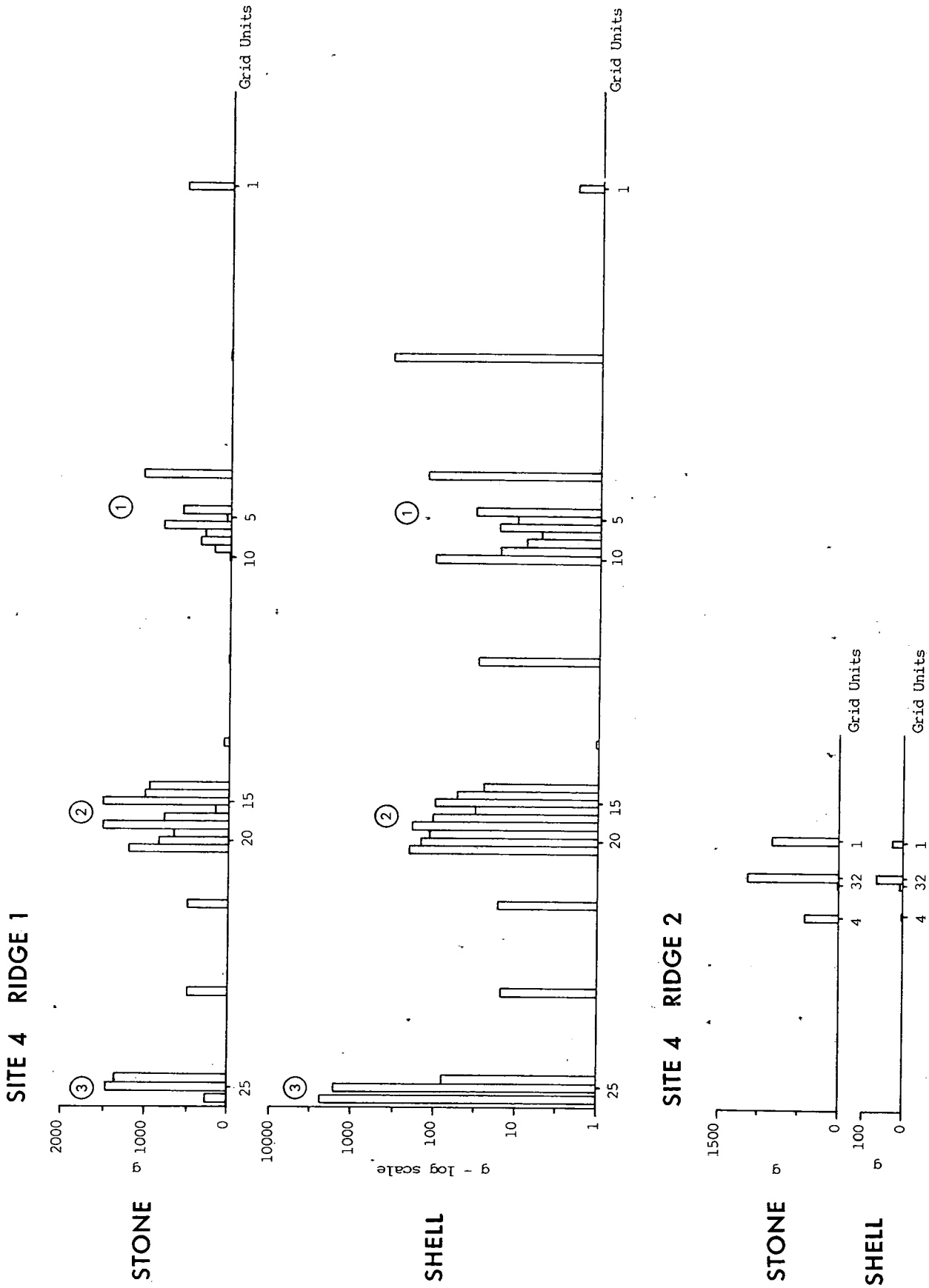

Figure 6. Changes in the relative amounts of stone and shell along Site 4 (Ridges 1 and 2).

Pit excavations

Three test pits were excavated on Ridge 1 and one on Ridge 2. All were placed in undisturbed areas towards the middle of each ridge. These excavations aimed to provide insights into the stratigraphic context and age of deflated stone artefact and shell scatters flanking the adjacent erosion face.

Pit A (Ridge 1)

This pit was dug to a depth of 59cm behind the erosion face adjacent to GU19 (Figure 4). The sandy deposit it revealed grades with depth from dark gray (10YR-4/1) to very dark gray (10YR-3/1). This trend appears to result from increasing moisture and proximity to the watertable. Sediment in the lower 20cm of the pit was moist. No stratigraphic breaks were identified.

Two major concentrations of shell and stone artefacts were found in Pit A. The first was in XUs 4 and 5 at a depth of 16-26cm and the other in XUs 7 and 8 at a depth of 31-42cm (Table 6). As the stratigraphic integrity of both concentrations appeared intact, it is probable that two chronologically separate units are represented. It is apparent that stone artefacts and shell found eroding out of the adjacent erosion face derive from one or both of these cultural units. Only taphonomic research will allow more definitive statements concerning the stratigraphic integrity of the sequence. No radiocarbon dates were obtained for the excavation.

Most (93.6% by weight) of the excavated shell is estuarine (i.e. oyster, cockle, club whelk and mud whelk), while the remainder is land snail (6.4%). Twenty-five individual shells were identified using MNI for each XU. Most (n=14) are oyster. No vertebrate remains were recovered.

Table 6. Maroochy River Mouth Site 4 Ridge 1 Pit A - weights and components.

Excavation unit (XU) (no.)	Mean XU thickness (cm)	Mean XU depth (cm)	XU weight (kg)	shell weight (g)	artefact weight (g)	pH
1	6	6	17.5	0.2	0.0	6.0
2	5	11	17.6	7.8	0.0	6.0
3	5	16	17.8	7.1	0.0	6.5
4	4	20	13.9	36.0	2.2	7.0
5	6	26	19.0	21.5	0.0	7.0
6	5	31	18.2	0.7	0.6	7.0
7	7	38	19.5	4.0	131.6	6.5
8	4	42	15.5	5.9	3.0	6.5
9	6	48	19.5	0.0	0.0	7.0
10	10	58	36.1	0.0	0.1	7.0
Total:				83.2	137.5	

Fourteen stone artefacts weighing 137.5g were recovered. As in the surface collection grids, the most common raw materials are silcrete and sandstone (Table 7). Fracture types represented include flakes (n=3), flaked pieces (n=6) and manuports (n=5). No formal implement types were identified.

Pit B (Ridge 1)

This pit was excavated to a depth of 55cm behind the erosion face adjacent to GU6 (Figure 4). In general, the sandy deposit graded with depth from very dark gray (10YR-3/1) to dark grayish brown (10YR-4/2). As with Pit A, colour change appears to result from increasing moisture and proximity to the watertable. No stratigraphic breaks were identified.

A discrete concentration of shell was found in XUs 4 and 5 at a depth of 16-28cm (Table 8). In contrast, stone artefacts were found below the shell layer to a depth of 49cm. Despite the stratigraphic separation of shell and stone artefacts, over 80% (by weight) of the shell and artefacts is restricted to a zone of 11cm depth in XUs 5 and 6. It is probable that this zone (22-33cm below the surface) represents the original stratigraphic context of most stone artefacts and shell located on the adjacent alluvial slope. No radiocarbon dates were obtained for the excavation.

Table 7. Stone artefact raw materials from Pits A, B and C Site 4 Ridge 1 and Pit A Site 4 Ridge 2.

Raw material	Ridge 1 Pit A		Ridge 1 Pit B		Ridge 1 Pit C		Ridge 2 Pit A	
	n	wt (g)	n	wt (g)	n	wt (g)	n	wt (g)
sandstone	4	2.5	1	4.1	9	16.3	1	0.1
silcrete	6	134.0	6	2.5	6	1.0	1	0.1
quartz	2	0.4	0	0.0	0	0.0	0	0.0
quartzite	0	0.0	1	0.1	0	0.0	1	0.1
volcanic*	2	0.6	5	0.9	1	0.1	0	0.0
other	0	0.0	0	0.0	6	5.0	0	0.0
Total:	14	137.5	13	7.6	22	22.4	3	0.3

* = unidentified volcanic rock

All of the excavated shell was estuarine in origin (i.e. oyster, cockle and club whelk). No diagnostic elements were found, precluding MNI calculations, and no vertebrate remains were recovered.

Thirteen stone artefacts weighing 7.6g were recovered. Once again, sandstone and silcrete are the most common raw materials (Table 7). All the artefacts are flakes and flaked pieces. Two exhibit bevels deriving from bevel-edged tools. No other formal implement types were identified.

Table 8. Maroochy River Mouth Site 4 Ridge 1 Pit B - weights and components.

Excavation unit (XU) (no.)	Mean XU thickness (cm)	Mean XU depth (cm)	XU weight (kg)	shell weight (g)	artefact weight (g)	pH
1	5	5	19.5	0.0	0.0	6.5
2	5	10	16.3	0.0	0.0	6.0
3	6	16	19.4	0.0	0.0	6.0
4	6	22	16.4	0.8	0.0	6.0
5	6	28	19.7	4.0	0.0	6.0
6	5	33	15.4	0.0	6.5	6.0
7	5	38	17.8	0.0	0.5	6.0
8	6	44	16.5	0.0	0.1	6.0
9	5	49	20.0	0.0	0.5	6.0
10	6	55	16.5	0.0	0.0	6.0
Total:				4.8	7.6	

Pit C (Ridge 1)

This pit was dug to 57cm depth at the extreme western tip of the ridge behind the erosion face adjacent to GUs 25, 26 and 27 (Figure 4). Three stratigraphic units were identified (Figure 3). Stratigraphic Unit 1 (SU1) extends from the surface to approximately 20cm and consists of very dark grayish brown (10YR-3/2) sand. Stratigraphic Unit 2 (SU2) beneath SU1 is some 20-25cm thick. It mostly consisted of black (10YR-2/1) to very dark brown (10YR-2/2) sand and contained most of the shell and stone artefacts recovered. Stratigraphic Unit 3 (SU3) lay beneath SU2 and continued beyond the base of the pit. It consisted of very dark gray (10YR-3/1) to very dark grayish brown (10YR-3/2) sand.

Although shells and stone artefacts were found throughout the sequence, the bulk of cultural remains appear to derive from a single layer focusing upon XU7, at a depth of 27-29cm (Table 9). This layer probably represents the original stratigraphic position of most cultural material found on the adjacent alluvial slope.

A 40g sample of cockle shell fragments from XU7 was submitted to Beta Analytic Inc. to establish the antiquity of the major shell layer. The resulting age in radiocarbon years is 840±60 bp (Beta-27086) (Table 4). This gives a calibrated age of 482 BP and indicates that the major shell layer was probably deposited in the late 15th century AD.

Most (93.6% by weight) of the excavated shell is estuarine (i.e. oyster, cockle, club whelk, mud whelk and scallop). The remainder consists of land snail (6.2%) and pipi (0.2%). Twenty-five individual shells were identified using MNI for each XU. The majority (n=19) are cockle and oyster. No vertebrate remains were recovered.

Twenty-two stone artefacts weighing 22.4g were recovered from the pit. Sandstone and silcrete are the most common raw materials (Table 7). Most (n=20) of the artefacts are flakes and flaked pieces, the remainder (n=2) being manuports. No formal implement types were identified.

Table 9. Maroochy River Mouth Site 4 Ridge 1 Pit C - weights and components.

Excavation unit (XU) (no.)	Mean XU thickness (cm)	Mean XU depth (cm)	XU weight (kg)	shell weight (g)	artefact weight (g)	pH
1	5	5	9.1	0.3	0.0	6.0
2	5	10	16.0	0.6	0.0	6.0
3	5	15	17.1	7.5	0.1	6.0
4	4	19	12.6	1.4	3.9	6.0
5	5	24	16.9	4.6	1.9	6.0
6	3	27	7.4	24.9	7.8	6.0
7	2	29	8.0	107.5	8.1	6.5
8	3	32	6.4	24.6	0.1	6.0
9	4	36	15.2	29.5	0.5	6.0
10	6	42	17.4	2.1	0.0	6.0
11	5	47	18.3	0.1	0.0	6.0
12	5	52	17.8	0.0	0.0	6.0
13	5	57	20.4	0.0	0.0	6.0
Total:				203.1	22.4	

Pit A (Ridge 2)

The pit was dug to 78cm depth behind the erosion face adjacent to GU3 (Figure 5). Three stratigraphic units were identified (Figure 3). Stratigraphic Unit 1 (SU1) extends from the surface to 25 cm depth and consists of dark gray (10YR-4/1) sand. Stratigraphic Unit 2 (SU2) lay beneath SU1 and was some 10-15cm thick. It consisted largely of light brown-gray (10YR-6/2) sand and contained the bulk of shell and stone artefacts recovered. Stratigraphic Unit 3 (SU3) extended from beneath SU2 to at least the watertable at the base of the pit. The sandy sediment graded from dark brown (10YR-3/3) to grayish brown (10YR-5/2) with depth.

Most shells appear to derive from a single layer in XUs 5 and 6, at a depth of 23-34cm (Table 10). Three small stone artefacts were recovered from XUs 6, 8 and 9 (Table 10). A bevel-edged tool was found in the northern wall of the pit at a depth of 28cm (Figure 3). The layer probably represents the original stratigraphic position of most stone artefacts and shell material found on the adjacent alluvial slope.

A 20g sample of cockle, oyster and pipi shell fragments from XU5 was submitted to Beta Analytic Inc. to establish an age for the major shell layer and the in-situ bevel-edged tool. The resulting age in radiocarbon years is 170 +/- 60 bp (Beta-27087) (Table 4). This gives a calibrated age of modern and indicates that the major shell layer and bevel-edged tool were probably deposited last century (Table 4).

Most (95.4% by weight) of the excavated shell is estuarine (i.e. oyster, cockle and club whelk). The remainder consists of pipi (3.4%) and land snail (1.3%). Sixteen individual shells were identified using MNI for each XU. Most (n=13) are oyster. No vertebrate remains were recovered.

Only three stone artefacts weighing 0.3g were found. They are all flaked pieces made from sandstone, silcrete or quartzite (Table 7). The sandstone bevel-edged tool removed from the northern wall of the pit weighs 280.2g.

Table 10. Maroochy River Mouth Site 4 Ridge 2 Pit A - weights and components.

Excavation unit (XU) (no.)	Mean XU thickness (cm)	Mean XU depth (cm)	XU weight (kg)	shell weight (g)	artefact weight (g)	pH
1	5	5	13.3	1.4	0.0	6.5
2	6	11	21.4	0.4	0.0	6.0
3	6	17	17.8	0.9	0.0	6.0
4	6	23	19.1	5.6	0.0	6.0
5	5	28	18.6	25.2	0.0	6.0
6	6	34	19.	13.3	0.1	7.0
7	3	37	14.2	0.9	0.0	7.0
8	1	38	3.4	0.0	0.1	6.0
9	3	41	13.3	0.0	0.1	6.5
10	6	47	16.9	0.0	0.0	6.5
11	5	52	17.8	0.0	0.0	6.5
12	7	59	27.5	0.0	0.0	7.0
13	9	68	42.3	0.0	0.0	7.0
14	10	78	10.9	0.0	0.0	7.0
Total:				47.7	0.3	

DISCUSSION

Subsistence Behaviour and Site Occupation

Faunal remains recovered from both the surface and pit excavations are dominated by shellfish. It is doubtful that the surface excavated vertebrate remains are cultural owing to their absence in the test pits. The lack of excavated vertebrate remains may be partly explained by differential preservation resulting from the slightly acidic to neutral sandy matrix. In view of the survival of shell, this potential taphonomic problem is considered to be unlikely, and the dearth of vertebrate faunal remains at Sites 2 and 4 is seen largely to reflect prehistoric subsistence activities. The dominance of shellfish remains within these sites probably reflects the operation of specialized faunal extraction activities focused upon shellfish. The dominance of oyster, cockle and club whelk in the middens indicates that shellfishing activities focused upon tidal estuarine mudflats and mangrove forests flanking the Maroochy River.

The scarcity of pipi in Sites 2 and 4 is interesting in light of the close proximity of the ocean coast. Similar patterns of shellfish exploitation in similar environmental contexts have also been reported to the north on the Inskip Point peninsula at Cooloola (McNiven 1985) and immediately to the south on Bribie Island (J. Hall pers. comm. 1988). The near absence of ocean beach shellfishing in all three situations contrasts with other ocean contexts in southeast Queensland

such as Fraser Island (Lauer 1977, 1979), Teewah Beach at Cooloola (McNiven 1985), Moreton Island (Hall and Robins 1984) and North Stradbroke Island (Durbidge 1984, Richardson 1984), where large pipi middens attest to intensive ocean beach shellfish exploitation.

The main difference between these sets of localities is that estuarine habitats are in close proximity to the former, while in the latter they are located many kilometres away. It appears that major ocean beach shellfish (i.e. pipi) exploitation only occurred in contexts far removed from estuarine environments. These differences strongly suggest that in coastal southeast Queensland during the late Holocene, estuarine habitats exerted greater subsistence 'pull' on shellfish gathering than ocean beach habitats (see Jochim 1976), probably because of the greater productivity and diversity of potentially edible shellfish in estuarine environments (see Meehan 1982, Alfredson 1984:52-55, Sullivan 1987:102).

The lack of fish bones in Sites 2 and 4 does not negate the possibility that Aborigines exploited the abundant fish in the adjacent Maroochy River. In fact, it is highly likely that intensive fishing did take place in this area, in view of the evidence for a well-developed fishery in Moreton Bay immediately to the south (Walters 1987, see also Steele 1983:177). Fish may simply have been consumed at other sites, such as Sites 1 and 3 which are located closer to the river bank (cf. Nolan 1986:92). This proposition can be tested through excavation.

The 300-500 year age difference between cultural materials from Pit C (Ridge 1) and Pit A (Ridge 2) indicates that Site 4 hosted a number of temporally separated occupational events. From the limited vertical extent of cultural materials and the limited range of activities associated with the faunal and stone artefact remains (i.e. shellfishing and plant food processing - see below) it is inferred that use of Sites 2 and 4 was mostly specialized and ephemeral.

Stone Artefact Raw Material Use

At least 10 different raw materials were used by Aborigines in the production of stone artefacts at Sites 2 and 4. All could have been procured from the immediate hinterland within 50 km of both sites. The most common raw materials by weight at both sites are sandstone (48.6%) and silcrete (18.9%) with the bulk of the remainder made up of volcanic rocks (29.2%) (i.e. quartz, trachyte, rhyolite and volcanic misc.). The dominance of sandstone in both middens contrasts with raw materials discarded at Sandstone Point midden, the nearest mainland midden site to the south of the study area with comparable data. Here quartz, quartzite and silcrete predominate while sandstone is poorly represented (Nolan 1986:79-84). A possible reason for the difference in sandstone utilization in the two areas is the quality of available sandstone. Both the Maroochy River mouth middens and Sandstone Point midden are dominated by flaked stone artefacts, with very little evidence for grinding (Nolan 1986:78). Over half of the sandstone discarded at the Maroochy River mouth middens is arkose, a very fine-grained sandstone with fair to good flaking qualities. In contrast to Sandstone Point midden, potential arkose outcrops are located close to the Maroochy River mouth (Caloundra 1:100,000 Industrial Rock and Mineral Resources Map, Geol. Surv. Qld. 1984). The lack of sandstone with comparable knapping qualities near Sandstone Point midden probably accounts for the minimal use of this raw material at that site. This situation contrasts

with that at Teewah Beach Site 26 midden, the nearest site north of the study area with comparable data. There, as with the Maroochy River mouth middens, arkose is in close proximity and dominates the flaked stone artefact assemblage (McNiven 1988).

Bevel-edged tool use

Stone artefact assemblages at Sites 2 and 4 are dominated by bevel-edged tools. These artefacts were the only formal implement type identified at both sites and represent over 50% by weight of all artefacts recovered. Clearly, activities associated with bevel-edged tools were of major significance at both sites (cf. coastal New South Wales - Sullivan 1982:85). At present, little information is available on the specific use of these implements. On the basis of studies on similar artefacts recovered from the north and south of the study area, it is likely that the Maroochy River mouth bevel-edged tools were used to process plant foods, in particular the starchy root of bungwall fern (Blechnum indicum) (Kamminga 1981, Gillieson and Hall 1982, Hall, Fullagar and Higgins 1989, Higgins 1988). The location of bungwall immediately north of the study area is consistent with such an hypothesis. Use-wear and residue analysis of the implements will allow more definitive identification of their function(s) (McNiven in press).

Late Holocene "regionalization"

Radiocarbon dates obtained from Sites 2 and 4 indicate that site usage only occurred during the last 500 years. This restriction of major shellfishing activities to the very late Holocene mirrors the general chronological patterning of midden sites found at Moreton Bay to the south (Hall 1982, Hall and Lilley 1987, Morwood 1986, Walters 1989), and Cooloola to the north (McNiven 1990). It is hypothesized that these changes in settlement-subsistence activities corresponded to increasing amounts of Aboriginal activity in the study area reflecting changes in the duration of use and/or relative number of people using the area. That is, increased use of the coast placed extra productive demands on local resources including shellfish and possibly stone materials. In this connection, recent work at Cooloola has found that the exploitation of stone sources becomes more regionalized through time, implying changes in the control of resource areas by local populations. Such changes may have coincided with changes in socio-political organization which saw the development of more localized residential groups in the region similar to that recorded historically (see Steele 1983). The notion of increased "localization" or "regionalization" of groups has similarly been alluded to for the Moreton region to the immediate south (Bowen 1989, Hall and Hiscock 1988, Morwood 198, Walters 1989).

It should be noted that these suggested changes in socio-political structure, may or may not have been associated with increases in population in southeast Queensland (see Hall and Hiscock 1988, Morwood 1987) and/or increases in the productive capacity of the landscape through the expansion of existing or creation of new resource zones (Hall and Robins 1984). Future research should be directed towards establishing the antiquity of the ridge system and associated mangrove habitats at the mouth of the Maroochy River. Such insights will allow more precise inferences to be made concerning the conditions against which these such changes in discard behaviour and possibly also in socio-political structure took place.

CONCLUSION

This report has demonstrated the excellent research potential of the Sunshine Coast. The region has a rich archaeological record which should be documented and researched. It also forms an important link between Moreton Bay to the south and Cooloola immediately to the north. The need for research on the Sunshine Coast is urgent because during the past few years it has witnessed a massive acceleration of environmentally-destructive development projects. Without such work it's rich archaeological resources will be lost.

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