The shell mounds of Albatross Bay: an archaeological investigation of late Holocene production strategies near Weipa, north eastern Australia

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Abstract

This thesis presents the results of an archaeological investigation of shell matrix sites, and in particular, shell mounds sites that occur around the shores of Albatross Bay, near Weipa on the north western Cape York Peninsula, northern Australia. It is the contention of this thesis that earlier approaches to the investigation of shell mound sites in northern Australia have tended to place too much emphasis on developing long-term explanatory models that gloss over explanations for the specific roles of these unique sites in past economic systems. While long-term explanations represent important contributions, it is argued here that short-term decadal scale modelling of the production systems associated with shell mound formation and use are required in order to fully understand the significance of the mid- to late Holocene emergence of these types of sites. A focus on production – defined in a substantive economic sense – is a suitable avenue through which archaeologists can expand our understanding of the role of these features in past gatherer-hunter societies, and their broader importance on longer-term time scales

The thesis thus develops a detailed model of the production strategies associated with the formation of shell mound sites that occur around Albatross Bay, while also considering the broader significance of this model, particularly within the context of Cape York Peninsula. It presents the results of field surveys and excavations carried out around Albatross Bay by the author, as well as a detailed review and analysis of work carried out by others. It is argued that shell mounds are the result of relatively specialised production activities focussing on a very specific resource base: mudflat shellfish species. Shell mounds offered a range of unique benefits for people engaged in these specialised activities, including as camp sites and as specialised activity

areas. These events were inherently flexible in size and in terms of timing, reflecting the dynamic nature of the resource base itself; yet the flexible nature of this production strategy also enabled more regular small scale social gatherings, along with a range of social and economic benefits to participants, than would have been otherwise possible. It is proposed that these types of strategies may represent an important characteristic of the production systems employed by gatherer-hunter peoples in late Holocene Cape York.

Overall, this thesis makes a significant contribution to both our understanding of late Holocene lifeways at Albatross Bay as well as to our understanding of the broader significance of the emergence of shell mound sites in Cape York. Furthermore, it highlights the range of insights that can come from a focus on short-term modelling of gatherer-hunter lifeways alongside approaches oriented toward longer-term explanations of economic, social and environmental change.

Statement of Sources

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature   Date

Acknowledgements

A large number of people have contributed in many ways to the production of this thesis and here I would like to briefly thank them.

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In acknowledging the support, encouragement and advice I have received in the preparation of this thesis I also should state that unless otherwise acknowledged, the ideas and arguments presented here are my own. I am also solely responsible for any errors or omissions this thesis may contain.

Michael Morrison
17 September 2009

Chapter 1: Introduction

This thesis presents an archaeological investigation of the production strategies apparent in the late Holocene development of shell mounds – a distinctive type of shell matrix site – in the Albatross Bay region, near Weipa, on the north western coastline of Cape York Peninsula, northern Australia (Figure 1-1). It sets out to address two broad problems. Firstly, shell mounds are one of the most prominent components of the pre-contact archaeological record in this region and thus present an important opportunity for understanding pre-contact lifeways. Yet despite almost 50 years of sporadic archaeological research in the region, our understanding of these lifeways remains limited. As such, this thesis specifically aims to explore the role of shell matrix sites – and shell mounds in particular – within local economies by investigating the character of the production strategies associated with their formation and use.

Production is defined here following on from substantivist economic approaches (e.g. Keen 2004; Narotzky 1997; Sahlins 1972) reflecting the culturally and socially located nature of the economy in gatherer-hunter societies and the differences that exist between these and (formalist) western capitalist economies. Thus, production is understood to represent not only diet and subsistence, but also, the social and cultural dimensions of production (Ingold 1988; Lourandos 1988; Marquardt 1988). Emphasis is placed here on drawing upon archaeological data to model the types of short-term (decadal scale) dynamics of these production systems along with their longer-term (multi-century) trajectories. This focus is in recognition of arguments suggesting that as scales of analysis shift, so too do the types of patterns and dynamics observed and further, that different scales of analysis can support different perspectives on the past (Bailey 2007; Knapp 1992; Lucas 2005; Murray 1999). Hence, it is argued that a short-term perspective on archaeological data may contribute to developing new insights into shell mound phenomena.

The second major issue taken up in this thesis relates to the broader implications of models about the production strategies associated with shell mound formation. After the mid-Holocene and certainly by the late Holocene shell mound features appear on Cape York, around the southern Gulf of Carpentaria and on several of its islands, throughout coastal Arnhem Land (Northern Territory), and on the Kimberly and Pilbara coastlines (Western Australia) (Figure 1-1). Their appearance has typically been interpreted as a reflection of changing economies, however the cause of these changes have been debated. In Cape York Peninsula, some have argued that the appearance of mounds reflects the adoption of new production strategies in response to the need to increase the productive capacity of landscapes as a result of both social and demographic shifts (e.g. David 2002; Haberle and David 2004). For other regions it has been suggested that these economic changes were brought on by adaptations to broader environmental changes including increased climatic instability after the Holocene Climatic Optimum (HCO) (Bourke, Brockwell, Faulkner and Meehan 2007; Faulkner 2006) or other environmental factors (Hiscock 1999; O'Connor 1999).

The bulk of research on shell mound sites has focussed upon changes occurring at the scale of millennia or centuries; it is proposed here that without decadal-scale models of the specific character of production strategies associated with their formation, it is difficult to adequately assess the role or significance of shell mound sites in the context of longer-term trajectories of economic change. Thus the second key aim of this thesis is to explore the broader implications of shorter-term modelling of production strategies associated with mound formation at Albatross Bay. In particular, this thesis explores alternative explanations to those already posited for the onset of mound formation in the late Holocene across this vast geographic area and what this represents in terms of changing gatherer-hunter economies. In doing this, the primary case study drawn upon is that of Cape York Peninsula and the Torres Strait where substantial research into the mid- to late Holocene archaeological record provides a robust overview of longer-term trends (David and Chant 1995; David and Lourandos 1997, 1998, 1999; David, McNiven, Mitchell, Orr, Haberle, Brady and Crouch 2004; Lourandos 1997; McNiven 2006).

These two major issues are addressed via archaeological field surveys, excavations and analyses carried out by the author in the Albatross Bay region between 2002 and 2005, as well as via the critical analysis of earlier work in the region. Importantly, before moving on it is necessary to clarify the core terminology used. In part after Claassen (1998), the term ‘shell matrix feature’ is used as a generic category for all deposits that are dominated by the remains of shellfish, regardless of their morphology, density or specific composition. However, within this generic category the terms shell scatter, shell midden and shell mound are used in keeping with the conventions of other researchers investigating shell matrix deposits in northern Australia (Bailey 1999; Bourke 2000; Faulkner 2006; Hiscock 1999; O'Connor 1999; Veitch 1999b). Here, these types of sites have been consistently defined based on the density of deposit at the most concentrated 1 m^2 portion of the site. Where this area of deposit was insufficient to cover 100% of the ground surface, it is termed a scatter and conversely, where the ground surface was completely obscured by shell matrix deposit it was termed a midden. When the deposit was sufficient to form a mound (typically > 5 cm high), they were categorised as shell mounds. These categories are descriptive terms only and are not intended to imply any specific formation process. In the extant archaeological literature in Australia the term 'shell mound' is typically used to describe mounded shell matrix sites regardless of species composition (Bailey 1999; Bourke 2005; Faulkner 2006; Hiscock 2008; O'Connor 1999; Veitch 1999b) though the dominance of the species *Anadara granosa* has led some to refer to these sites as '*Anadara* mounds' (O'Connor 1999). This latter convention is not followed here in preference of the generic term 'shell mound'.

1.1 Shell mounds and the question of change in late Holocene northern Australia

Debates about shell mounds are prominent in the archaeological literature of northern Australia since, as with Albatross Bay, these sites are often prominent in coastal archaeological landscapes. Intensive research on shell mounds has taken place in north Western Australia (Clune 2002; Clune and Harrison 2009; Harrison 2009; O'Connor 1999; Veitch 1996, 1999b, 1999a), the Northern Territory (Bourke 2000; Faulkner 2006; Hiscock 1997, 1999; Hiscock and Mowat 1993; Mowat 1994; Roberts 1991), on the mainland coastline and islands of the Gulf of Carpentaria (Robins, Stock and Trigger 1998; Sim and Wallis 2008) and Cape York Peninsula (Beaton 1985; Cribb 1986; Cribb, Walmbeng, Wolmby and Taisman 1988) (Figure 1-1). Explanations of these features have varied both in terms of scale of analysis and also in terms of the role that shell mounds were considered to have in past economies; here previous work is briefly reviewed.

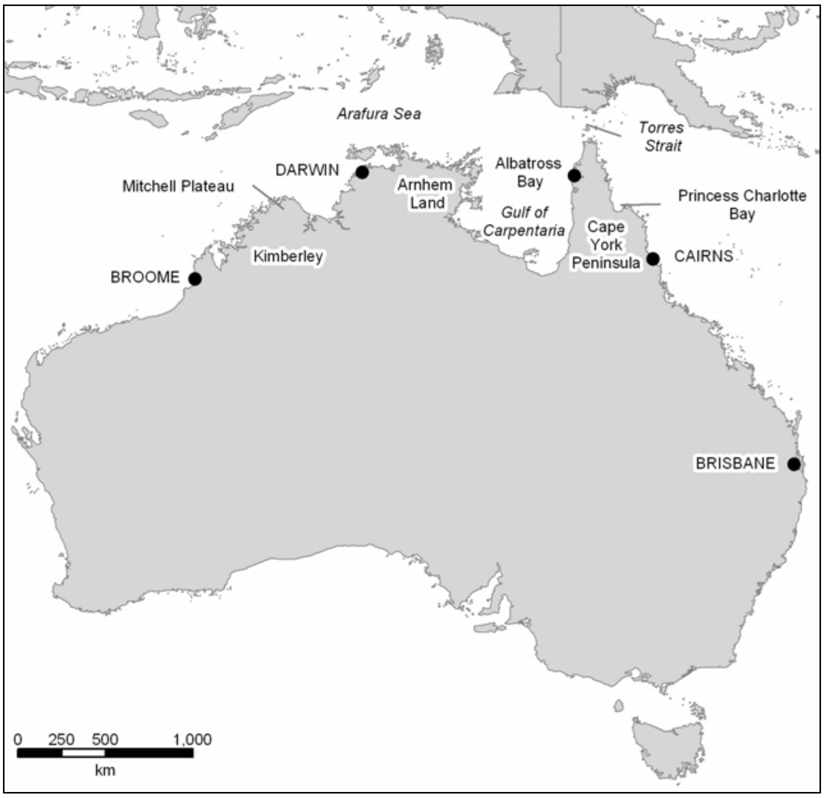

Figure 1-1: Location of the Albatross Bay study area and other places mentioned in the text

1.1.1 Long-term models

Long term patterns in the appearance and – in some areas – the cessation of shell mound building activity in the mid- to late Holocene has been a prominent issue for Australian archaeologists. The timing of the onset of shell mound formation across the north appears to be earliest in western Australia where such features appear in the Pilbara ca 4,200 BP [1] and in the northern Kimberly by ca 3,000 BP suggesting a south to north gradient in the timing of their appearance (O'Connor 1999; Veitch 1999b). Elsewhere across the north, including both in Arnhem Land and Cape York, shell mounds only appear after 3,000 BP (Bailey 1994; Beaton 1985; Bourke 2000;

[1] Radiocarbon determinations from beyond the immediate study area are cited here in the form given by the original author. The term 'BP' is given for Conventional Radiocarbon Ages (CRAs) while 'cal BP' is used for determinations that have been given in calendar years. All determinations from the study area have been calibrated and calendar age ranges at one standard deviation are cited here. Calibration methods are outlined in Appendix 1. A full table of radiocarbon data from the study area generated during research prior to this project is provided in Appendix 2.

Faulkner 2006; Hiscock 1997, 1999). Several explanations have been proposed for the commencement of mound building in these geographically disparate regions at these times, though there is a general consensus that this phenomenon reflects the emergence of new economic strategies focussed on the intensive use of shellfish with concomitant changes in population sizes, demography, settlement and mobility patterns.

Some have linked the mid-Holocene onset of mound building solely with social or demographic changes. For instance, Veitch (1999a) saw the emergence of shell mounds in the past 4,000 years on the Mitchell Plateau (north west Western Australia) as reflecting a broader shift toward economic strategies involving small organisms with extreme fecundity (*r*-selected species), including grass seeds. He argued that the development of production strategies around shellfish were part of an overall increasing emphasis on species from lower trophic levels and that this enabled larger populations to be sustained in coastal areas.

Others have argued that these changes were more likely the result of complex, long term interactions between environmental changes and associated cultural and social responses. In northern Australia there is good palaeoclimatic evidence for a period of greater biomass productivity between about 6,000 and 4,000 years ago followed by an increase in climatic variability after around 4,000 years ago (Haberle and David 2004; Shulmeister, Rodbell, Gagan and Seltzer 2006; Wanner, Beer, Butikofer, Crowley, Cubasch, Fluckiger, Goosse, Grosjean, Joos and Kaplan 2008). Haberle and David (2004), drawing on extensive earlier work across south eastern Cape York Peninsula, proposed that widespread and sustained population increases took place by 6,000 years ago. However, after 4,000 years ago increased climatic instability triggered regional demographic fissioning and the formation of smaller land owning groups. This brought on a need for these groups to develop more intensive production systems as a result of reductions in their available area for subsistence activities; in turn resulting in a broadening of the range of foods used and associated development of new production strategies. They suggested this ‘broad spectrum revolution’ included the onset of seed grinding and the use of toxic plants, along with the commencement of “…large-scale exploitation of the small marine bivalve *A. granosa* in central residential places only after 2,000-1,600 cal yr BP” (Haberle and David 2004:177). They argued these changes were ‘climatically conditioned’ because, although they had their roots in mid-Holocene environmental and climatic changes, it was social agency that drove sustained demographic and cultural changes after the impact of environmental changes had ceased.

Others have directly linked environmental shifts to the onset of mound formation. In north west Western Australia O’Connor (1999) suggested that a northward movement of the Australian monsoon resulted in the decline of previously extensive mangrove forests. The opening up of these forests resulted in increased accessibility to shellfish resources; in O’Connor’s view this factor is more likely to be implicated in the emergence of shell mounds than independent social pressures alone. Importantly, O’Connor argued that these environmental shifts may have manifested differently in specific areas and probably also saw equally varied cultural responses to them. Gross inter-regional similarities in the timing for the onset of mound formation ~ 3,000 cal BP has also recently led some to suggest that “…broader scale processes of environmental change were indeed the primary cause behind economic change during the late Holocene" (Bourke *et al.* 2007: 97). This is because prior to around 2,500 to 3,000 cal BP environmental conditions suitable for *A. granosa* did not exist (Bourke 2005; Bourke *et al.* 2007; Faulkner 2006: 284). Reasons for the incorporation of this new resource are often not explained however it is suggested that the appearance of *A. granosa* "…may have enabled a lowering of mobility levels and an increase in population size, although this was possibly only a moderate increase as the data is more suggestive of an increase in the intensity of resource exploitation and site deposition" (Faulkner 2006: 284).

A final important aspect of long term explanations of shell mounds is the recent argument that mound building activity ceased across northern Australia between around 800 and 500 BP. First proposed by Hiscock for western Arnhem Land, (Hiscock 1997, 1999) this pattern has now also been observed across the rest of Arnhem Land (Bourke 2000, 2004, 2005; Faulkner 2006, 2008) and is argued to have been associated with a dramatic reduction or complete removal of suitable habitats for mudflat bivalves from estuaries. Significantly, it has also been suggested that the Arnhem Land model provides a suitable explanation for perceived cessation of mound building elsewhere, including Albatross Bay and Princess Charlotte Bay on Cape York Peninsula. Thus, proponents of this model suggest that *A. granosa* shell mound construction represents a cultural practice whose emergence and disappearance was tied to widespread environmental changes affecting mudflat shellfish populations (Bourke 2004, 2005; Bourke *et al.* 2007; Faulkner 2006; Hiscock 1999; Hiscock 2008; Hiscock and Faulkner 2006). Hiscock and Faulkner (2006) argued that this not only caused the cessation of shell mound building but also resulted in fundamental changes in associated economic systems and – potentially –

the nature of social relations and cosmology across much of northern Australia at this time.

1.1.2 Short-term models

As can be seen from the preceding discussion, much attention has been afforded to the issue of economic changes associated with long-term trends in shell mound formation across northern Australia. Modelling the short-term character of these production systems has been less of a focus and issues such as the specific role or function of mounds, economic scheduling or associated settlement patterns are often only considered in general terms. O'Connor also observed this problem:

> Lastly, there is the question of what the presence of mounds actually means. This question remains outstanding regardless of whether we believe that the lag between sea level stabilisation and the appearance of mounds is a reflection of environmental or cultural change. It is a question that has been discussed at length by Bailey…but in terms of attempting to answer it through the archaeological record, as opposed to resorting to ethnography, we are not much closer to a solution (O'Connor 1999:48)

Modelling of the activities associated with shell mound sites in Arnhem Land are best typified by recent intensive investigations by Faulkner (2006) and Bourke (2000) both of whom present relatively different views. Faulkner (2006: 283-88) viewed shell mounds as the result of a short-lived and relatively specific production strategy heavily focussed upon what he termed 'super-abundant' *A. granosa* populations in the period around ~2,500 to 500 years ago. He suggested they were the result of intensive, short term exploitation of this resource, an argument originally proposed for mounds at Albatross Bay (Morrison 2003b). Faulkner saw this intensive focus as a response to increased environmental and climatic instability, arguing that *A. granosa* provided a more reliable and less seasonally variable resource base and was thus associated with a decrease in mobility. He noted that “variability in mound size and occupation is seen to reflect the differential variability in the availability of other resources in the area through time, such as water and vegetable foods” (Faulkner 2006: 287). Thus, Faulkner viewed the intensive exploitation of *A. granosa* as a fallback food that a relatively semi-sedentary population resorted to at times when other, preferred resources were not available. Faulkner did not consider in detail the social dimensions of shell mound production strategies or the role of mounds themselves as his work was explicitly focussed upon understanding long-term archaeological changes rather than the development of short-term models.

Bourke’s work represents a more detailed attempt to develop short term models of the production strategies associated with shell mound formation. She suggested mounds reflect an overall strategy of shellfish gathering focussed upon open mudflat bivalve species (Bourke 2000, 2004, 2005) and that the presence of small numbers of locally varying non-molluscan resources within mound deposits reflect low intensity use of other locally available resources (Bourke 2005: 39). She proposed that mounds in each of her two study areas of Hope Inlet and Middle Arm Point (near Darwin – see Figure 1-1) reflect differences in the cultural practices associated with their use. Slow accumulation rates in the Middle Arm Point mounds reflect low intensity usage by small groups who actively discarded shell in mounds in order to provide a clear living area. Conversely, she suggested that mounds at Hope Inlet – which accumulated more rapidly – indicate larger scale and more intensive use, probably by larger numbers of people. She proposed they may have been “…specialised processing sites built up through episodic aggregations of people gathered together for the purpose of ceremonial exchange [and that] this accounts for both imported stone and large, rapidly forming mounds" (Bourke 2005:43; c.f. Morrison 2003b). The reason offered for the formation of mounds was that they provided home bases during these gatherings and accumulated gradually (and unintentionally) as a result of this type of activity (Bourke 2005). Noting the monumental character of many mounds she also considered their possible symbolic dimensions, suggesting they may have been used "…perhaps as markers or monuments, built in the landscape to ensure (re)production of human and related totemic species" (2005: 43).

Bourke's model represents one of the few concerted efforts toward short-term modelling of practices associated with shell mound formation in Australia and other explanations of mounding phenomena elsewhere are far less specific. In the southern Gulf of Carpentaria at Bayley's Point for instance it has been suggested that 'cultural rules of discard' are implicated in the formation of mounds however the authors do not go on to elaborate on these rules in any detail (Robins *et al.* 1998). Similarly, Beaton suggested that shell mounds at Princess Charlotte Bay along the eastern coastline of Cape York Peninsula "…are one depositional aspect of an economy that was very heavily focussed on intertidal resources and centred on one species, *Anadara granosa*" (Beaton 1985: 9). Significantly, he outlined a shell mound developmental model which attempted to explain cultural and geomorphic factors that contributed to their formation highlighting how factors such as aeolian silt, leaf litter and patterns of human use contribute to the distinctive alternating layers within mound sites. However this model is also not specific in terms of the short-term character of these production systems. Cribb (1996) developed a similar preliminary model for mounds at Aurukun also on Cape York Peninsula however this was not supported by any data on mound chronology or composition. In summary then, research into mound formation in north west Australia has addressed in detail the issue of long-term patterns in shell mound formation however this work has yet to take up shorter-term modelling as a serious research question (O'Connor 1999).

1.1.3 Research questions: the bigger picture

The primary aim of this thesis is to articulate a model to explain the character of production systems associated with shell mound formation at Albatross Bay, however this does have relevance to broader debates. In particular, the thesis also sets out to explore the implications of short-term, decadal scale modelling of production systems in the context of longer-term models. For example, in what ways can shorter-term models inform our understanding of longer-term changes in population size, demography, economy and society or the mid- to late Holocene appearance of shell mound phenomena more broadly. In this regard, Cape York Peninsula is used as the primary case study here because of the depth of previous archaeological research and the availability of relatively robust models of mid- to late Holocene trends.

1.2 The study area

Albatross Bay is located on the western coast of Cape York Peninsula in northern Queensland (Figure 1-1) adjacent to the towns of Weipa and Napranum (formerly Weipa South). It is the largest embayment on the western Cape York coastline and provides an extensive area of relatively calm sheltered waters compared with the adjacent seas of the Gulf of Carpentaria. Four major rivers flow into the bay; the Hey, Pine, Embley and Mission, with the latter two extending many kilometres inland, dissecting an extensive low relief tertiary-era plateau. The area is located well within the tropics and has an environment similar to that which occurs throughout northern Australia: hot monsoonal summers between November and March alternated by a long, warm to hot yet basically dry period during the remainder of the year. Vegetation in the region is typically *Eucalypt*-dominated open woodland.

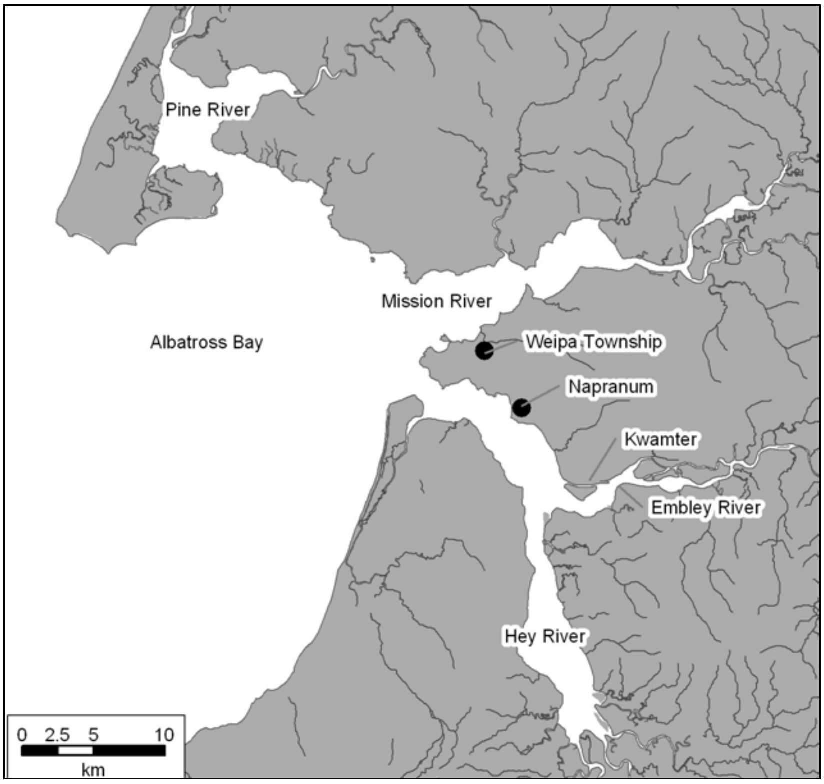

Figure 1-2: The Albatross Bay study area showing places mentioned in text

There has been a longstanding broader interest in shell mound sites around Albatross Bay, partly as a result of their physical prominence (Bailey 1994; Claassen 1998; Hall and McNiven 1999; Waselkov 1987). There are an estimated 600 mounds, of which 300 have been recorded with their shellfish composition by all estimates comprising 80-90% or more of the cockle, *Anadara granosa*. Some mounds are known to be as much as 14 m in height and 150-200 m in length (Bailey 1994, 1999) however, overall only a small proportion of mound sites are this spectacular: the sample area is vast and past research has shown that the majority of sites are less than 1 m in height and 30 m in diameter (Bailey 1994). Less prominent shell scatters and middens are also common.

The question of the origin of these shell deposits has been widely debated since they were first reported by the ethnographer Roth (1901) who observed the remains of huts and campfires atop several along the lower reaches of the Embley River. Preliminary theories proposed in the late 1950s and early 1960s were that mounds were either of natural origin and associated with changing sea levels (Stanner 1961) or of human origin (Valentin 1959). Systematic archaeological research in the region designed to contribute to the mound origin debate commenced with Wright in the 1960s (Wright 1963, 1971) who, having excavated several mounds, argued they were of human origin. Wright's work was followed by that of Bailey in 1972 (Bailey 1972, 1975b, 1975a, 1977) which involved extensive surveys on the Embley and Hey Rivers during which he recorded over 300 sites and excavated a 1 m^2 test pit on a single large shell mound at an area known by Traditional Owners as *Kwamter*.

Apart from what seems to have been a substantial but largely unpublished program of field research by Beaton in the early 1980s (Beaton 1984; see also Stone 1995) little new work was carried out until the early 1990s. This phase of research took place in response to claims that the shell mounds were natural deposits heaped up by a bird, the yellow footed scrub hen (*Megapodius reinwardt*), in order to create incubation nests for their eggs (Stone 1989, 1992, 1995); this argument was later modified to include scraping up of pre-existing anthropogenic shell deposits. These claims prompted publication of much of the data resulting from Bailey's original period of fieldwork (Bailey 1993a, 1993b, 1994) along with data obtained during new field investigations conducted in 1993 (Bailey 1994).

In recent years the commencement of mining-related cultural heritage surveys in the region has seen a dramatic increase in knowledge about local archaeological landscapes and has signalled a range of new research opportunities (Shiner and Morrison 2009). The most significant contribution of this work so far has been the recording of a wider range of sites including stone artefact scatters and earth mounds.

1.3 Shell matrix sites and gatherer-hunter production strategies at Albatross Bay

The 'self-selecting argument' is the prevailing explanatory model for shell mound formation and use and was first proposed by Bailey (1977). He suggested that shell mounds were the result of the discard of shellfish collected during the wetter months as part of a broad-based foraging strategy employed by small family groups using a range of locally available resources such as shellfish, fish, crustaceans, birds, mammals and reptiles. He interpreted mounds as residential base camps, a view partly drawn from ethnographic observations from both the western Cape York area (e.g. Thomson 1939) and the Northern Territory where low earth mounds were still used for such purposes into the 20th century (Peterson 1973). Bailey considered that existing shell deposits attracted repeat habitation because their raised surfaces provided a dry living area on substrates that were at least waterlogged, if not flooded during the wetter months. It was envisaged that larger clusters of mound sites developed as a result of people moving between specific locations in response to prevailing local weather conditions: during windy periods or times of heavy rainfall people would occupy sites that were within sheltered woodland, only moving to more exposed mounds when conditions improved. Over longer periods of time these types of local, short-term dynamics saw the formation of a range of different sized mound deposits often forming large clusters within geographically constrained localities.

More recently Morrison (2000, 2003b) argued that the self-selecting argument does not convincingly explain the archaeological patterns in mound formation in the region. He cited several factors that point to the possibility that mounds were not residential base camps: the almost total lack of resource types other than *A. granosa* shellfish remains; a tendency for many mounds to occur on well-drained, flood-free substrates (such as dune ridges) where a mound would provide no functional advantage, at least in respect of waterlogged ground; and finally, examples of closely spaced mounds in clusters where movement between different sites would not provide access to different resources, or for that matter provide a more or less sheltered camp site.

Morrison (2003b) proposed a preliminary alternative archaeological model positing that shell mounds were in fact specialised resource sites, rather than general-purpose residential bases. He suggested they were associated with specific yet dynamic production strategies timed to take advantage of local gluts of *A. granosa*, a species prone to forming large biomasses under suitable environmental conditions. Like Bailey, Morrison viewed the shell mounds as a long-term record of short-term dynamics in the way they were used and attempted to model the nature of these short-term dynamics. He proposed that local availability of these shellfish on a year-to-year basis as well as socio-political factors were likely influences on the location, duration and timing of these specialised resource gathering events. Ethnographic and anthropological sources were used to highlight examples of potential socio-political factors that may have relevance to interpreting the archaeological record at this short-term scale.

Morrison’s model presented a relatively different view of shell mounds as specialised resource sites rather than general purpose occupation areas; however it was substantially limited by a lack of detailed supporting empirical data. Furthermore, this model lacked any specific details on the types of activities associated with the formation of mounds themselves. For example, no explanation was provided for the deposition of shell in mounds or for the frequent tendency for mounds to occur as part of clusters. It is argued here that further consideration and refinement of either Bailey’s or Morrison’s model – or development of other models – and advancement of our knowledge about the prehistory of the region as a whole is difficult without the benefit of a wider range of data.

There are four specific areas where current archaeological data about the shell matrix sites in the region are lacking and these represent key avenues for exploring further the issue of the production strategies associated with the formation of such sites. Firstly, while spatial data about shell matrix sites in the region is detailed owing to Bailey’s extensive program of field surveys, two key gaps remain: several large geographic areas, most notably the Mission River, were not included in Bailey’s survey; and secondly, his data lacks accurate coordinates for specific sites which therefore limits its usefulness for analysis using modern geographic information systems (GIS) software. Site survey and recording carried out as part of the research described in this thesis aimed to expand and refine the picture of shell matrix site distribution to complement earlier work by Bailey and to allow some of the latter to be incorporated into a database for GIS analysis. This is important because exploring spatial data to identify possible correlations between site size or morphology and substrate type, proximity to contemporary shorelines and so on may help to reveal other factors associated with the formation and use of these sites.

Secondly, detailed compositional data has so far been published for only one shell matrix site in the region (*Kwamter*) and as a result we have very little understanding of the potential variability in shell matrix site composition. There is, for example, a distinct possibility of spatial and temporal variation in mound composition within mound clusters or across different types of environments. Knowing this is fundamental to critically evaluating arguments that mounds were specialised resource sites or that they reflect a more generalised production strategy targeting a broader range of local resources. Documenting mound composition therefore offers a crucial insight into the production strategies associated with their formation and use. To this end, excavations carried out as part of this project aimed to obtain controlled samples from a range of shell matrix sites in several clusters to understand possible temporal and spatial variations in composition at the local level.

Thirdly, tightly constrained and extensive temporal data are crucial to questions about the production strategies associated with mound formation and use. They add depth to compositional and spatial data by allowing more subtle temporal trends to be defined within the broader period of time over which shell matrix sites formed at Albatross Bay. This includes both regional patterns in mound development, as well as trends occurring within particular sites and groups of sites. The general intent of the excavations undertaken as part of this research were twofold: firstly, to understand broad temporal patterns in site accumulation across specific ‘clusters’ of sites and to relate this, where possible, to late Holocene changes in shoreline locations; and secondly, to obtain sufficient compositional data from a range of shell matrix sites to document inter- and intra-site variations in site discard patterns and site function. Analysis of the diversity and abundance of non-molluscan faunal remains was also a key aim given recently raised questions regarding the limited range of non-molluscan fauna represented in these sites (Morrison 2003b). Given the overall focus here on shorter-term modelling, greater attention has been placed on understanding temporal trends within particular locales rather than attempting to define long-term regional trajectories.

Fourthly, western Cape York Peninsula has a rich and extensive ethnographic and historical record detailing aspects of the character of Aboriginal societies and economies in the region at the time of contact. Some recent attempts have been made at exploring the relevance of this to archaeological data (Morrison 2000, 2003b) and Bailey (1977) also drew on Thomson’s (1939) work to develop his self-selecting argument. Recently the relevance of ethnography to the interpretation of shell mounds across northern Australia has been dismissed on the basis that there is a 600 year hiatus between the end of shell mound formation and ethnographic accounts (Faulkner 2006; Hiscock 2008; Hiscock and Faulkner 2006). For example, Hiscock and Faulkner argued that “…recent cultural, social and symbolic statements of these places cannot inform us of the process or ideology of the formation of *Anadara* mounds” (2006: 220), warning against the ‘naïve’ use of ethnography in archaeological interpretation because the production systems associated with shell mound formation have no contemporary ethnographic equivalent. This represents a key issue taken up here for several reasons. Firstly, it is far from certain that such a temporal hiatus even exists at Albatross Bay and therefore to universally dismiss the role of ethnographic data is to place a considerable constraint on archaeological analysis and modelling. Furthermore, ethnographic data plays an important role in terms of bridging archaeological narratives with contemporary community narratives and can be used "..to create a history that extends seamlessly from the present or near-present into the deeper past" (McNiven and Feldman 2003). The position taken here is that it is more constructive to critically evaluate ethnohistoric sources and their role in archaeological interpretation rather than universally dismiss them; such an approach has also been taken up elsewhere in the region in recent years (David and Wilson 1999; McNiven and Feldman 2003). There are important methodological and theoretical issues in regards to the role of ethnohistory in archaeological interpretation and some of these are taken up here using ethnographic data from western Cape York Peninsula.

1.4 Structure of the thesis

The thesis is divided into three broad sections. The first, comprised of Chapters 2 to 4, describes the context within which the research at Albatross Bay was undertaken. Chapter 2 describes the climate and environment of the study area and Cape York more broadly during the Holocene as well as outlining the character of contemporary environments. Chapter 3 reviews the history of the study area since the mid-1800s and also draws upon anthropological accounts of societies near Aurukun, to the immediate south of Albatross Bay, to develop a generic model of the character of production systems on western Cape York during the early contact period. Finally, Chapter 4 provides a detailed overview of previous archaeological research at Albatross Bay and then places this within the regional context by reviewing data and models relating to the mid- to late Holocene period in Cape York and the Torres Strait.

The second major section of the thesis presents the results of field investigations carried out as part of this research, incorporating where appropriate relevant work of previous researchers. Chapter 5 outlines the methodologies used for field surveys and excavations, as well as those used to compile survey data relating to the region into a single database. Chapter 6 presents field survey results along with results of earlier work, and principally sets out to describe and analyse the distribution of shell matrix sites across the study area. Finally, Chapters 7 and 8 present the results of excavations carried out at two locations known to Traditional Owners as *Prunung* and *Bweening*.

The final section of the thesis comprises three chapters. Chapter 9 draws on archaeological data presented in Chapters 6 through 8 to develop an explicitly archaeological model of the production strategies associated with shell mound formation at Albatross Bay. Chapter 10 sets out to build upon the model developed in Chapter 9 by drawing upon insights provided by ethnographic data presented in Chapter 3, and concludes with a detailed discussion of the broader implications of this model. This includes exploring the broader significance of the model proposed in Chapters 9 and 10 in terms of the appearance of shell mounds in Cape York and across northern Australia in the late Holocene. Chapter 11 concludes the thesis by summarising key arguments presented and also discusses prospective avenues for further work in the region.

Chapter 2: The study area

This chapter provides a detailed introduction to the Albatross Bay study area within its regional setting, Cape York Peninsula. It begins with a discussion of contemporary environments of the Cape York and Albatross Bay areas before discussing in more detail the current range of evidence regarding the character of regional environments throughout the Holocene. This includes consideration of post-glacial sea level changes, coastal dynamics – particularly in the late Holocene – and finally, climate and vegetation.

2.1 Contemporary environments

Cape York Peninsula is located well within the Australian tropics with daily annual average temperatures ranging between 21 – 23° and 30 – 33° (Anon. 2007b, 2007c). The region also has some of the highest rainfalls in Queensland with over 1,600 mm falling annually over northern Cape York (incorporating the study area) while the central and southern regions receive 800 to 1,200 mm annually (Anon. 2007a). An important feature of these rainfall patterns is their extreme seasonality; the bulk of rainfall occurs between the months of December and April in a period known as the 'wet season' with very little rain falling throughout the remainder of the year, or the 'dry season'.

Figure 2-1 illustrates geological regions and landforms of Cape York Peninsula. Extensive low-lying plains dissected by numerous watercourses that drain into the Gulf of Carpentaria occur west of the Great Dividing Ranges. This area, known as the Carpentaria Lowlands, has a more recent geological origin with extensive sedimentary deposits formed by erosion (Anon. 1998). In the north these plains are largely heavily eroded lateritic plains while in the south they are predominantly alluvial in origin. The highest areas of elevation on Cape York are found within the Great Dividing Range and these ranges comprise most of the Coen geological region where extensive occurrences of igneous and metamorphic rock occur. The Quinkan geological region in south east Cape York is characterised by distinctive, dissected sandstone plateaus and tablelands (Anon. 1998).

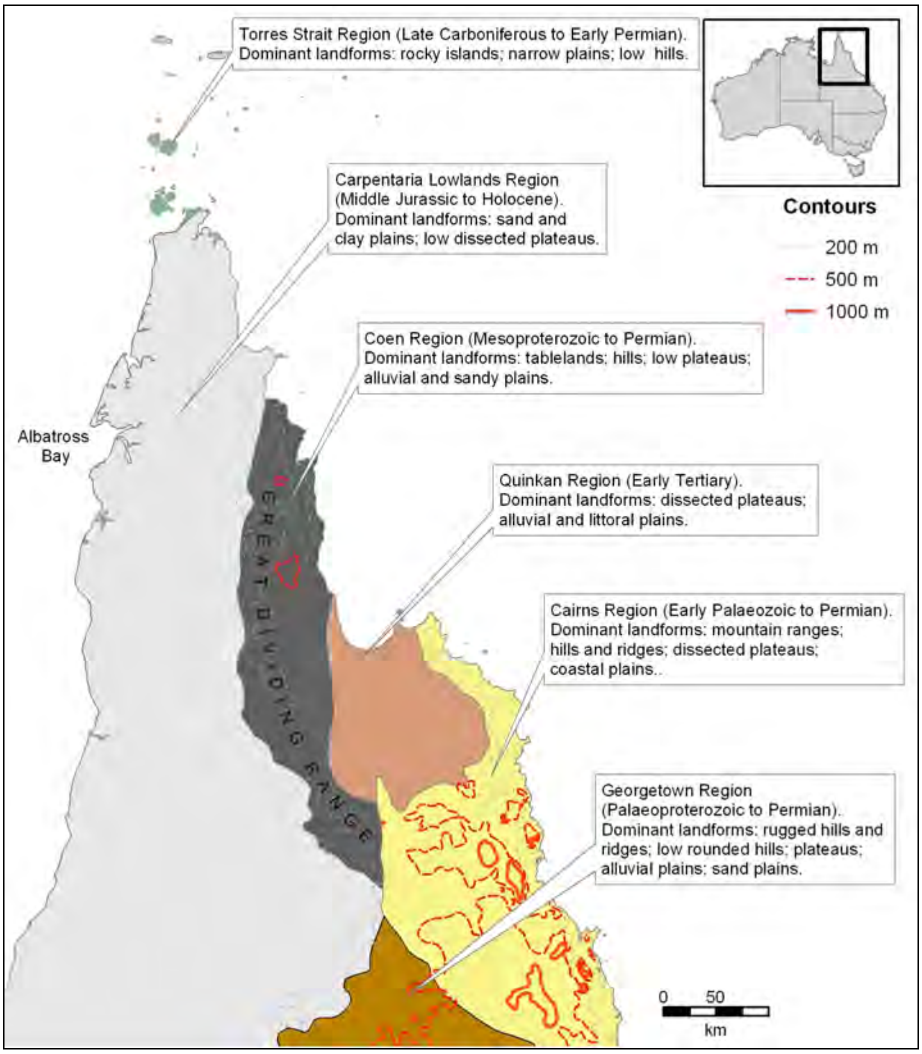

Figure 2-1: Geology and landforms of Cape York Peninsula
(data from Anon. 1998)

Cape York Peninsula is host to numerous unique and complex vegetation areas and Figure 2-2 highlights the dominant vegetation communities according to tallest stratum (after Anon. 2003). Based on this categorisation *Eucalyptus* is clearly the most widespread vegetation type. *Melaleuca* forests and woodlands are also well represented occurring mostly on alluvial plains in the south western region. A third frequently occurring vegetation type is simply classified as ‘mixed or other’ which are most common in the north east and south east. This category includes rainforest around Cairns and notophyll or mesophyll vine forests on the coasts and hinterlands principally north of Coen.

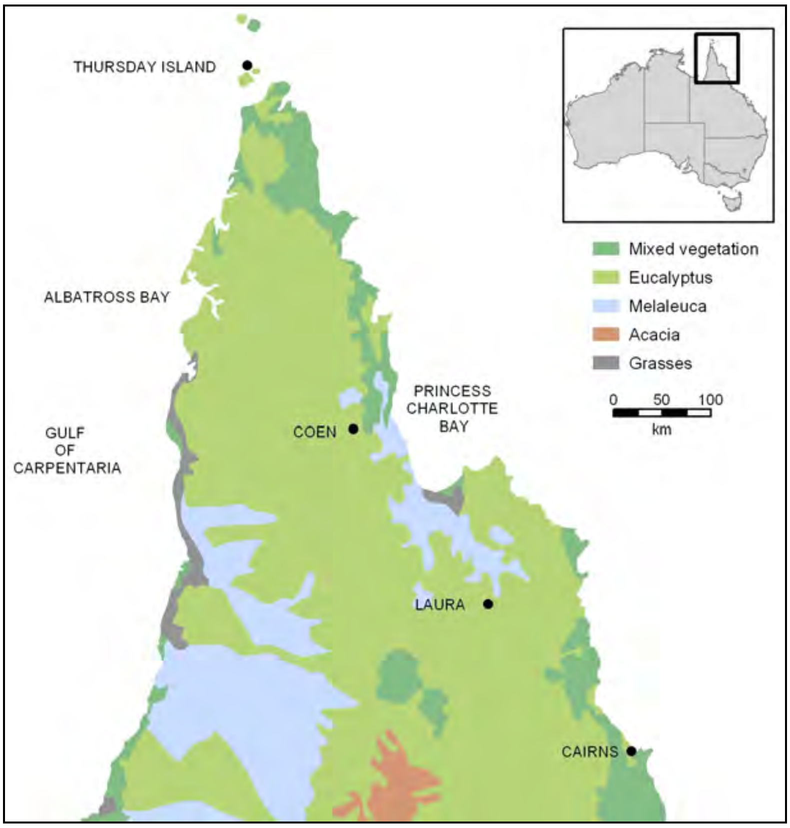

Figure 2-2: Dominant vegetation, Cape York Peninsula (1988)
(Data from Anon. 2003)

The underlying geology and prevailing weather systems have a strong influence on the character of the Albatross Bay region. The local geology is exclusively sedimentary in origin and comprised of extensive level to gently undulating erosional plains (Taylor and Eggleton 2004; Whitaker et al. 2005). Figure 2-3 illustrates land zone classifications for the study area based on Queensland Regional Ecosystem land zone classifications (Anon. 2005; Sattler and Williams 1999). As this figure shows, the most widespread land zone consists of 'old loamy to sandy plains' which in the study area are comprised mostly of Cainozoic ferruginous duricrust plateaus (Taylor and Eggleton 2004). They are locally known as 'bauxite plateaus' due to the widespread occurrence of this mineral within these deposits and this is a term used henceforth to describe them. These low relief plateaus are composed of a distinct 2-3 m deep layer of pisolitic bauxite overlying a subsoil of mottled clays of a white, pale grey or reddish brown colour; ironstones also frequently occur within and below these subsoils. Numerous narrow, shallow creeks and gullies incise the bauxite plateaus.

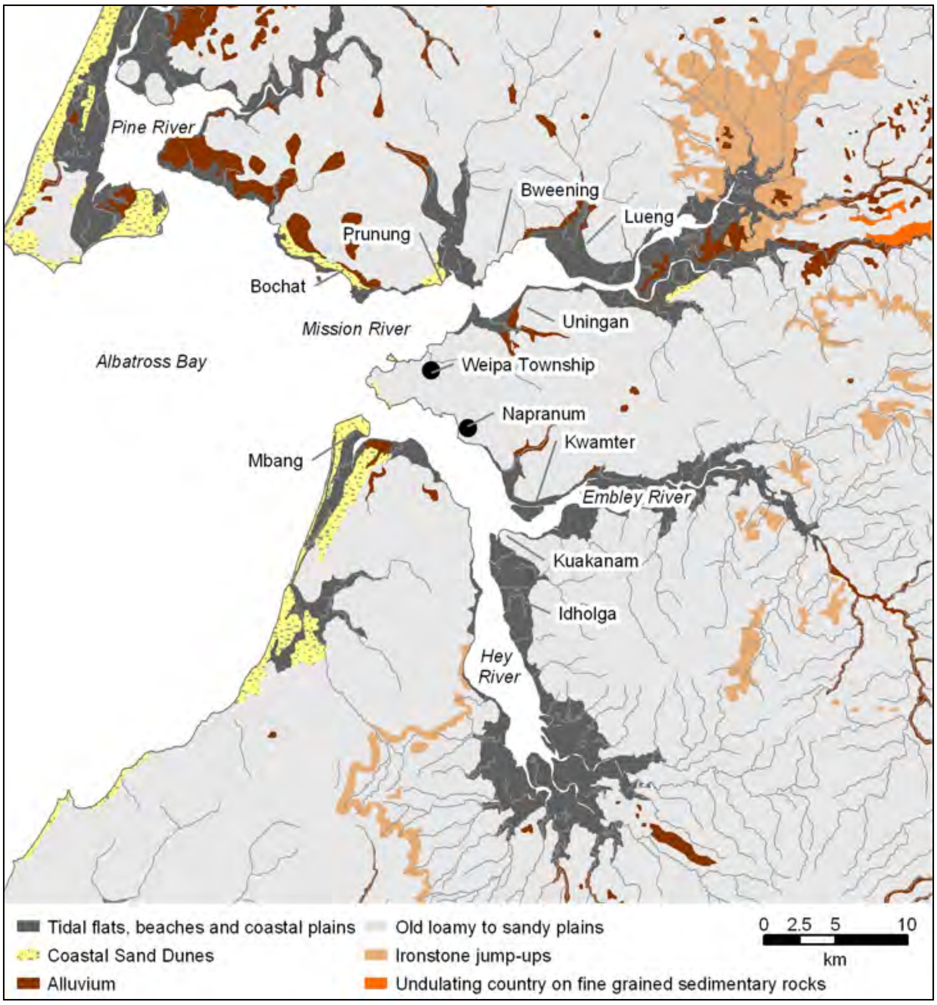

Figure 2-3: Landzones and drainage, Albatross Bay region

Other more recent regoliths have formed on incised areas of the bauxite plateaus or along their margins (Taylor and Eggleton 2004). These include alluvial deposits on many freshwater creeks or water bodies and low tidal coastal plains within more sheltered areas of the bay. Coastal sand dunes are common in areas exposed to the Gulf of Carpentaria and these include shore-parallel dunes and extensive beach ridge plains. These substrates have invariably formed at or over the eroded margins of the bauxite plateaus and the transition between these two landforms are often clearly delineated in the landscape in the form of abrupt escarpments or sudden, distinct slopes.

As with other areas of northern Australia, the weather systems of the Albatross Bay region are strongly influenced by the seasonal effects of the northern wet season (Table 2-1). During the three months before the onset of the monsoon in December or January temperature and humidity levels increase and violent afternoon thunderstorms become more frequent. The monsoon proper is typically heralded by a sudden change from southerly to north westerly winds followed by intense and often prolonged periods of heavy rainfall. It is during this period that the Weipa township receives the bulk of its annual rainfall (peaking in February), and consequently is also the period of maximum vegetation growth. After April, rainfall and temperatures drop steadily marking the start of the dry season. Wind typically changes to a southerly as the landscape begins to dry out and bodies of surface water contract or disappear. Grassfires, which remove large areas of dry wet season grasses, are relatively common and this continues until as late as December when rains recommence.

Tidal averages within Albatross Bay vary annually though no data is presently available on the specific nature of these variations. However, personal observations over the past nine years indicate that tides are highest during the wet months and much lower during the cooler dry months. It is therefore likely that seasonal increases in rainfall exert some influence on tide levels, contributing to higher tides in the wet season. Between January and April - coincident with heavy rainfall and runoff - coastal mudflats and sandbanks are rarely exposed during low tides, while during the dry season these same areas are extensively exposed. Similarly, low-lying coastal plains and saltpans are typically dry and easily traversed throughout the dry season however these quickly become flooded by as much as 1 m of water as maximum tide levels increase during the wet season and rainfall commences.

Vegetation throughout the region is classified here into 12 major types based upon Queensland Regional Ecosystem vegetation data for the region (Anon. 2005) as shown in Figure 2-4. This figure understates the complexity and variety of local vegetation communities which have been elsewhere classified into as many as 37 distinct units based on vegetation structure, species composition and substrate type (Godwin 1985).

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual
Mean maximum daily maximum temperature (° C)	31.1	30.9	31.9	34.3	35.5	35.5	33.3	32	31.1	31.8	32.4	31.9	32.6
Mean minimum daily minimum temperature (° C)	19.8	18.6	18.6	19.5	21.9	23.5	24.2	24.1	24.1	23.8	22.8	21.4	21.9
Mean 9am relative humidity (%)	74	73	70	66	62	65	76	82	87	83	77	75	74
Mean 3pm relative humidity (%)	48	44	41	37	40	47	63	72	78	70	59	52	55
Mean 9am wind speed (km/hr)	16.3	16.3	17.7	19	19.4	16.6	13	11.8	9.9	11.9	16.2	16.1	15.3
Mean 3pm wind speed (km/hr)	18.9	19.1	19.2	19.6	19.7	18.8	16.2	16	13.3	14.4	16.8	17.4	17.4
Mean monthly rainfall – (mm)	3.9	0.9	7	2.1	18.4	105.3	318.3	441	618.1	447.1	93.1	16.5	2071.8

Table 2-1: Monthly climate averages, Weipa airport 1972-2004
(after Anon. 2007b)

On bauxite plateaus within the study area open *E. tetradonta* (Messmate or Darwin Stringybark) woodlands are the most frequently occurring vegetation community. These woodlands consist of a tall (20 – 30 m) stratum of *E. tetrodonta* with generally low proportions of other tall trees and an understory of dense seasonal grasses and sparse shrubs and small trees (see Figure 2-5). Beyond the bauxite plateaus mixed open woodlands are widespread and dominant canopy species vary depending upon substrate type, slope, proximity to water and elevation. Common species within these mixed woodland communities include *Corymbia nesophilia* (Melville Island bloodwood), *Corymbia clarksonia* (Clarkson's bloodwood) *Erythrophleum* *chlorostachys* (Cooktown ironwood), *E. tetrodonta*, *E. confertiflora* (cabbage gum), *E. cullenii* (ironbark) and *E. polycarpa* (bloodwood). Thus, *E. tetradonta* dominant woodland on bauxite plateaus and mixed but regionally variable open woodland collectively are the most extensive vegetation communities with the study area.

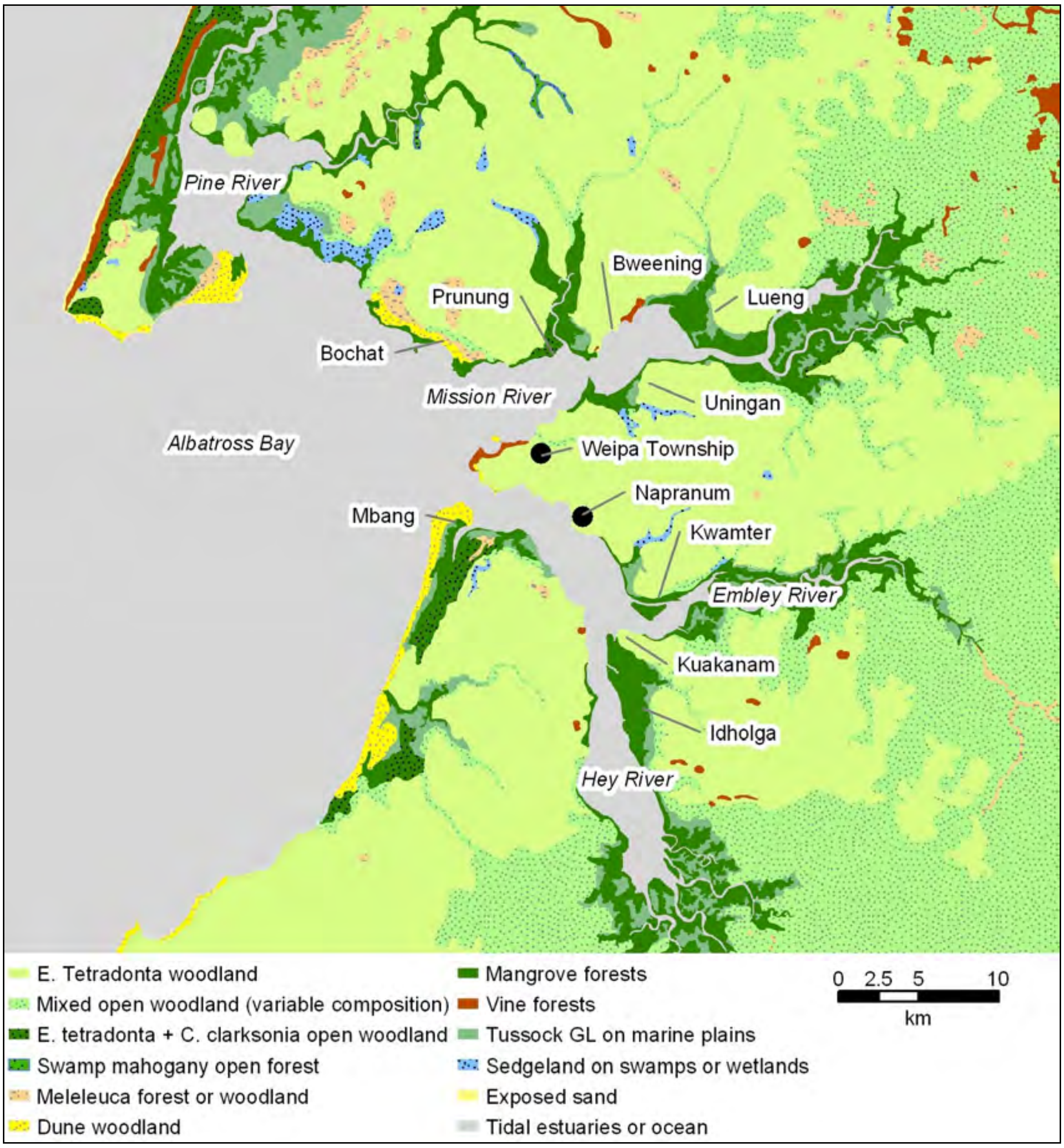

Figure 2-4: Albatross Bay ecosystems

Figure 2-5: Photograph showing a typical example of *E. tetradonta* open woodland in the study area

Melaleuca spp. forests (paperbark swamps) occur in a range of seasonal and permanent water bodies, most commonly on broad shallow depressions on bauxite plateaus or around the margins of freshwater streams and wetlands. Where they occur they tend to form shady groves though species composition varies depending upon the degree of inundation and salinity levels (Godwin 1985: 94). Within the adjacent waterbodies a range of culturally important species such as *Eliocharis dulcis* (spikerush) and *Nymphaea* sp. (water lily) can be found and canopy species including *Melaleuca leucadendron*, *M. viridiflora* (long-leaf paperbark) and *M. symphiocarpa* occupy more frequently inundated areas (see Figure 2-6). In areas that are less often inundated canopy species include various Melaleucas along with *Lophostemon suaveolens* (swamp mahogany), *Pandanus spiralis*, *Parinari nonda* (Nonda plum) as well as species from the surrounding dominant vegetation zones. *L. suaveolens* (swamp mahogany) also forms distinct forests in areas and occupy similar areas to *Melaleuca* spp., often being co-dominant.

Figure 2-6: Photograph showing *Melaleuca* spp. dominant forest near a permanent spring.

Also common around bodies of freshwater are stands of vine forest, although unusually these vegetation communities also occur in isolated locations on the bauxite plateaus within *E. tetradonta* woodlands. Godwin (1984: 93) suggested these forests are dry-adapted versions of the wetter vine forests which are common along the eastern coast of Cape York, and which are similar in general appearance (but not composition or structure) to rainforests. Common canopy species include *Canarium australicum* (turpentine tree), *Acacia polystachya*, *Ganophyllum falcatum*, *Dysoxylum oppositifolium*, *Bombax ceiba* (canoe tree) and *Alstonia actinophylla* (soap tree). Vine forests are typically rare throughout the study area.

The remaining three dominant vegetation communities occur on coastal substrates. Dune woodlands occur in areas of sand dunes or beach ridge plains and contain numerous *Acacia* spp., ('wattle') *Terminalia* spp., and *Allocasuarina* spp. (e.g. 'sheoak') forming a canopy < 10 m high. These occur in a number of areas around Albatross Bay where sandy substrates occur and are most extensive around the lower reaches of the Pine and Mission River. On the Gulf of Carpentaria coastline to the north of Albatross Bay a series of shore-parallel dune ridges occur which extend up to 1 km inland in some areas. The most seaward of these dunes are as much as 8-10 m in height and are interspersed by low-lying swales that transform into seasonal swamps during the wet season. Large stands of *Melaleuca* spp. populate these swales while dune woodland vegetation communities occupy adjacent, more elevated areas.

The coastal or 'samphire' plains and mangrove areas are highly saline environments that are completely inundated by high tides during the wet season. Coastal plains themselves sometimes support no vegetation as is the case with saltpans, though more commonly, a limited range of salt-tolerant herbs and sedges can be found (such as *Arthrocnemum* sp., *Xerochloa* sp.) (see Figure 2-7). Mangrove forests occupy the intertidal mudflats and margins of coastal plains throughout almost all of the tidal estuaries within the study area, particularly around estuary deltas. The dominant stratum varies depending upon location, sediment type, level of inundation and salinity levels (Godwin 1985). For example, in areas that are regularly inundated by freshwater originating from springs or seasonal flooding, and rarely by tides, freshwater mangrove forests occur, often in close association with salt tolerant *Melaleuca* spp. More commonly though a range of often very dense mangrove forests occur on mudflats and sandbanks which are regularly inundated by rising and falling tides.

Figure 2-7: Photograph showing example of typical coastal area that transitions from open woodland on a bauxite plateau, to coastal plain and dense mangrove forest

The fauna of the region is highly similar to those of other northern Australian near-coastal environments (Winter and Atherton 1985). The estuaries and mangrove areas are particularly rich in a number of species of rays (Dasyatidae), fishes, prawns (*Dendrobranchiata*) and crabs (including the mud crab, *Scylla serrata*), along with large numbers of saltwater crocodiles (*Crocodylus porosus*). Dugong (*Dugong dugon*) and various species of marine turtles also occur inside Albatross Bay and intertidal mudflats, sand flats and soft mangrove sediments support a range of different species of shellfish. Swamps and freshwater streams support freshwater tortoises and fishes, and small mammals such as possums, bandicoots and wallabies are common in vine forests, dune woodlands and the *Eucalypt* dominated woodlands.

Larger macropods such as kangaroos are less common in coastal areas but are more prevalent further inland within mixed open woodland. A wide range of bird life is found throughout the region and notable species include the emu (*Dromaius novaehollandiae*), ibis (*Threskiornis* spp.), jabiru (*Ephippiorhynchus asiaticus*), brolga (*Grus rubicunda*), magpie geese (*Anseranas semipalmata*) and various species of small duck. Today, various feral animals are common and these include European domestic pigs (*Sus scrofa*), wild horses (*Equus caballus*) and cattle (*Bos Taurus*), along with the ubiquitous cane toad (*Bufo marinus*), all of which have significant environmental impacts.

2.2 Holocene palaeo-environments

Sea level changes between the last glacial maximum (LGM) approximately 17,000 – 18,000 BP and the early to mid-Holocene represent a key issue in terms of understanding Holocene palaeo-environments. Generally speaking, the Holocene was a period of significant dynamism: sea level changes and climatic shifts are perhaps most notable, however significant shifts in the characteristics of coastal landforms and vegetation communities also occur.

2.2.1 Post-glacial sea level changes

Massive sea level changes since the LGM have had a dramatic affect on north eastern Australian environments rising around 120 m in ~12,000 years, consequently flooding large expanses of low-lying land. This was especially the case within the Gulf of Carpentaria where sea floors are on average only between -40 m and -67 m below current mean sea levels (Torgerson, Luly, De Deckker, Jones, Searle, Chivas and Ullman 1988). For this reason, even minor changes in sea level in the past would have caused radical alterations in the locations of shorelines around the Gulf of Carpentaria.

Voris (2000) has developed a series of maps outlining the shape of north Australian and South East Asian coastlines at various periods during the past 250,000 years. These take into account the effects of hydroisostacy and tectonic uplift and also consider the length of time that sea levels were at or above a particular contour during the past 250,000, 150,000 and 17,000 years. Voris' sea level data for the past 17,000 years are of particular interest to this study and are presented in Table 2-2. For almost 50% (8,400 years) of the past 17,000 years sea levels were at or below the -30 m contour and for 65% of the time (11,000 years) they were at or below the -10 m contours and close to current levels.

Sea level[1]	**Years**[2]	**% of time**[3]	**Years BP**
120	1,000	6	16,000
100	4,000	24	13,000
75	5,500	32	11,500
50	7,000	41	10,000
40	7,500	44	9,500
30	8,400	49	8,600
20	9,200	54	7,800
10	11,000	65	6,000

Table 2-2: Sea level heights during past 17,000 years

After Voris (2000: 27, Table 1). See also Fairbanks (1989) for original data. Note that columns 2 and 3 are reproduced from Voris and column 4 is recalculated based on Voris' data. Notes: (1) metres below current mean sea levels; (2) number of years within the past 17 ka that sea levels were at or below column 1 level; (3) percentage of years within the past 17 ka that sea levels were at or below column 1 levels; (4) time at which seas reached the levels indicated in column 1.

Data from Column 4 are plotted below on Figure 2-8 and as this shows, the rate of sea level rise was relatively steady, at about 1 m every 100 years overall and with the period of fastest sea level rise between 17,000 and 11,000 BP. Nevertheless it is likely there were significant local variations in the rate of sea level rise that are masked by the crudeness of the datasets.

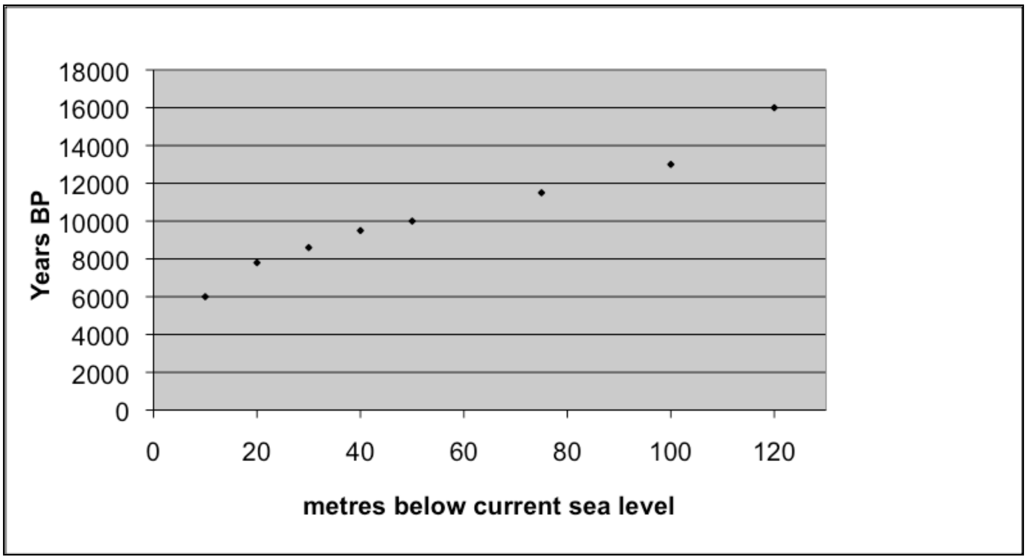

Figure 2-8: Rates of sea level rise during the past 17,000 years

Data from Voris (2000: 1154, Table 1).

In the series of figures below general changes in the locations of north Australian coastlines are shown for the periods 17,000 BP (Figure 2-9), 10,000 BP (Figure 2-10), 9,500 BP (Figure 2-11) and at 6,000 BP (Figure 2-12) when sea levels are thought to have reached approximately modern levels.

Figure 2-9: Locations of coastlines at the 120m contour at the end of the last glacial maximum, approximately 17,000 BP
(after Voris 2000 Figure 1)

Figure 2-10: Locations of coastlines at the 50m contour, approximately 10,000 BP
(after Voris 2000 Figure 1)

Figure 2-11: Locations of coastlines at the 40m contour, approximately 9,500 BP
(after Voris 2000 Figure 1)

Figure 2-12: Locations of coastlines at the 10 m contour, approximately 6,000 BP
(after Voris 200: Figure 1)

Several major studies of the sedimentary record of the Gulf of Carpentaria during the late Quaternary have been undertaken and these provide an important insight into local sea level perturbations (Reeves, Chivas, Garcia, Holt, Couapel, Jones, Cendon and Fink 2008; Torgerson, Hutchinson, Dearle and Nix 1983, 1988). This body of work indicates that from 40-12 kya the Gulf of Carpentaria was a large confined water body (Lake Carpentaria) that had formed between two sills to the west (-53 m Arafura sill) and east (-12 m Torres Strait sill). During the LGM sea levels were at their lowest at around -125 m however following the end of the LGM at around 18,000 BP an expansion of the lake to a maximum height of -59 m occurred. Transgression of the Arafura Sill by rising post-glacial seas occurred at around 12.2 cal BP with a short transitional period until 10.5 cal BP when fully marine conditions became established.

The Torres Strait and the east coast of Cape York Peninsula experienced similar levels and rates of sea level rise to the Gulf of Carpentaria however these had different local effects. The Torres Strait lies on the relatively shallow Cape York-Oriomo Inlier. The presence of this broad shelf meant that even as late as 6,000 BP a

50 to 100 km wide land bridge existed through parts of what are now the Torres Strait Islands (based on Voris 2000: 1163; see also Lambeck and Nakada 1990). It has recently been suggested that inundation occurred primary after ~7,000 BP as indicated by coral reef colonisation, but that sea levels remained + 0.8 m to + 1 m until 5,800 BP falling gradually until 2,300 BP (Woodroffe, Kennedy, Hopley and Rasmussen 2000). In contrast, on eastern Cape York Peninsula there was relatively less east-west movement of coastlines between 17,000 BP and 6,000 BP compared to the Torres Strait and the Gulf of Carpentaria. This is primarily due to the fact that the continental shelf is relatively close to modern shorelines along the eastern Cape. Even Princess Charlotte Bay – the largest bay on Cape York Peninsula's east coast – appears to have had relatively little shoreline movement when compared to Albatross Bay (see Figure 2-12).

There is increasing evidence for low amplitude sea level changes as opposed to smoothly falling sea levels throughout the Holocene. In an early review, Hopley (1983) argued there had been regional variations in maximum sea levels during the Holocene, noting evidence for up to + 3 m and + 1.5 m sea levels on Cape York Peninsula (Rhodes 1980; Rhodes, Polach, Thom and Wilson 1980) (see also Chappell 1982; Chappell, Rhoades, Thom and Wallensky 1982). Recent work by Woodroffe *et al.* (2000) in the Torres Strait supports these arguments, suggesting a mid- Holocene highstand of + 0.8 m to + 1 m at around 5,800 BP, with subsequent smoothly falling seas until around 2,300 BP as indicated by progressing reef platforms at a number of locations. Some have acknowledged that ± 0.5 m variations in the past 4,000 years may have been obscured by the standard error margin (Chappell 1983a, 1983b; Chappell, Chivas, Wallensky, Polach and Aharon 1983). A common criticism of the data used to argue for smoothly falling sea levels is based on cross-regional dating of corals, which according to some is problematic (Baker and Haworth 2000; Hopley 1982, 1983). In a recent study, Baker and Haworth (2000: 363) argued that:

> For the range 6,000-600 yr BP, data that was initially thought of as indicative of a smoothly declining sea level in response to hydro-isostatic adjustment may also be portrayed, with equal statistical justification, as often having one oscillation of up to or over 1 m in amplitude.

The bulk of their argument is based on the recalculation of sea level curves using polynomial regression rather than linear regression although they also incorporate new data from fixed biological indicators such as tubeworms. They tentatively suggest that these new curves show distinct peaks at 4,500 BP and 2,000 BP, and troughs at 3,500 BP and 1,500 BP.

More recent work on fixed biological indicators along the eastern seaboard of Australia also strongly supports a model of oscillating mid- to late Holocene sea levels (Lewis, Stephen, Wust, Raphael, Webster, Jody, Shields and Graham 2008). The authors suggested rising post-glacial sea levels had reached their maximum height only by ~7,000 cal years BP, 1,000 or so years earlier than previously thought. They identified two synchronous + 0.3 to + 1.0 m sea level oscillations (relative to present sea levels) along the eastern seaboard and into the Torres Strait, the first at 4,800 to 4,500 cal years BP and the second at 3,000 to 2,700 cal years BP. They argued that after 2,000 cal BP sea levels smoothly fell to their present heights. Importantly, they suggest these oscillations were each a few hundred years in duration and that these results are consistent with studies in both the Pacific and Atlantic.

The conventional model of smoothly falling sea levels after 6,000 BP is not preferred here in light of this recent work on fixed biological indicators which are acknowledged as being more reliable for understanding sea level changes (Lewis *et al.* 2008:74). The weight of present evidence is more supportive of ~7,000 cal year BP sea level high followed by low amplitude (< 1 m) oscillations at 4,800 to 4,500 and 3,000 to 2,700 cal years BP followed by a smoothly falling sea after 2,000 cal years BP. This has important implications for interpreting the character of the coastal archaeological landscape.

2.2.2 Late Holocene coastal dynamics at Albatross Bay

The Albatross Bay region remains poorly researched from a geomorphological perspective though a number of preliminary studies do provide useful information on late Holocene coastal dynamics in the region. Geomorphological research projects have been undertaken at five separate locations within Albatross Bay. The first geomorphological research in the region was by Hayne (1992) on the broad beach ridge plain at *Bochat* (see Figure 2-4) which indicated that accumulation of sandy sediments began here after ~2,500 BP. Hayne argued that changes in longshore sediment transport along the Gulf of Carpentaria shorelines led to an increase in deposition of sandy sediments within exposed areas of Albatross Bay at this time.

Stone's (1992: 147-48) assessment of the development of the beach ridges at nearby *Prunung* (see Figure 2-4) concluded that mangrove mudflat sediments here began accumulating in the past ~2,700 to ~ 4,500 years. At *Uningan*, which comprises a wide coastal plain backed by a narrow sandy ridge, Stone (1992: 150-53) suggested that coastal progradation primarily took place during the past 1,400 years. However, the dates on which he based this claim appear to be derived from anthropogenic shell deposits rather than the substrates themselves and are thereby unlikely to reflect the actual progradation sequence for the plain.

Bailey, Chappell and Cribb (1994) published C14 ages for marine shell samples obtained by Beaton, Chappell and Wallensky in 1984 from the *Mbang* and *Kuakanam* areas (see Figure 2-4). The *Mbang* samples were from a set of beach ridges and results suggest that these were formed after ~2,500 BP, a date consistent with those obtained from *Bochat* by Hayne (1992). Similarly, dates for the accumulation of an intertidal flat at *Kuakanam*, on the eastern banks of the Hey River, suggested accumulation commenced after ~3,500 BP.

A lack of regionally oriented studies makes interpretation of these disparate results difficult. However, at minimum this preliminary data indicates that progradation of coastal plains and sandy beach ridge plains appears to have primarily occurred within the past 3,000 to 4,000 years. This points to the likelihood that coastal plains that occur throughout the study area today are a late Holocene phenomenon.

2.2.3 Climate and vegetation

The transitional period between the end of the LGM and the beginning of the Holocene is argued to have been the driest period in north eastern Australia during the last 40,000 years or more (Johnson, Miller, Fogel, Magee, Gagan and Chivas 1999; Kershaw 1994; Kershaw and Nanson 1993; Nanson, Page, Callen and Price 1993). There are strong indications of an inactive or substantially reduced monsoon system during the LGM as indicated by reduced summer precipitation (Hope, Kershaw, van der Kaarsb, Xiangjunc, Liewd, Heussere, Takaharaf, McGloneg, Miyoshih and Mossi 2004; Johnson *et al.* 1999; Reeves *et al.* 2008; Shulmeister 1999). Evidence for these climatic conditions are evident in the vegetation record across north eastern Australia and indicate a broad dominance of sclerophyll woodland communities which are more tolerant to drier conditions (Chivas, Garcia, Van Der Kaars, Couapel, Holt, Reeves, Wheeler, Switzer, Murray-Wallace, Banerjee, Price, Wang, Pearson, Edgar, Beaufort, De Deckker, Lawson and Cecil 2001; Haberle and David 2004; Hope *et al.* 2004; Johnson *et al.* 1999; Reeves *et al.* 2008). For example, palynological data from the Atherton Tableland suggest that previously extensive rainforests were restricted to refuges and that sclerophyll woodland was more dominant (Kershaw, Bretherton and Vanderkaars 2007; Kershaw 1994). Similarly, pollen data from cores obtained in the Gulf of Carpentaria indicate that vegetation around Lake Carpentaria was principally sclerophyll woodland and grasslands (Chivas *et al.* 2001). The nearest data to the Albatross Bay study area comes from pollen cores obtained at Three Quarter Mile Lake on central eastern Cape York Peninsula, less than 250 km from Albatross Bay (2006). These reveal a hiatus in the pollen record for the period just before the Holocene and the authors suggest this is a result of its removal through increased erosion, oxidation or burning associated with drier conditions at the time.

There is strong evidence from a number of research sites that the early to mid-Holocene saw a gradual increase in effective precipitation following the arid conditions of the LGM (Johnson *et al.* 1999; Kershaw 1994; Kershaw and Nanson 1993; McCulloch, De Decker and Chivas 1989; Reeves *et al.* 2008; Shulmeister 1999; Shulmeister and Lees 1995; Stephens and Head 1995). The Holocene climatic optimum (HCO) is acknowledged to have occurred between 6,000 to 5,000 and

3,700 BP which was marked by a period of increased effective precipitation following a gradual increase from the Holocene-Pleistocene transition (Kershaw 1995; Lees and Clements 1987; Luly *et al.* 2006; Nanson *et al.* 1993; Prebble, Sim, Finn and Fink 2005; Schulmeister 1992; Shulmeister 1999; Shulmeister and Lees 1995). This is signalled in palynological data from lake sediments on the Atherton Tableland indicating maximum effective precipitation between 5,500 and 3,700 BP with a simultaneous peak in water levels at Lake Euramoo (Shulmeister and Lees 1995).

The mid-Holocene period is also associated with a well-documented expansion of mangrove vegetation, particularly *Rhizophora* mangroves and this has been termed the 'Big Swamp Phase' (Woodroffe, Thom and Chappell 1985). This phase has been best documented in the Alligator River region in the Northern Territory between 6,800 and 5,300 BP and is marked by a period of infilling of river valleys with marine mud and sands which were subsequently colonised by mangroves (Clark and Guppy 1988; Woodroffe 1993; Woodroffe, Chappell, Thom and Wallensky 1989; Woodroffe *et al.* 1985). As Allen argued (1996), this saw mangrove dominated forests covering much larger areas than in subsequent periods, rapidly colonising extensive, newly forming coastal plains. Although the coastal plains and flood plains remained, mangrove forests had retreated seaward by 4,000 BP (Woodroffe 1988, 1993; Woodroffe *et al.* 1989; Woodroffe *et al.* 1985). Although some have suggested the Big Swamp Phase is most likely only a feature of larger north Australian river systems (Crowley 1996), evidence for an increase in *Rhizophora* mangroves in pollen records at a number of locations have led some to suggest this phase was more widespread (Luly *et al.* 2006; Rowe 2007). Rowe (Rowe 2007:98) suggested that mangroves had been present at three major islands in the Torres Strait from 7,000 BP but that *Rhizophora* dominant forests underwent “extensive expansion” between 6,000 and 3,000 BP. She also pointed to a number of recent studies that indicate a regional Big Swamp Phase during mid-Holocene times at a number of sites ranging from the southern coast of Papua New Guinea and as far south as Innisfail, near Cairns.

There is strong evidence for more variable climatic conditions after around 3,000 to 4,000 BP and more frequent and severe ENSO events in northern Australia. It has recently been suggest this was associated with a decrease in solar irradiance after 5,500 cal BP in the northern hemisphere and a corresponding increase in the southern hemisphere: the global effect of this was a southward movement and weakening of the Inter Tropical Convergence Zone (ITCZ) and the Afro-Asian monsoon system (Shulmeister *et al.* 2006; Wanner *et al.* 2008:1819). A number of regional proxy records indicate an onset of increased variability after this time, including relatively rapid onset of aridity in some regions of northern Africa and Mexico at 4,200 and 3,800 cal years BP respectively (Wanner *et al.* 2008: 1819). Decreases in effective precipitation have been noted to occur in Australia (south and north) and New Zealand between 5,000 BP and 4,000 BP after the mid-Holocene HCO (Shulmeister 1999).

In the Pacific region both proxy datasets and simulations indicate increased ENSO activity from 5,500 cal years BP after gradually increasing since the early Holocene. A recent review of evidence from across the Pacific points to increased ENSO activity and strength throughout the Holocene as a result of seasonal (summer) reductions in Pacific trade wind intensity (Shulmeister *et al.* 2006). Recent reviews also implicate other factors such as changes in oceanic circulation involving the Indo-Pacific Warm Pool (Donders, Wagnercremer and Visscher 2008) – including circulation changes bought on by tectonic events (Hope *et al.* 2004) – or atmospheric warming and cooling associated with heat differences between land and sea (Walker Circulation) (Shulmeister 1999). There is however broad recognition of increased climatic variability brought on by stronger ENSO events during the past 5,000 years. In southern Ecuador this is suggested to have occurred between 3,000 and 1,200 BP (Moy, Seltzer, Rodbell and Anderson 2002). In the Australasian region such changes appear from 4,000 BP and the highest amplitude events are evident in pollen records after 3,000 BP, particularly in Australia and New Zealand (see also Donders, Haberle, Hope, Wagner and Visscher 2007; Donders *et al.* 2008:577; Smith, Williams, Turney and Cupper 2008).

Climatic changes which resulted in less effective precipitation see a broad trend toward more open sclerophyll-dominant across northern Australia and increasing prevalence of fire (Hope *et al.* 2004). Although no pollen record exists for the immediate study area, work within the broader region is of high relevance. On the Atherton Tablelands in far southern Cape York Peninsula sclerophyll woodlands become more dominant after 5,900 BP (Hiscock and Kershaw 1992; Kershaw *et al.* 2007), however late Holocene records for this area appear to be low in resolution or have not been the subject of significant attention (Rowe 2007). Three-Quarter Mile Lake record on eastern Cape York is significant because it remains the nearest record to the Albatross Bay study region. After around 5,000 BP the lake itself shifts from a fluctuating ‘brackish’ water body to one of permanent freshwater with an accompanying expansion of sclerophyll woodland species (notably E. *tetrodonta*), swamp forest vegetation along with a dramatic increase in fire as indicated by charcoal representation (Luly *et al.* 2006). This is taken to indicate a dryland environment dominated by sclerophyll woodland while the immediate areas around the lake supported swamp forest species. The authors suggest that it is unclear whether increasing charcoal proportions in the local record are a result of the broad regional shift toward more open, fire-supporting sclerophyll vegetation, or a result of increased human induced firing (Luly *et al.* 2006: 1091). Importantly, they suggest that the local context of the site probably renders it insensitive to broader reductions in effective precipitation noted for this time across northern Australia.

Stephens and Head (Stephens and Head 1995) documented a local expansion of swamps in the Laura region in southern central Cape York Peninsula after about 2,700 BP at four separate swamp sites. They suggested this may indicate that regional late Holocene reductions in effective precipitation may not have been substantive enough to interrupt local swamp development. They also noted a trend toward more open woodland and increased charcoal levels at this time, interpreting this as a response to human induced fire. They noted that "drier conditions could also contribute to such changes, but as we have argued on sedimentary grounds for increased water levels, a climatic explanation is not preferred", instead suggesting an anthropogenic influence (1995: 30). They suggested that the expansion of local swamps is an anomaly which may be explained by increasingly variable or more seasonal effective precipitation tied to El Niño and La Niña events that resulted not only in drier conditions, but increased seasonal precipitation contributing to the maintenance of freshwater ecosystems.

At Vanderlin Island there is an ongoing expansion of open woodland vegetation indicated in sediments dating to the past 3,000 years and this includes peaks in *Pandanus* spp. (Prebble *et al.* 2005). A similar trend occurs on Groote Eylandt, albeit with a more intensified fire regime in the last 1,000 years (Shulmeister 1992). At both locations this has been interpreted as resulting from increased disturbance as a result of higher cyclonic activity and human impacts, most notably fire. Based on analyses of a number of pollen sites across the Torres Strait, Rowe documented a reduction in canopy cover and forest fragmentation which she suggested signals a broad change from forest to open schlerophyll woodland (Rowe 2007:99). This corresponded with a loss of rainforest taxa and a marked rise in charcoal levels at 3,000 BP with a second increase around 1,000 years ago. Importantly, Rowe (2007: 100) suggested that "a single discrete shift toward changed drier environmental conditions is [not] implied, but a shift incorporating, overall, heightened climatic variability" associated with a less reliable monsoon and more frequent ENSO activity.

It has recently been proposed in the archaeological literature that northern hemispheric climatic events including the little climatic optimum (LCO, 1200 to 700 BP) and the Little Ice Age (LIA, 600-100 BP) had a marked, measurable effect in northern Australia (Bourke *et al.* 2007). The effects of the LCO are not clearly stated however they suggest that cooler, drier conditions of the LIA from 600 BP led to enhanced variability and greater aridity which had substantial implications for human occupation of these regions (Bourke 2005). It is suggested here that this view is unfounded and represents a misinterpretation of the palaeoenvironmental literature.

No recent reviews note any evidence that such changes occur in the southern hemisphere, let alone the Australian region (Donders *et al.* 2007; Donders *et al.* 2008; Shulmeister *et al.* 2006; Wanner *et al.* 2008). Instead, Wanner *et al.* (2008: 1819) suggested that:

> The LIA appears at least to be a hemispheric phenomenon, and model simulations support the inference that it may have been bought about by the coincidence of low [northern hemisphere] orbital forcing during the late Holocene with unusually low solar activity and a high number of major volcanic events.

Future research may more clearly delineate small scale climatic perturbations within the past 1,000 years, however at present the gradually intensifying ENSO after 3,000 BP and associated increasing variability is viewed here as the dominant influence on north east Australian climatic systems at this time. The only evidence of any climatic change (other than ENSO variability) within the past 1,000 years in the region comes from palynological records at Vanderlin Island, Groote Eylandt, the Torres Strait and in the Laura region. In all cases this as been interpreted by the authors as a result of more intensive human settlement and or an increase in anthropogenic fires. (Luly *et al.* 2006; Prebble *et al.* 2005; Rowe 2007; Shulmeister 1992; Stephens and Head 1995).

Chapter 3: Ethnohistoric insights

This chapter uses ethnohistoric data from the Wik region, to the immediate south of Albatross Bay to develop a model of Aboriginal economy during the 'ethnohistoric present' (1880s-1940s) in the study area. Recent work has criticised the application of ethnohistoric data to the investigation of shell mound sites in northern Australia (see section 1.3). However, as outlined in Chapter 1, it is argued here that a critical approach to the use of ethnohistoric data can help improve our understanding of the archaeological record: it is proposed that these benefits only come when ethnohistoric data are examined though an explicitly articulated theoretical framework.

Ethnohistoric data is pivotal to the exploration of the character of production systems associated with shell matrix site formation and use. In particular, the critical examination of ethnohistoric data is an important means through which models of the short-term (decadal-scale) dynamics associated with Indigenous production can be generated. The theoretical framework adopted here is particularly well suited to this endeavour. A substantivist economic approach (e.g. Keen 2004; Narotzky 1997; Sahlins 1972) is drawn up in order to reflect the socially and politically located nature of the economy in gatherer-hunter societies and the differences that exist between these and (formalist) western capitalist economies. More specifically, the approach taken here to the investigation of Indigenous economies follows after the work of those who advocate an 'anthropological political economic' or 'Hegelian dialectic' approach (McGuire 2002, 2006; Ollman 1976, 2003; Sayer 1987). Importantly, the purpose of this chapter is therefore to develop a model of

Indigenous production within the region during the ethnohistoric present. Latter chapters set out to critically explore this model and its application within an archaeological context.

3.1 Theoretical perspectives

An Hegelian dialectic approach follows on from the broad Marxist definition of political economy as the investigation of the historical reality of lived conditions and how these both produce and yet are also produced by social action (Marx 1906). However, as McGuire (2006: 133) stated, a Hegelian dialectic approach also differs from this in that it takes on Ollman's relational or Hegelian concept of the dialectic which sees the social world "…in terms of relations and not in terms of things". The social whole is viewed as a complex web of internal relations between entities (McGuire 2002, 2006; Ollman 1976). These are referred to as social relations.

The example of the social relation of master and slave are often used to illustrate this particular logic; as McGuire (2002: 126) stated:

> According to this view, any given social entity is defined by the relationships with other social entities. Conflicts that result from relational contradictions may result in quantitative changes in those relations that build to a qualitative change. Rebellion by slaves may lead the masters to enforce stricter and stricter discipline, thereby heightening slave resistance until the relation of slavery is overthrown. The social relations that result from such a qualitative change are a mix of the old and the new; the old social form is remade not replaced.

Relational contradictions are viewed as the motor of cultural and social change and therefore of history; the social relations that comprise the whole do not fit neatly together, and therefore contradictions between social categories can lead to action and social change. By seeking out these relational contradictions through our analysis we thus situate ourselves to best understand the processes of historical change.

This view differs from traditional Marxist approaches as well as more recent structural Marxist views. Hunter-gatherer studies have been particularly strongly influenced by the latter which set out to understand change as a result of contradictions between different structural levels within a society, such as between the base and superstructure. For example, work by Lourandos (Lourandos 1983, 1988) was strongly influenced by such an approach and he saw structures of power and competition within a society as driving changes in production, consumption, distribution and exchange which are noted in the archaeological record.

An Hegelian dialectic approach takes a more open stance on the matter of change; rather than seeing the causes of social change restricted to the interaction between base and superstructure, it considers change as potentially being influenced by any number of contradictory social relations. General categories or – in Marxist terminology – ‘abstractions’, are used to describe these underlying social relations however there is a recognition that these are temporary and largely inadequate understandings of complex underlying social relations (McGuire 2002). Importantly, an Hegelian dialectic approach also brings with it a critical and reflexive approach to analysis so that as our knowledge of the social relations (and therefore the world) increases, so too does our opportunity to critique the categories we use.

The goal of such an analysis is ultimately an understanding of the lived and historically constituted reality of people through the analysis of social relations.

Hence, this is the goal of analysis of ethnohistoric data presented here. However, it is important to acknowledge that the purpose of this is not to develop an ethnohistoric model of entire Aboriginal society (c.f. Morrison 2000) but rather to understand the social relations potentially related to the formation of the material (archaeological) record. This is similar to what Muller (Muller 1997) referred to as a more materialist stance which reflects the nature of the data with which archaeologists engage.

In terms of shell matrix sites, archaeological data reflect the long term operation of socially constituted strategies of production and consumption (and quite possibly exchange or distribution) of marine mudflat shellfish species and other resources. Hence, the following chapter sets out to understand the social relations of production and consumption, as well as other important related issues such as demography, material culture, the organisation of labour and the control of access to resources. It is these issues that are argued here to have most bearing on the formation of the material record and therefore are of most concern here.

3.2 A brief history

A Dutch ship, the *Duyfken*, made landfall on western Cape York Peninsula in 1606, a date that also represents the earliest documented European contact with Australia (Heeres 1899; Hercus and Sutton 1986; Loos 1974; Sutton 2008; Wharton 2005). While the first point of contact was most likely at Pennefather River, to the north of Albatross Bay (Wharton 2005), first contact with Indigenous Australians and earliest documented landfall occurred in an incident where one Dutch sailor was speared on the Wenlock River, near the contemporary township of Mapoon (Sutton 2008; Wharton 2005). Although the Gulf of Carpentaria was sporadically visited by Dutch navigators until the last recorded expedition in 1756, more regular encounters between mainland Indigenous populations and Europeans did not take place until the 1800s. Numerous voyages passed along the west coast after this time, including Matthew Flinders and various other government parties (Hercus and Sutton 1986; Sharp 1963; Urquhart 1897; Wharton 2005). These paved the way for both pastoralists and the development of maritime industries (such as pearl shell and *bêche de mer* harvesting) working along the coasts of northern Cape York from bases in the Torres Strait. Both industries had devastating impacts on Indigenous people living in the northern Cape.

The first major inland incursion through western Cape York was by the Jardine Brothers who drove a large herd of cattle along the west coast to establish the settlement of Somerset at the tip of Cape York in the mid-1860s (Byerley 1994). Soon after the cattle station of York Downs was established within the hinterland of the Albatross Bay catchment and this represents the first permanent European presence within the immediate vicinity of the study area. It remained a relatively remote frontier settlement although pastoralists and miners were present in large numbers in the more southerly regions of the Cape as a result of gold rushes to the Palmer (1872) and Hodgkinson Rivers (1876) (Bolton 1963:93). During this period Indigenous people were viewed as a threat and there are references to attacks on miners and pastoralists (Bolton 1963). On the other hand, miners, station workers and police are known to have conducted raids to ‘recruit’ Aboriginal men and women as workers, in addition to punitive police raids (Kidd 1997).

From the mid- to late 1800s the early incursions of Torres Strait based labour recruiters associated with the then fledgling beche-de-mer and pearl shell fishing industries began to have a more sustained presence along the northern coastal regions of Cape York (Loos 1982). These industries were well developed by 1880 and early reports by the Queensland Commissioner of Fisheries suggest that Aboriginal people were regularly being recruited as labourers from areas along the north west and north east coasts of Cape York Peninsula (Saville-Kent 1890). The full extent and impact of this is not really known at present though it seems clear that after the mid-1880s the demand for Aboriginal people to be used as 'cheap' labourers was heightened because of the cessation of the Papua New Guinea labour trade (Loos 1982). According to Loos (1982:140), the earliest official reports of such contact in the Albatross Bay region appear in 1893 when it was reported that Aboriginal people from the Pine River region had killed recruiters in retaliation for mistreatment. In response to this and other reports of violence, the Government Resident on Thursday Island urged the Queensland Premier to consider establishing missions and Aboriginal reserves along the western coast of Cape York Peninsula in order to reduce the impacts that recruiters were having on local Aboriginal groups (Kidd 1997). Three Presbyterian Missions were established on western Cape York during this period: Mapoon Mission, to the north of Albatross Bay on the shores of Port Musgrave (1892); Weipa Mission, on the upper reaches of the Embley River (1898); and a third, Aurukun Mission, on the banks of the Archer River to the south of Albatross Bay (1902) (Kidd 1997: 61; Wharton 2000).

The Weipa Mission was located in a far from favourable location due to poor access for boats, a succession of crop failures, heath problems and other concerns and was relocated in 1932 (Morrison, McNaughton and Shiner In Press.; Wharton 2005). The new settlement was at Jessica Point where the contemporary Aboriginal community of Napranum is today (see Figure 1-2). Many of the contemporary generation of community elders were born and raised in the Jessica Point settlement. In 1955 the region's extensive bauxite deposits were first sampled by Consolidated Zinc Pty Ltd and in 1957 a subsidiary of Consolidated Zinc established a small settlement for its employees near the mission settlement (Suchet 1994). By the end of 1956 Consolidated Zinc had formed a new company to develop the local bauxite reserves: the Commonwealth Aluminium Corporation Pty Ltd (Suchet 1994).

During the 1960s mining infrastructure and housing were built and there were seven attempts to relocate the Weipa Mission community elsewhere though none of these were successful as the community refused to move (Suchet 1994). In 1966 the mission became a state government settlement administered by the Department of Aboriginal and Torres Strait Islander Affairs. By the 1970s the mining township had significantly grown and had taken on the name Weipa North, while the former mission settlement became known as Weipa South. During the late 1980s however the community in Weipa South became Napranum while Weipa North simply became Weipa. Today, the separate townships are maintained with Napranum being a small community of primarily Indigenous people including both local Traditional Owners (i.e. people with descent based ties to local lands) as well as Indigenous people from other Cape York communities who have moved to the region since the commencement of mining.

3.3 Sources of data

Cape York Peninsula has a long and prominent history in terms of ethnographic and anthropological research into Australian Aboriginal societies. This dates to as early as the late 1800s and is tied to the commencement of formal government and church intervention in the lives of people in the area. Roth is a notable figure here as he made extensive descriptions of the lifeways of Aboriginal people across north eastern Australia in his capacity as Government Protector (Roth 1900b, 1900a, 1901, 1902, 1904, 1909, 1910a, 1910b, 1910c, 1919). However, it was not until the 1920s and later that formally trained anthropologists such as Donald Thomson, Ursula McConnel and Lauriston Sharp took up research in the region (McConnel 1930, 1933, 1935b, 1935a, 1936, 1939, 1953, 1957; Sharp 1933, 1934, 1935, 1937, 1938, 1952; Thomson 1932, 1933, 1934b, 1934a, 1935, 1936, 1939, 1946, 1972).

Although a range of researchers worked in western Cape York subsequent to Thomson, McConnel and Sharp (see Sutton 1978; von Sturmer 1978 for references), it was not until the 1970s with the commencement of the Cape York Ecology Project that a series of major anthropological research projects took place (Anderson 1988). Doctoral projects of relevance to the present study were undertaken with Aboriginal groups who hailed variously from Cape Keerweer (Sutton 1978), Edward River (Taylor 1984; von Sturmer 1978), north east Cape York (Chase 1980) and south eastern Cape York (Anderson 1984). While there was some early anthropological interest in Weipa (Hinton 1964b, 1964a), the region was largely left off the agenda in terms of anthropological research. It has been suggested that a key reason for this was that Aboriginal societies from these areas were perceived to have been too greatly influenced or altered by the establishment of missions and the latter commencement of large scale bauxite mining in the region (McNaughton 2006; Morrison and McNaughton 2005; see also Hinton 1964b). Hinton's work, for example, was primarily focussed upon Indigenous labour and involvement in the mining industry, and did not involve an attempt to develop understandings of Aboriginal society and lifeways during the early stages of European settlement in the area.

A limited range of unpublished oral historical and ethnographic data exists for the Weipa region and much of this was obtained in the 1960s, 1970s and 1980s. Use of this material for research purposes is not possible at present because much of it is part of pending Native Title applications and as such, held under restricted access. A number of local, small scale anthropological research projects have been undertaken in recent years which have some relevance to the present study (Duke 2004a, 2004b, 2004c; McNaughton 2006; Morrison and McNaughton 2005), though these have primarily explored contemporary cultural heritage values in the context of development work.

The lack of detailed ethnographic data for the Weipa region specifically is not considered to be a critical problem here. Morrison (2000) reviewed a broad range of ethnographic and historical data for western Cape York and explored the relevance of this material to the Albatross Bay region. This review concluded that Aboriginal societies across much of the western Cape York Peninsula had sufficient similarities to warrant the development of a general ethnohistoric model for the region. This chapter sets out to develop such a model with a specific focus on production strategies and associated social dynamics in the Wik region. Anthropological sources are primarily used, most notably von Sturmer (von Sturmer 1978) and Sutton (Sutton 1978, 1994) rather than earlier ethnographic materials and this is because the former sources are more systematic, detailed and deal with work produced by earlier researchers in a more thorough and critical fashion than could be undertaken here.

3.4 Demography and social organisation

The quality of detail regarding our knowledge of demography and social organisation varies considerably across the region, as do the terms used to describe this. Thomson and McConnel draw on the notion of dialectic tribe to describe the most inclusive units of social organisation in the Wik region however both Sutton (1978) and von Sturmer (1978) discuss the problems with this at length. Both stress the complexity of language or dialect-speaking abilities in regards to social organisation and suggest that social groups, territorial rights and linguistic affiliations were rarely the same. Both develop their own terminology to describe units of social organisation. While the depth of anthropological discussion about the appropriateness of terms such as ‘clan’, ‘clan estate’, ‘horde’, ‘band’, ‘company’, ‘corporation’ and so on to describe units of social organisation are acknowledged here, detailed discussions of these issues are avoided. Where possible the terms used in the source in question are used here. Where this is not possible, or where independent arguments are being developed, the term ‘social unit’ or ‘social group’ and ‘social territory’ are used. These terms are considered to appropriately reflect the highly contextual nature of Aboriginal social organisation, as well as the explicitly archaeological intentions of this review.

For Sutton, the key social unit in the Cape Keerweer region were ‘clans’, which he defined as a patrilineal group sharing the same totems and territory (1978: 51). Clan territory is conceived primarily of economic property whose possession and composition is ritually validated. This notion is broadly supported by von Sturmer (1978) who referred to ‘companies’ oriented around a particular estate. Membership or participation in social units was not entirely fixed and high degrees of movement between them took place. Sutton suggested that clan composition is a more appropriate term than ‘membership’(1978:59):

> ‘clan’ may be more neatly applicable in some cases than in others; not all clansmen are clansmen in relation to all the country claimed by any one of them, and not all territories have a ‘clan’ in possession of primary and unique rights over them. But it is fair to say that the clan as a patrilineal land-holding totemic unit with a unique country is the target towards which the flux of reality is continually pushed, and forms the model into which people attempt intellectually to compress the often somewhat ragged facts. It is the social and political facts which are ragged. The shape and content of the territories remain relative constant and unambiguous, and provide a matrix for ecological and political stability.

An individual had rights of access to the social territories of both their parents and, as Sutton’s quote states, in many cases this appears to have been primarily focussed upon the patriline. This was an inherently flexible social institution whereby if required, an individual could spend lengthy periods away from their primary social territory and use kin relationships to access other areas. Rights of tenure and rights of access are discussed in greater detail toward the end of this chapter.

Social territories varied in size: they were smaller in coastal regions where there was greater access to estuaries, swamps and ecologically rich dune woodland environments across relatively small geographic areas. Inland social territories however were larger and encompassed extensive areas of more homogenous environments (such as open woodland). Both von Sturmer and Sutton suggested that one of the most important social distinctions in the region were between social units whose primary territories are ‘top side’ (non-coastal, inland) or ‘bottom side’ (coastal or near-coastal) (Sutton 1978:86, 1994; von Sturmer 1978). The division in both cases appears to be oriented around the environmental distinction between the coastal plains and the higher relief country of the erosional plateau further inland. This environmental division has associated economic differences – discussed in more detail below – but according to von Sturmer, also had significant implications for social life and social organisation.

Sutton (1978) calculated that in 1976, within the Cape Keerweer area, the average size of the 26 extant Wik Ngathan clans was 21 individuals per clan or a total of 377 people. He noted a dramatic decimation of populations in the region in the late 1800s and early 1900s caused by outbreaks of influenza, measles, whooping cough and so on. Through genealogical research with elderly Wik people he attempted to reconstruct population numbers prior to these outbreaks suggesting it was likely there were around 20 individuals within each of the 26 clans. This equated to an estimated total of 520 people in a geographic area of about 2,000 km^2, or 1 person per 3.6 km^2. He suggested that this estimate compares favourably with Sharp’s earlier and more reliable figures for the Yir Yoront of 1 person per 3.8 km^2 obtained further south in the 1920s.

Both Sutton and von Sturmer indicated that inland regions had lower population densities, though no figures are available as both undertook the bulk of their work at coastal locales. McConnel (1939) provided some general estimates of population sizes of people living around the Archer River however von Sturmer was highly critical of these largely due to the way she collected her data (1978: 81).

3.5   The cultural landscape

According to a Hegelian dialectic view (McGuire 2002), the physical or natural world is socially meaningful and perception of its possibilities and constraints enter into the complex web of social relations which comprise any society. Yet, these perceptions are also the product of dynamic social relations and the consciousness in which it was perceived. Hence, here the term cultural landscape is used to reflect the fact that physical world is culturally constructed and is itself both the outcome of and yet contributes to the web of social relations which comprise a society. Cultural landscapes thus embody the social relations of that society and also reflect the histories of these relations. The shifting cultural landscape is part of a dialectic with social actors. Changes in the cultural landscape can potentially bring about changes in other social entities and in the ways people interact with this landscape. The following discussion considers the cultural landscape of the Wik peoples, including their broad understandings of seasonal changes, classification of the landscape, resource opportunities and constraints and finally, residence patterns.

The western Cape York coastline south of the Archer River has a similar range of environmental areas to those outlined for the Weipa region, however there are important differences in the way these are distributed. The primary contrast between these two areas is that the Wik region consists of a sequence of sandy dune ridges and intervening swales which frequently have small tidal estuaries, freshwater creeks and swamps or narrow low-lying coastal plains; all of which are oriented in a north-south direction of the sequence of dune ridges and the adjacent coastline. These broad coastal plains abut the seaward margins of the erosional plateaus that are of higher relief and similar to the *E. tetradonta* dominant open woodland of the Albatross Bay region. The coastal plains are typically between 5 and 10 km in width, and in some cases extend westwards from the margins of the plateaus by as much as 20 km. The dune ridges support dense stands of dune woodland and for many months of the year the intervening low swales, creeks and swamps are flooded or recharged as a result of wet season rainfall.

3.5.1 Places of significance

A key feature of the cultural landscapes described by Sutton and von Sturmer were the marked distinctions between inland and coastal environments. As implied above, this environmental division has social and economic implications. These divisions are most appropriately summarised by reference to a series of tables provided by von Sturmer that are reproduced below in Table 3-1.

Inland	Coastal
Heavy seasonal flooding and impaired mobility	Heavy seasonal flooding and impaired mobility
Reduction in resource quantity and accessibility during wet season	Reduction in resource quantity and accessibility during wet season
Low environmental diversity over long distances (with few microenvironments)	Great environmental diversity over short distances (with many micro-environments)
Choice of campsites not progressively limited over dry season	Choice of campsites progressively limited through dry season
Fixed (and relatively small) range of food resources with little seasonal variation in population numbers, and numbers of species available	Many food resources, with marked seasonal variability in population numbers, and numbers of species available.
Small repertoire of exploitative techniques, relatively unchanging throughout the year (exception of fish poisoning in kay.man (~July-Oct)	Wide range of hunting techniques, and strategies geared to specific resources, varying according to seasonal and environmental conditions
Less marked peaks and lows with respect to available resources, and a more stable economy	Marked alternation between abundances and shortages in food resources
No water shortages throughout year	Water shortages during late dry season
Low carrying capacity	High carrying capacity
High reliability of resources (relative)	Low reliability of resources (relative)

Table 3-1: Comparison of production systems for coastal and inland economies
(from von Sturmer 1978: 530-31)

The key areas of the inland landscape were evidently the swamps and waterholes, the inland streams and waterways and other distinct microenvironments within the open woodland environments of the erosional plains. Conversely, a greater range of microenvironments existed in coastal areas, each of which offered distinct resource opportunities at specific times of the year. These are discussed in more detail below.

Sutton and von Sturmer both indicated that the landscape was comprised of a multitude of named places: Sutton (1978:51) used the term locale and von Sturmer (1978: chapter 9) preferred the term site; the latter is used here. Sites were often quite specific areas however their names were also used to refer to the surrounding area in general. A range of site types were identified by both researchers, and these included night camps or camp sites, dinner camps, cremation centres, specialised resource sites, increase sites, ceremonial centres, and so on. Some of these are of particular interest to the present study and are discussed in more detail here.

Camp sites were places where people slept, and particularly those sites used consecutively for more than a few nights. Some camp sites were short-term and oriented to a specific resource, others facilitated access to a range of resources, and yet others offered distinct advantages during particular times of the year. Wet season camps are an obvious example of the latter. A range of factors influenced the selection of preferred campsites (after von Sturmer 1978:255-264), including:

1. Water availability and quality;
2. Protection from weather, particularly during the wet season when people tended to camp in more dense woodlands;

3. Access to dry, flood free area that offered a high degree of mobility during the wet season when mobility was most constrained;
4. Access to food resources. Favoured sites had good access to a suitable resource base, including close proximity to either a particularly abundant resource type (including those seasonally available) or a range of less abundant resources.
5. Availability of non-food resources;
6. Freedom from vermin including mosquitoes, venomous snakes, and in rare cases, leeches. Crocodiles are not specifically noted by von Sturmer, though it is likely that these too were of concern in low-lying areas adjacent to estuaries;
7. Presence of shade trees. These provide relief from sun, shelter for sleeping areas, storage areas for food and so on; and,
8. Suitable sleeping surfaces. This primarily included sandy substrates (either on beaches or inland), dusty substrates, and other dry, soft areas.

However, given all of these factors, von Sturmer (1978: 261) suggested that:

> There is a basic weakness in attempting to establish the location of campsites on deductive grounds and, even more, the location of preferred campsites. The fact is that not all possible campsites are occupied; and people often choose campsites on the basis of considerations which, from a utilitarian viewpoint, may appear quite irrational. The question of aesthetic and sentimental criteria has not been raised. Yet it is likely that in defining any site as 'home', it is precisely these factors – evolving and modified themselves through a long history of human occupation – that may be crucial.

He went on to add that:

> When we are talking about a living population the choices of campsites made by them are simply (or largely) within a repertoire of choices transmitted to them from the past. Thus the question should not be

> approached as though it were a situation of 'first choice'. The Kugu-nganychara landscape is itself a cultural fact.

von Sturmer's argument regarding landscape as cultural fact is a key issue for several reasons. Firstly, it fills out our understanding of the context – or social reality – in which land use and settlement decisions were made. Secondly, it introduces the idea that history is writ large on the landscape, and that this has a significant influence on the day to day lives of individuals. It is with points such as these in mind that the term cultural landscape is used here.

Dinner camps or day camps are areas that were rarely used for the purposes of camping and were often utilised during trips between camp sites, or during forays from these to exploit resources or carry out other activities. They were locations at which people would cook food, rest and relax during the hotter hours of the day. Shade was an important quality at these sites. Neither Sutton or von Sturmer clearly indicated if these areas were reused, however their inclusion as 'named places' suggests that they at least were not randomly chosen and thus likely to have been reused on a periodic basis.

Specialised resource sites include areas that were noted for an abundance of resources at specific times of the year. Based on von Sturmer's discussion (1978: 264), these appear to include campsites that had access to a particularly highly productive resource (or range of resources). These were often seasonal resources, used for short periods on an annual basis.

Sutton suggested that in addition to the quite specific locale types discussed above, many other places were named. These included clearly defined areas of lakes, coastlines, estuaries, and so on that were used for hunting or fishing (and, presumably, gathering or other resources). Other locales were defined by physical environmental boundaries such as lagoons, saltpans, grass plains, watercourse, tidal creeks, landing areas and so on.

Another significant aspect of the cultural environment is the existence of established tracks that played a large part in influencing how people moved through the landscape. These tracks typically consisted of strings of named places, and according to Sutton (1978:92) were closely associated with patterns of resource exploitation. Indeed, he went so far as to suggest that movement from a campsite typically involved following a specific route out and following this same route back, and that it was unconventional to not do this.

3.5.2 Resource opportunities and scheduling

Before proceeding with an overview of resource opportunities and scheduling, it is useful to briefly discus social units as they relate to occupational units. It is clear from von Sturmer’s and Sutton’s work that the social unit engaged in particular subsistence activities was not consistent in size. In some cases, at particular times of the year, the key economic unit comprised small numbers of closely related family members. In many more cases, numerous such groups resided at specific locales, including people from outside the primary social unit. Finally, at other times large numbers of people with a range of social affiliations resided at a single place. This variation in social organisation in relation to production has numerous implications and is taken up in more detail elsewhere. In the following discussion a generalised model of seasonal shifts in food resource opportunities and associated patterns of movement of social units is outlined. Unless otherwise stated, the discussion specifically draws upon von Sturmer (1978) and Sutton (1978), and it should be noted that von Sturmer noted that seasonal categories proposed by Thomson (Thomson 1939) a little to the north of Weipa also generally apply south of the Archer River.

Month/s	General terms	Description
December to March/April	'Wet time' or 'North west time'	Monsoonal period. North west winds. Intense rainy periods and often windy or squally conditions.
March/April to June/July	Post wet season or 'dry wet time'	Rains ease significantly however large amounts of surface water, particularly in lower lying areas. Hot, but cooling
May to June	'Good wet' or 'dry wet time'	Cessation of rains; high water levels falling slowly
July-August/October	'Dry time' or 'hot time'	Little wet season surface waters remaining except in lagoons and deeper water holes. General drying out of landscapes to the point where grass burning can take place. Becomes very hot.
August/October - December	Late dry, 'first storm'	Continuation of 'dry time' but commencement of isolated early wet season storms and increasing temperatures.

Table 3-2: Seasonal classifications, western Cape York
(after Sutton 1978 and von Sturmer 1978: 199-200)

A generalised overview of general seasonal classifications are outlined in Table 3-2 and these are also consistent with the work of Taylor (1984) further to the south near Kowanyama. At coastal locations, the wet season was often referred to as a 'hard time' because of the immobility that came with high waters, both at inland and coastal locations, and decreased availability or access to food resources. As indicated earlier, during these months (December – March) coastal groups established (or re-used) camp sites which were essentially permanently occupied for the duration of the wet season. At these times, one or more family units would camp in relatively close proximity, though conceivably the size of these settlements varied with context. In coastal areas, dune ridges were the preferred areas for such camps, particularly those locations that afforded the greatest degree of mobility and widest range of access to the more limited food resources at this time. Camps were typically set within the shelter of dune woodland and under large trees and open, exposed locations were generally avoided. Shelters were ideally made from the soft, flexible bark of the paperbark (*Melaleuca* sp.) though in cases where it was not available messmate bark (*E. tetradonta*) was also used (Sutton 1994). Settlement sizes at coastal areas are not specified; however, given the constraints on resources and mobility, it is likely they were not more than several family groups.

Sutton's resource calendar (Figure 3-1) indicates that key resources during the wet season included megapode eggs, shellfish, saltwater fish, rays and sharks, with less frequent use of macropods and small mammals. Vegetable foods such as roots and bulbs were also difficult to obtain and comprised a smaller part of the diet. Overall during this period of the year, and at the height of the wet season in particular, there was a greater reliance upon more marginal foods – such as those that required processing or which were less palatable – and access to food resources varied depending upon accessibility and the local context of the campsite(s). Food storage was extensively practiced at this time (von Sturmer 1978: 236).

Our knowledge of wet season subsistence and settlement patterns at inland locations is less detailed, though von Sturmer suggested that the resource stress experienced in coastal areas was less severe at inland locations. This is primarily because of the less seasonal character of inland resource opportunities (1978: 236). As with coastal areas, wet season flooding resulted in reduced mobility at inland locations. No information exists on settlement sizes or preferred locations, though again it is likely that higher relief areas that provided access to a broad range of resources while enabling greatest degree of mobility were preferred. No information is available regarding shelter types, though presumably messmate bark (more common in these areas) was a key material in constructing shelters and as with coastal areas, the most substantial shelters were built at this time of the year to provide refuge from rain and mosquitoes.

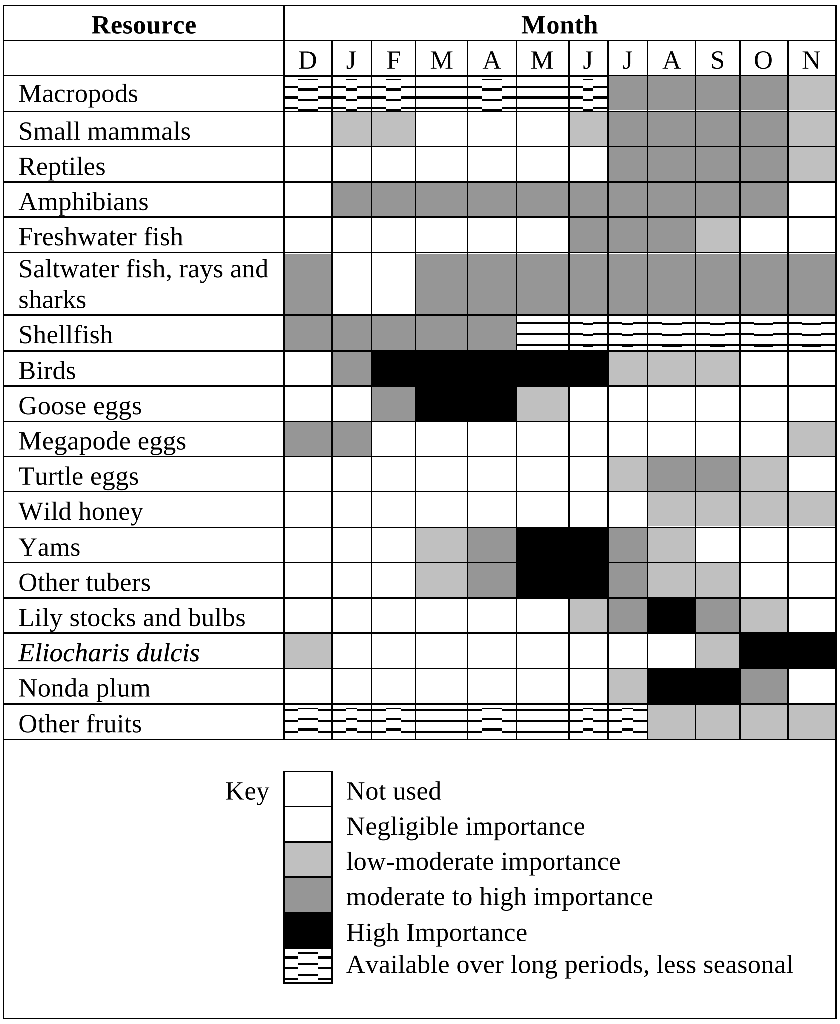

Figure 3-1: Seasonal resource availability, Cape Keerweer
(after Sutton 1978:46)

As the wet season rains began to subside, magpie geese and their eggs, as well as ibis, brolga and other birds became an important resource in coastal areas. Bark canoes (made from the bark of *E. tetradonta*) were constructed to traverse the waterways and swamps to raid the nest of magpie geese and to hunt the birds themselves. This general period was also noted for the greater availability of vegetable foods including yams, tubers, lily stocks and bulbs and so on. People occupying dune ridges would move out to more open areas in order to access breezes and to avoid mosquitoes. Those with access to territories closest to the coastlines were restricted in movement for the longest period of time because of the higher water levels in these areas. The range and abundance of resources in an environment charged by the prolific growth of flora during the months of rain and tropical conditions can not be understated. Many groups spread out during this time as it provided the first opportunity for easy movement across the landscape after the wet season, and Sutton noted that people often travelled large distances to visit family for a few weeks at a time (but typically less than 35 km).

Sutton suggested that following the wet, those groups with estates on the more landward dune ridges became mobile sooner because they had greater access to higher ground of the erosional plains. This may also apply to movement of people at inland locations. It is also likely that the glut in vegetable resources of coastal areas was less significant at inland locations because of environmental differences, though some resources such as water lilies were available in larger quantities after the wet. Fish and freshwater tortoises were exploited at inland waterholes and large poisoning events took place, a practice that appears to have been common over the course of the drier months. Further to the south Taylor (1984) described a pattern of movement which saw people systematically exploit these water holes as they dried out, saving the larger and more permanent waterholes for later in the dry season; it is conceivable that a similar strategy was used further to the north.

Sutton's resource calendar illustrates that during the early to mid-dry season a wider range of seasonal resources were available. These included macropods, small mammals and reptiles, freshwater tortoises and fish, saltwater fish, rays and sharks, nonda plum and other fruits. Fire was used as a cooperative hunting technique on the grass plains at this time, often resulting in large yields of wallaby (Sutton 1994:84). However it is clear that towards the end of the dry season the reduction in surface waters also saw both a reduction in resources, as well as their concentration into smaller areas. Marginal foods became more common as the range and quantities of vegetable foods reduced (Sutton 1978: 48). Nonda plum was one such vegetable resource though yams and some vegetables were still available in those areas with larger water bodies. Sutton (1994) suggested that night camp sites during the dry weather were generally in open areas such as level sand dunes, salt pans, coastal swales or plains where sand was soft, free of grass and where visibility of the surrounding landscape was greatest. The focus on visibility during the drier months is significant because while it provided an opportunity to identify resource opportunities, it also allowed for other people to be noticed.

von Sturmer stressed the importance of marine species obtained from tidal estuaries during the drier months, particularly fish, sharks and rays. Shellfish are briefly mentioned: he stated they were used occasionally during the wet when washed up on beaches, as well as being more frequently accessed on tidal mudflats during the dryer months when mean tides were lower than in the wet months. Broadly speaking, the late dry season also saw a more limited range of vegetable resource opportunities and as discussed further below in many coastal areas more cooperative based activities were required to obtain resources.

Overall, seasonal environmental changes had a significant impact upon resource opportunities and settlement strategies. Wet season rainfall recharged waterways and swamps and encouraged the growth of many of the resources used later in the year. These rains and the thick vegetation that followed encouraged more sedentary settlement patterns and this reduced mobility and resulted in more constrained opportunities for obtaining resources. As the wet season rains ended and mobility became less restricted a large range of resource opportunities presented themselves, particularly in coastal areas. These became more limited towards the end of the dry season however strategies such as food storage, resource scheduling and cooperative activities to a large extent ameliorated this until the onset of the next wet season.

There are distinct regional differences in this broad strategy which, according to both von Sturmer and Sutton, are expressed primarily in terms of the inland/coastal division. The key feature of coastal areas is the diverse range of micro-environments with associated resource opportunities that were highly seasonal in nature. Conversely, inland areas were more homogenous with a substantially smaller range of micro-environments, though overall resources were more stable on a year-round basis. Overall, the cultural landscape was one of numerous opportunities for production but which varied in timing, duration and extent. It is argued here that von Sturmer's notion of landscape as a 'cultural fact' is particularly useful in understanding the ethnohistoric record: past choices, practices and experiences along with current knowledge and understandings of the cultural landscape were in part responsible for structuring land use decisions and the production opportunities which were available.

3.6 Material culture

Material culture embodies the social relations and consciousness that represent the conditions under which they are created. This is because human labour represents socially meaningful activities which are influenced by the social relations which comprise a society; the whole of the human condition takes a material role in the production and reproduction of real life through material culture (McGuire 2002, 2006). Hence, material culture reflects the underlying social relations of its creation. Moreover, according to this view, material culture does not passively represent these social relations but enters into them because it “enables and limits the production and reproduction of real life that forms social labour. It is both the symbolism of the material and its physical reality that engages in a dialectic with social actors” (McGuire 2006: 128). For these reasons, considering the material practices associated with production are an important avenue for acquiring knowledge regarding the social relations of production: in an archaeological context where material culture is a key access point to the social relations of the past this is a particularly important point.

Sutton (1994) provided a detailed review of material culture traditions of the Wik peoples and this is the primary source used here. It is evident from this paper, and the ethno-historic data more broadly, that the Wik had a material culture which utilised a range of raw materials including bone, teeth, shell, wood, bark, plant and animal derived fibres, plant gums and resins, plant extracts for dyes, ochre, clay and stone. These raw materials were used for varied range of purposes including as shelter, containers, for food preparation and processing, digging, trapping, decorative purposes, magical/ritual purposes, watercraft, weapons, tools, binding or hafting and firewood. It is my intent here to outline broad elements of these traditions, particularly those relating to production.

The tools and materials used to collect, hunt, carry and prepare foods varied depending upon the resource in question, and also in terms of the time of year. However, there were a number of common tools used year round. Digging sticks were used by women to obtain roots and tubers, some ground burrowing animals, as well as for a range of other general purposes including fighting. Sutton is not specific about raw materials, though given their utilitarian nature it is likely these were constructed from harder woods such as the Cooktown ironwood (*Erythrophleum chlorostachys*) or *Acacia* sp. Woven baskets were also an item manufactured primarily by women. These were made for a range of purposes and provided a key means of transporting large amounts of food resources and a range of plant fibres were used for the manufacture of baskets.

Spears were an item used primarily to hunt fish, rays and sharks, terrestrial animals such as wallaby, birds and so on. These were typically multi-pronged with attached barbs made from bone or stingray barbs however larger land game were often hunted using spears with a composite head constructed from hardwood and a double-ended bone point. Spears were typically thrown using a woomera or spear thrower so as to propel the spear with greater force. These were constructed from an elongated wooden blank (hardwood or softwoods, depending on its use) with a wooden peg at one end and a handle at the other. The handle was constructed using beeswax and several pieces of baler shell, and then decorated with the bright red seeds of the gidigidi (*Abrus precatorius*) (see Sutton 1994 Figure 11). Lightweight woomera were used for hunting on water, and a false woomera was also used, though primarily for fighting.

A further common item of the toolkit and one frequently used by men was what Sutton refers to as the ‘ironwood palette’ and Roth (1901) referred to as a ‘paddle’. This item was versatile and was used in many areas of Cape York. It consisted of a flat, elongated palette of Cooktown ironwood (*E. chlorostachys*), typically less than 40 cm long, with a narrow stem at one end upon which a kangaroo incisor was hafted. In other areas of Cape York (typically further inland) stone flakes were used for this purpose. It was used as a paddle for applying and smoothing hot gum or resins to spears and also as a tool for engraving, cutting and scraping purposes.

Sutton suggested that stone as a raw material in artefact manufacture was of little importance in the lives of coastal Wik people (1994:33):

> The coastal Wik region is practically devoid of stone and certainly devoid of hard stone suitable for tool-making. There are stony ridges, however, in the hinterland far to the east. In many months of combing the coastal and peri-coastal country while mapping old habitation and other sites with Wik people this author has only found two stone artefacts, both axe heads. Such stone must have been traded in from a long distance. Apart from local ochres, and the mud and shale used in cooking, most raw materials come from plants…and animals…

The only stone tool type noted to have been used with any regularity in this region are stone hatchets, though Sutton (1994, 1978) did not provide great detail on these apart from stating their importance in the collection of wild honey (1994:38). It is clear from Sutton’s discussion that wood, shell and bone comprised the primary raw materials for manufacturing scrapers, knives, awls, points on spears and other similar purposes to which stone was frequently used in other parts of Australia. Shell knives, typically constructed from the durable bivalve *Polymesoda erosa* were a common item in tool kits of coastal people and appear to have been used widely for this purpose in other areas of western Cape York (Schall 1985).

A range of other more specific items were also used in relation to subsistence activities. Baler and conch shells were used widely for carrying water and for digging in soft sand or mud (Sutton 1994:38) and wooden pounders and anvils were used for pulverising carbohydrate rich tubers or bulbs, seeds and fruits, particularly those that required processing to remove toxins. A range of other plant derivatives such as bark and leaves were used in a more expedient fashion as food preparation surfaces, to carry foods, as drinking containers, pouches and so on.

No hooks are reported for this region and spearing – discussed above – and trapping were the key means by which fish, sharks, rays, freshwater tortoises and so on were obtained. Sutton suggests that most fishing was undertaken in estuaries and lakes rather than on the open beaches of the coastline of the Gulf of Carpentaria. Much fishing involved stalking, the use of collective drives, the construction of weirs and fences, or the use of poisons to stun or disorient fish.

Fire was central to food preparation processes and Sutton suggested that one of two techniques were commonly used: cooking on an open fire and the use of earth ovens. The use of open fires requires little elaboration and therefore my attention here is given to earth ovens. Sutton suggested that earth ovens were used widely for cooking large game as well as for cooking large quantities of small game. The method of cooking using an earth oven included the following broad steps (Sutton 1994: 44):

- Digging a pit and building a strong, hot fire in this;
- (in the case of large game) singing the fur away in the hot fire and then scraping away remaining hair and burnt sections of skin;
- placing lumps of termite mound[2] into the hot fire as heat retainers;
- when heat retainers are sufficiently hot and the fire has died down, a layer of green leaves were placed over them;
- the item/s to be cooked were placed on the green leaves and then covered with paperbark and sealed with sand.

Sutton reported the use of shellgrit lumps where termite mounds were not available, and suggested that earth ovens were usually near overnight or base camps. A single earth oven was generally used repeatedly, and the lumps of termite mound or shellgrit were also reused until fragmented. These areas tended to accumulate large amounts of offal, skin, bone, feathers and so on, and so were not generally located immediately adjacent to camping areas because of their smell. It is significant to note here that at Albatross Bay today, clean dead shell is sometimes used as a heat retainer for ground ovens (personal observation); Meehan (1982) also noted this in the Blythe River region of the Northern Territory.

Sutton provided some broad detail on the character of huts and shelters used however Thomson (1939) provided greater detail. As discussed in the previous section, wet season huts were the most elaborate and comprised a frame of tree limbs over which paperbark (*Melaleuca* sp) or messmate bark (*E. tetradonta*) were placed. Smokey

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[2] Termite mounds are mounds of highly compacted earth up to 4 m in height constructed by colonies of small ants (Ispoptera).

fires were lit inside these and they were sealed to keep out mosquitoes. Substantial shelters were less of a requirement in the drier months, however structures were made from tree saplings to provide day shade in some cases (Sutton 1994:35).

3.7 Social dimensions of production

The following discussion considers aspects of the organisation and control of resources and production, or broadly speaking, the social and political context in which production takes place, termed here as the ‘social dimensions of production’. This term is used in place of the more conventional ‘social relations of production’ used by other authors (e.g. Keen 2004; Lourandos 1988, 1997; Narotzky 1997) because of the specific way in which the term ‘social relations’ is used throughout this chapter. For clarity, the following discussion has been sub-divided into several broad categories including the control of access to resources, and the organisation and control of productive labour.

3.7.1 The scale of production

An important aspect of production systems throughout Aboriginal Australia, and arguably an issue that is all too often overlooked by archaeologists, is that the scale of production varied quite considerably in different social and environmental contexts. Simply put, production was not entirely about small social units ‘subsisting’ and moving about the landscape in a nomadic fashion without recourse to anything but requirements for food and water. Far more elaborate and nuanced strategies are evident and this is well documented in the Wik region.

The basic economic unit did indeed comprise small units of people, often family groups consisting – typically – of children and a man and women with varying numbers of other kin also often attached (including both other men and women). This represents perhaps the smallest economic unit (apart from an individual) involved in resource production activities. These units acted less commonly as isolated residential units and in most cases resided at sites with a number of other similar family units. Although there were systems of food redistribution in operation within such residential arrangements, production in these cases was principally focussed upon providing for the needs of that particular social unit. That is, production activities were scaled in relation to the economic units of a small group of closely related people.

More commonly however, both von Sturmer and Sutton implied that in many instances people within such residential groups would routinely cooperate in production related activities. For example, in the post-wet period groups of women would cooperate in the exploitation of rootstocks and bulbs available in swamps while small groups of men would be involved in exploiting nesting birds and their eggs or involved in small scale cooperative hunting (i.e. fish drives and wallaby drives). These often involved close kin and were part of the broad residential group of a particular estate. The simple point here – and one developed in greater detail below – is that production activities routinely involved cooperative activities that enabled greater degrees of production. Importantly, these need not have involved ceremonial or ritual aspects beyond those practices and beliefs that were a normal part of everyday life.

In this respect however there is a clear relationship between larger scale production events and ceremony. von Sturmer (1978:240) suggested that:

> the ceremonies of the late dry season coincide with economic activities which, with group labour, provide a surplus which could scarcely be obtained without co-operative effort, or the efforts of a number of individuals geared towards a single goal.

Sutton (1978) also noted that during the late dry season larger scale production events were associated with ceremonial activities, and that these were often focussed around one or two resources. Both von Sturmer and Sutton indicated these events were associated with resources that were more easily exploited via cooperative activities. Coastal swamps (birds eggs, rootstocks and bulbs), water holes (fish, freshwater tortoise and bulbs), tidal creeks (fish trapping), dune woodland on ridges bracketed by exposed open plains (wallaby drives), and finally, grassy plains (fire to obtain small mammals, reptiles and wallabies) were all variously the focus of such activities. The ceremonial events associated with these appear to vary. In some cases both von Sturmer and Sutton implied these took on the form of highly formalised (and often restricted) activities such as those associated with fish poisoning and von Sturmer (1978: 213) quoted an informant who provided a useful example:

> Children, women – they can’t be present at the poisoning. They are not allowed to go through there too soon. The poisoning takes a long time…Young men camped a long way off (indicating a distance of 0.5 km) making spears. The main camp is separate because nobody can camp alongside the lagoon…
>
> …When morning comes (of the allotted day), all come in as arranged – men, young men, children, women. There is no ‘law’ now because we have finished making the spears ready for the fish. The camp is moved near to the fish spearing, say to another lagoon with freshwater alongside.
>
> Large groups of people come in for the fish spearing…two messengers would have been sent one way, another two messengers sent another place…
>
> …End of the dry season, when the country is very dry, and the water low people would say: ‘the water is low. It is time to poison fish with the leaves’…

von Sturmer (1978: 214) stressed the highly ritual and ceremonial nature of this event as indicated by the division of labour according to age or status, the separation of the primary camp from the activity, and the culmination of preparations in a final day of activities. Presumably, other social activities were also undertaken in association with such events given that invitation that had been extended to other social groups. von Sturmer (1978: 237) perhaps provided the most useful summary of these events:

> Some techniques require or employ a large body of labour, and provide a large surplus, e.g., organised wallaby hunts (individual hunters), wallaby drives (multiple hunters and the use of fire), and fish poisoning. In many cases they are linked formally with a ceremony…In other cases, e.g. fish poisoning, the activity exhibits many of the characteristics of a ceremony: the exclusion of women and children from the site of the poisoning; the obligation imposed on young men ready for the 'final day'; and the summoning of visitors from neighbouring areas to participate in the final day of feasting.
>
> …The activities [associated with these ceremonial and ceremonial-like activities] occur in the (late) dry season, on a fairly regular basis.

As this implies, in some cases these events were associated with regular (i.e. annual) formalised ceremonies. von Sturmer provided several examples of these (1978: 386-388) however does not elaborate greatly on their characteristics.

Overall, there are few other accounts of what are termed here as cooperative production activities. Their key aspects however are a strong orientation towards a limited range of resources that could be obtained in some abundance through cooperative labour. Sutton, von Stumer and also Taylor all noted that these types of productive events were often quite formalised, and involved numerous people from a range of groups. Also, these were most commonly held in the late dry season and according to von Sturmer, were oriented on the coastal areas where some of the last remaining seasonal resource abundances were available. Presumably however, the specific micro-environments varied and a range of resources and production strategies were involved in different contexts.

Less frequent but even larger scale and more highly formalised production events were also undertaken in association with formal, named ceremonial events. A range of different ceremonial events existed and these were organised at various intervals, as frequently as one or two years apart or in extreme cases, as much as 10 or 15 years apart. Again, very large groups of people (as many as 100-150) would attend these events which, in some cases, seem to have lasted as long as two months. A significant resource base in conjunction with a greater degree of organisation of labour was required to sustain such events. von Sturmer suggested that the ceremonies were of a different level of importance compared with those described above, and also involved different production activities. He articulated the differences between these and the above mentioned late dry season activities (1978: 240) thus:

> Although the ceremony does depend on abundant food resources…it does not rely upon a single abundant resource *[as is the case with late dry season events]*, or two major resources…It exploits the whole range of resources. The ceremonies of the late dry coincide with economic activities which, with group labour, provide a surplus which could scarcely be obtained without cooperative effort, or the efforts of a number of individuals geared toward a single goal. The early dry season ceremonies appear different in this respect. It is a period when food resources are most abundant; and exploitation by small economic units (often no more than a single nuclear family) is the norm at this time. *[An argument for the primacy of economic factors]* applies less well for the early dry season ceremonies which appear to be mainly social in character…In years other than those in which the *[large scale]* ceremony occurs, subsistence strategies would be quite different *[for]* the early dry season was normally a period of exploitation and consumption by small, isolated family units.

Distinct locations for many of the major ceremonies existed, and there were often strict divisions of labour and associated allocation of geographic areas for resource exploitation for particular groups. Importantly, these events were held when resources were at their most abundant: the post-wet season or early dry, though the infrequent nature of these events must be stressed.

3.7.2 Organisation of labour

The organisation of labour varied with the context in which production was being undertaken and many issues of relevance here have been identified above. For this reason, only general comments are appropriate here.

At what has been referred to as the family or domestic level production, less organisation of labour was required because it often only involved production for a small group. Conversely, large ceremonial events outlined by Sutton and von Sturmer were of a very great scale, involving many people (von Sturmer suggests as many as 100) who were involved in the ceremony for weeks or even over several months. While some aspects of the nature of labour organisation were similar regardless of scale there are also distinct and important differences in labour organisation depending upon the scale of production required.

Generally, it seems that on western Cape York men 'hunted' and women 'gathered'. A typical day in the life of a small kin group is provided by von Sturmer (1978: 220-21):

> Typically, a hunting-gathering party may consist of a man, his wife, young children, his wife's sister, and her daughters. Having arrived at the intended destination…*[in this case a sand ridge]*…the man will go off by himself carrying his spears (and nowadays, commonly, a shotgun)

> looking for birds. The women and children will go off together scouring the intertidal zone for crab holes which they will prod with short spears; some of the older girls may walk among the mangroves looking for mudshells. After an hour or two the party will assemble back on the sandridge, the women likely to arrive back before the man. They will clear away the grass…making sure that there are no wasp nests or caterpillar nests in the trees under which they wish to rest, and careful not to disturb any green ant nests. The girls will gather firewood and the crabs will be cooked directly on the flames. The mudshells may be buried in the hot ashes on the margin of the fire. When the man returns, perhaps with a couple of ibis and also some crabs, everyone will eat, each person distributing what he or she has caught, essentially within the nuclear family…

Men were most active in seeking meats and women were focussed upon vegetable foods and small game. Hunting was often an individual pursuit while conversely women's activities were more social in character. von Sturmer noted that there were considerable overlaps in activities at the domestic scale. For example, opportunistic use of spears by women to obtain fish or crabs was not uncommon. Men and women were also often involved in what von Sturmer referred to as 'lengthy periods of social activity' that were oriented around processing particular resources (1978: 220). In many smaller scale cooperative events the organisation of labour was often based on gender however again, these events involved greater cooperation between sexes. Fish drives and wallaby drives are good examples where the involvement of both women and men (and probably children) was required to fulfil critical roles to ensure successful drives.

Where production was of a more formal nature and associated with large scale production (such as the fish poisonings referred to earlier) or in the case of formal ceremonies, strict labour divisions were enforced. Based on the available material it seems that senior men ('bosses') had dominant roles in these events, particularly in regards to their preparation, although women were rarely – but not always – fully excluded from the final day of feasting. In some cases threefold division of labour was used: men; women and children; and finally, boys or young men. Each group was allocated a specific geographic area in which they could seek resources that contributed to the ceremonial activities. Indeed, von Sturmer suggested that women played a pivotal role in many of these events because they provided the bulk of the resources required, and this commonly included those resources that required long periods of labour. Again, vegetable foods are the example most frequently used.

3.7.3 Control of access to resources

As outlined earlier, a key feature of Aboriginal societies in the Wik region is the division of land into social territories which are essentially a number of named sites to which a variety of individuals claimed primary rights. This typically was around 20 or 30 individuals, however there were substantial variations on these numbers. Importantly, those individuals with rights of tenure (primary) were not necessarily a land-residing group but also included visitors of various duration, including those with secondary rights or rights of access to the area in question.

Aboriginal societies throughout much of Cape York Peninsula appear to have been largely patrilineal (Sutton 1978; Sutton and Rigsby 1982; von Sturmer 1978) and therefore rights of tenure (primary access) were obtained from one’s father. Rights of access (secondary access) were obtained through one’s mother and therefore marriage patterns were a primary means in which people gained access rights to other estates. Control of land and ownership or control of particular social territories was often influenced by individual political action (Chase and Sutton 1998; Sutton 1978; von Sturmer 1978) and von Sturmer suggested that in some cases secondary rights could be converted to primary rights, though this does not appear to have been a frequent occurrence.

Named sites within an estate were often renowned or valued for a particular resource or range of resources. In this context, it is significant to note that sites were controlled by either estate groups or, in some cases, were shared by members of what von Sturmer termed ‘companies’ (often comprised of individuals from different estate groups). People with tenure rights in estates typically controlled sites within the estate, however some sites were shared and control was by a more diverse group of people. Most estates have what von Sturmer and Sutton termed focal sites which were the most central or pivotal sites within an estate, and were often what an entire estate was named after.

Certain individuals were afforded the greatest amount of control or management over specific sites and these individuals were referred to as ‘bosses’, a term used here. Bosses were individuals who, for a variety of reasons and through a range of mechanisms, had attained a greater degree of influence and prestige over other members of a social territory. A key factor in acquiring such influence was through support that they received from other close kin and while bosses clearly had an influential position, it should not be assumed that it was a position of unquestionable authority. Many different sites within an estate had individual bosses, and while not explicitly discussed by von Sturmer or Sutton, it is feasible that these were sites which were either of cosmological importance (such as increase sites) or which were of strategic importance, and this included important resource areas. It is unclear if all named sites had bosses, though conceivably only those sites of greater importance or which were more regularly used were controlled in these ways.

Estates commonly had a ‘biggest boss’ (von Sturmer 1978), individuals who held the greatest degree of influence over other members of an estate, including other bosses, and who received substantial levels of support from kin networks. Again, the relationships between these individuals and resource control are rarely explicated in any detail however von Sturmer at least suggested that these individuals made some decisions about economic strategies, areas used at a site by visitors and so on.
von Sturmer argued that the focal male and his kin tended to gravitate towards occupying the focal site within an estate (1978:445):

> Certain sites work in the favour of the resident ‘big man’ or ‘boss’ for they themselves are more favoured for residential purposes than other sites, or because they have acquired a long and prestigeful history. In general, I argue that there will be a general movement of the most powerful individuals and estate corporations towards control of these sites.

It is easy to conceive of a situation whereby the resource potential of particular sites was a major factor in such systems. Indeed, von Sturmer implied this in his discussion of the strategic importance of river mouths in *Kugu Nganychera* society, and the strong tendency there for both: (1) the focal site of an estate to be located at a river mouth and; (2) the most senior person or boss of the estate (i.e. the most senior person with the estate) to be the boss for that site and often reside there (von Sturmer 1978: 426-429). According to von Sturmer(1978: 427), the marine resource potential of these areas was among the highest along a river system:

> …they provide the best and most easily exploited fisheries. The large fish may be speared as they negotiate the shallow bar. The intertidal zone attains its maximum width at river mouths. This zone is rich in shellfish,

> and the various rays may be speared as they move over the mudflats and sand banks with the incoming tide. The river mouth is a funnel through which fish moving between the rivers and the sea must pass.

He went to argue that river mouths were also strategic in terms of their utility as crossing points, their greater defence and security features, the more intense social life available in such areas and also in terms of the broader cultural geography of the estate. The key point here is that the *production potential* of particular sites was one factor which had social repercussions for those in control of the site. Given this, it is suggested here that sites with high resource potential were also locations that were subject to greater levels of competition to control them.

Control of access to resources, including preferred sites, is considered to have been of greater gravity in contexts where there were greater demands upon the scale of production. It is clear from the Wik data that the prestige of a group or individual were enhanced through being able to host larger scale events. As noted earlier, production occurred at several scales, and often included events that involved groups from different estates attending particular sites to be involved in cooperative events. These often had a ceremonial or ritual component to them. It is in this context that control of particular sites may have provided social benefits to both the estate members as well as the boss of that particular estate.

Beside this, a broad range of other means of controlling resources were also practiced, though none of these are viewed here as being of as critical importance to that relating to land tenure and the control of sites. A range of prohibitions on resource exploitation existed, often applying in quite specific contexts such as during pregnancy or initiation, or depending upon seniority and ritual status. Similarly, it seems clear from a range of sources across Cape York that particular resources were owned: yams beds, for instance, are frequently cited as being owned by a particular group or even particular individuals and this has also been noted to apply to other resources such as wild honey, trees used for making spear throwers and dugout canoes, shade trees and highly productive fruit trees (Morrison 2000). Unfortunately, in most cases references to such instances of the control of resources are rarely explicated in any great detail. At the very least it teases out the politically loaded nature of resource use in western Cape York: rather than being a landscape of resource opportunities with few constraints other than those related to resource availability, it seems more likely to have been the case that resources were bound at various scales by social realities which controlled who could access these, and when.

Chapter 4: Archaeological context

Extensive previous archaeological research has been carried out at a number of locations throughout Cape York Peninsula and the Torres Strait and this chapter sets out to review broad results of this research along with key explanatory models. The chapter begins with a detailed review of previous work at Albatross Bay. Following this, it reviews evidence for demographic and economic changes in the mid- to late Holocene period in both the Torres Strait Islands, mainland south east Cape York Peninsula and Princess Charlotte Bay. Results and interpretations from these three regions are of high relevance to the questions being addressed in this thesis because they provide regionally comparable data on mid- to late Holocene economic changes.

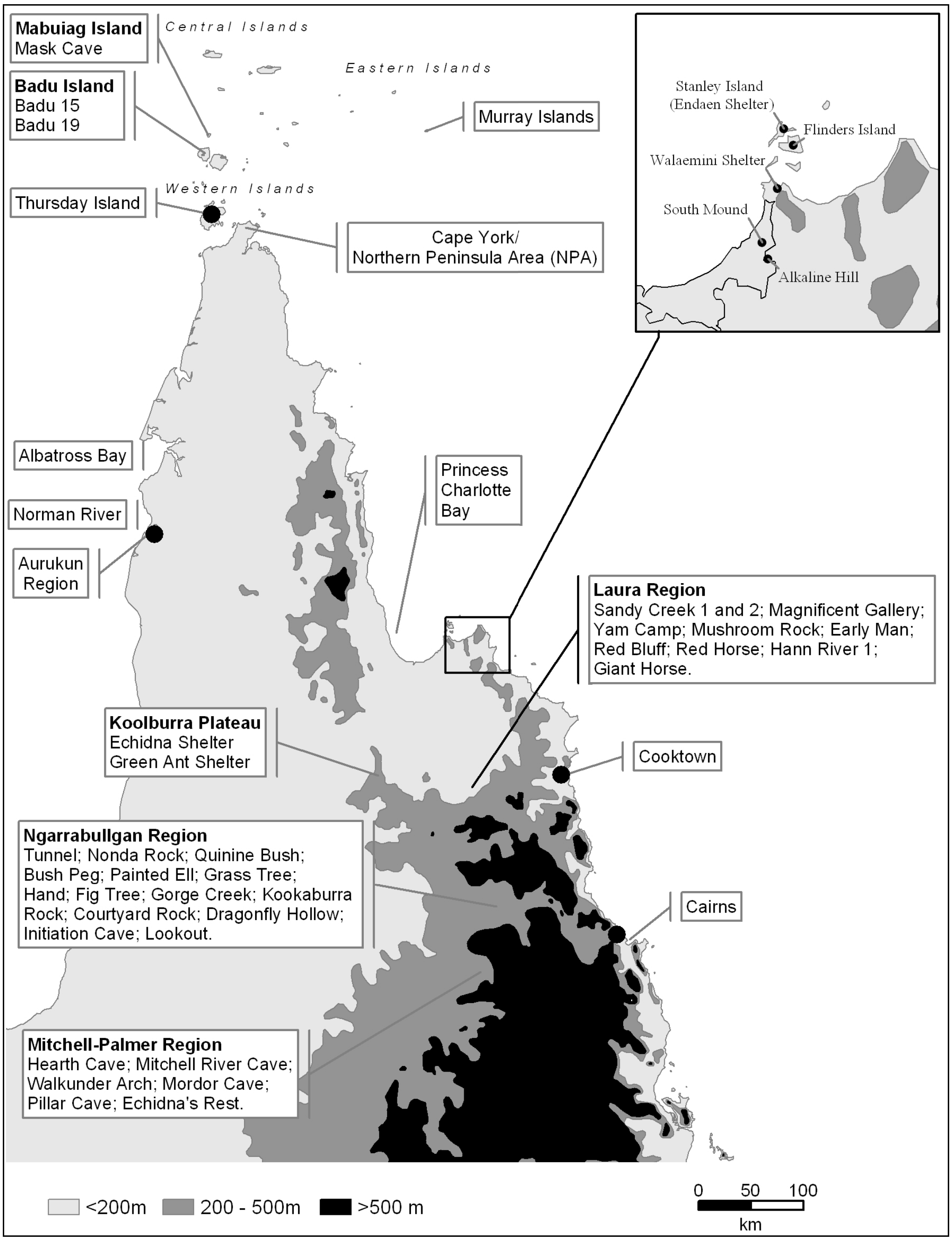

Figure 4-1: Cape York Peninsula and the Torres Strait Islands showing places mentioned in text

4.1 Terminal LGM to mid- Holocene

Although the focus of this chapter is specifically on the period after the mid-Holocene some general comments on earlier occupation trends provide important context. To date, evidence for occupation of what is now Cape York Peninsula during the Pleistocene is confined to a number of rock shelter sites in the south east. At Ngarrabullgan Cave (see Figure 4-1) human presence had originally been dated to ~34,700 BP (David, McNiven, Bekessy, Bultitude, Clarkson, Lawson, Murray and Tuniz 1998; David, Roberts, Tuniz, Jones and Head 1997: 173) though this figure has more recently been increased to around 39,000 BP (David 2002). New dates from the nearby Nonda Rock suggest a commencement of human occupation “sometime between ca. 67,000 and ca. 40,000 years ago”(David, Roberts, Magee, Mialanes, Turney, Bird, White, Fifield and Tibby 2007:476). These two sites thus represent the earliest evidence of human occupation of Cape York Peninsula.

The general consensus is that sometime after the end of the last glacial maximum (LGM) populations across greater Cape York Peninsula (including Torres Strait) gradually increased in concert with improving environmental conditions. For the period 15,000 to 7,000 BP Morwood and Hobbs (1995a) suggested that dramatic environmental changes facilitated demographic shifts that included larger populations and the establishment of “territorial estates and local residence groups, with subsequent changes in the sequence (after the mid-Holocene) occurring as a result of further population growth”. David and Lourandos (1997) broadly agreed but suggested a period of more marked increases at 9,000 BP. This general argument has been supported in more recent syntheses that point to 6,000 BP as the period by which human populations across north Queensland had increased to unprecedented levels (Haberle and David 2004:177).

Drawing on archaeological and rock art evidence from south east Cape York, David and Chant (1995) argued that prior to the mid-Holocene, socio-cultural systems were relatively homogenous as a result of low population densities and the informal nature of social interaction networks. Ideas were spread rapidly through more open social networks and thus the opportunity for distinctive regional archaeological patterns to develop was more limited. They argued that evidence for this lies primarily in the form of low-intensity use of rock shelter sites and the lack of dated regionally distinct rock art forms.

Minimal data are available for coastal or near-coastal regions in the early Holocene due to inundation of the former coastline by rising sea levels. Earliest evidence for near coastal settlement comes from Badu 15 at 8,053±42 BP and while this deposit lacks faunal materials (David *et al.* 2004) it nevertheless demonstrates that between ~8,000 and ~6,000 years ago people remained in the area as sea levels rose, and it is thus not unreasonable to imply they were also utilising adjacent coastal regions. The authors suggested use of Badu 15 involved visits from Cape York rather than permanent settlement. Like other parts of northern Australia (O'Connor 1992; O'Connor and Sullivan 1994; O'Connor and Veth 2000; Sim and Wallis 2008) no evidence presently exists for continued occupation and use for the period 6,000 to 3,800 BP. In short then, there is a major gap in the archaeological record regarding coastal occupation during the early to mid-Holocene period in Cape York and the Torres Strait.

4.2 Albatross Bay

As outlined in Chapter 1, prior to 2001 only a relatively small amount of archaeological research had taken place at Albatross Bay. Here results of earlier research are presented along with summaries of previous models proposed for shell mound phenomena in the region. Radiocarbon determinations obtained by previous researchers are also discussed here and presented in Appendix 2; methods used for calibrating and correcting these determinations are highlighted in Appendix 1.

4.2.1 Previous research

Although shell mounds were first noted in the early 1900s (Jackson 1902; Roth 1900b, 1901) these sites were not subject to any form of academic interest until the late 1950s. It was at this time that Valentin (1959) – a geomorphologist – noted the mounds in the course of aerial surveys and suggested that they must have been cultural features owing to their large size. Conversely, Stanner – an anthropologist – concluded they were natural features as he considered them too large to have been built by Aboriginal people (Stanner 1961). It was only after these preliminary discussions about the origins of shell mounds that the first systematic archaeological investigations were undertaken by Wright (Wright 1963, 1964, 1971). These were in part intended to resolve the question of whether shell mounds were of natural or human origin.

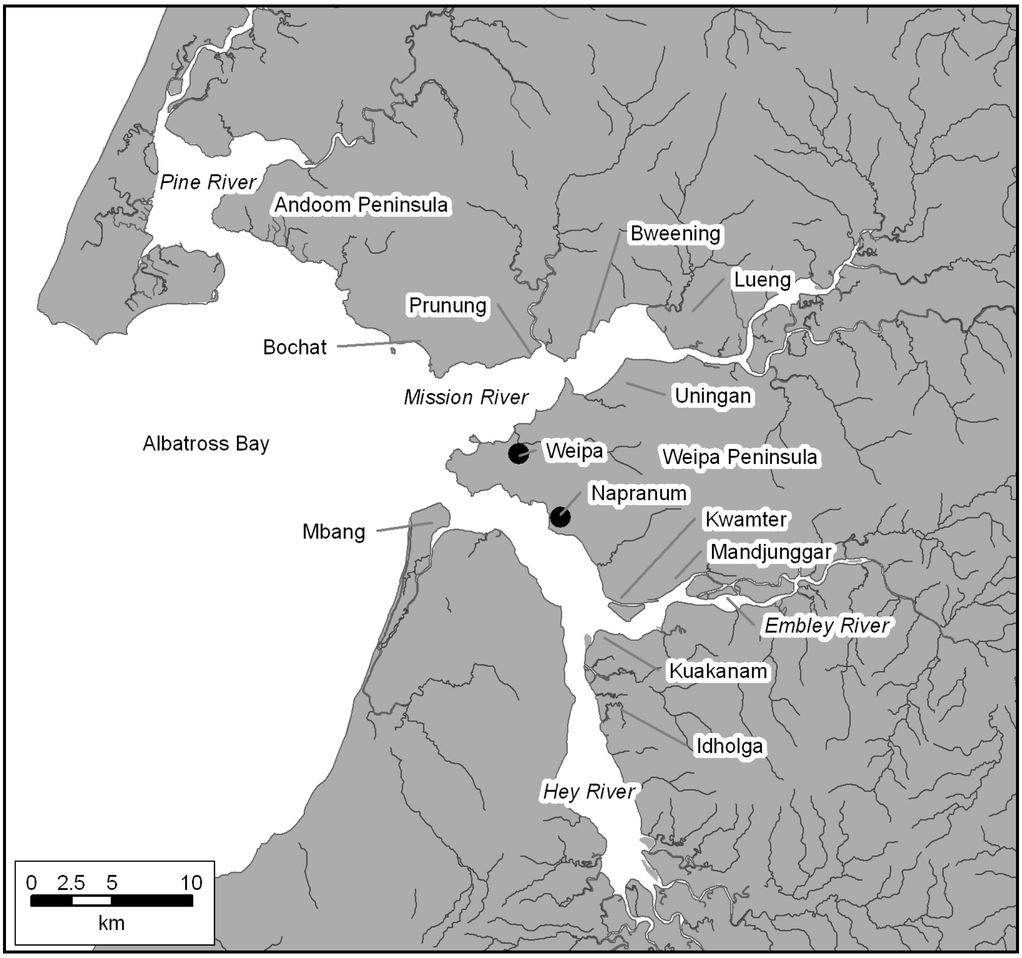

Figure 4-2: The Albatross Bay region showing places mentioned in text

Wright excavated two large shell mound features, one at *Kwamter* and another at a second, larger site at an unknown location on the eastern shores of the Hey River, probably near *Kuakanam* or *Idholga* (Figure 4-2). Wright does not detail results of excavation of the second shell mound on the Hey River. The *Kwamter* excavation was undertaken on a large mound adjacent to swamps and mangroves on the northern banks of the Embley River. A long section had been previously cut through the centre of the mound by earthmoving equipment allowing observations of its internal characteristics and structure. Wright excavated three test pits on its upper surface, each of these 4 feet by 4 feet (1.22 m by 1.22 m). He did not publish detailed results of the analysis of the deposits and no information is available about spit depths, sieve fraction sizes, or excavation techniques. He noted the mound's stratigraphy was predominantly *A. granosa* shellfish remains differentiated only by varying charcoal, soil and shellfish ratios. Few other shellfish species were recovered, although he noted that the gastropods had often been cracked or broken. A small number of stone artefacts and several double-ended bone points were recovered along with wallaby bones, stingray barbs and a crocodile tooth; no detailed descriptions or quantitative data are available for these materials. Auguring indicated that the mound feature was of different composition to its underlying sandy substrates and basal and near-surface radiocarbon dates on charcoal samples indicated that accumulation had taken place between 675(692)717 cal BP (I-1738) and 154(186)286 cal BP (I-1737). He concluded that this and other shell mounds were anthropogenic deposits based on the presence of artefacts, the very high proportions of whole *A. granosa* and low proportions of small sized shells and finally, the extent to which the mounds he investigated were distinct from surrounding landforms.

Bailey commenced research at Weipa in 1972 (Bailey 1972, 1975a) when he recorded detailed data on the size, location and general characteristics of 304 shell mound sites, estimating that a total of about 500 occurred throughout the region. These data have been more recently published in some detail (Bailey 1993b, 1994) and the resulting site specific data has been incorporated into the database developed and analysed in this thesis. Bailey's surveys initially appear to have involved aerial survey to identify areas with large numbers of shell mound sites. The local mining company carried out some of these aerial surveys in order to estimate the gross volume of shell mound deposits in the area (Evans 1957). These results were made available to Bailey who undertook more detailed pedestrian surveys, particularly on the eastern Hey River and the northern and southern coastal strips of the Embley River. Although there are limitations on the use of spatial data recorded by Bailey (see Chapter 5), on the whole his data provide a detailed and consistent record of shell mounds in these areas.

Bailey (Bailey 1975a, 1977) also excavated a single 1 m^2 pit on the same mound at *Kwamter* that Wright had previously excavated. He chose to excavate on the east wall of the trench that had previously been cut through this site, excavating 3 m of deposit in 21 units. He noted little in the way of clear internal stratification beyond variations in charcoal and soil proportions. The only exception to this was the occurrence of lighter, more brittle shell in the lowest 10 cm of the deposit. He noted (1977: 134) that the mound had gone through several phases of growth consisting of “an earlier phase in which shells were scattered to form low mounds or surface deposits; and a later phase, when shells were confined to a more restricted area, and the main upward growth of the deposit took place”.

Excavated samples were sieved through fractions of 8 mm and 2 mm. As Table 4-1 shows, this saw the recovery of a broad range of materials including quartz flakes, polished bone points, stingray barbs, wallaby incisors and a range of fish, crab and mammal bones. *Anadara granosa* comprised 95% by weight of molluscan fauna; the remaining 5% comprised a total of 14 other species.

Material	Quantities
Polished bone points	8
Small quartz flakes	15
Quartz pebble	1
Large flakes	1
Stingray barbs	5 broken pieces
Wallaby incisors	Several, artificially split
Agile wallaby bone (*Macropus agilis*)	265 pieces (combined total)
Short-nosed bandicoot bone (*Isoodon macrourus*)	
Unidentified fish bone including bream (*Mylio* spp.)	125 vertebrae, spines and occasional jaw fragments
Mudcrab (*Scylla serrata*)	21 claws

Table 4-1: SM:393 artefacts and faunal remains
(after Bailey 1993b: 113).

Three samples of charcoal were submitted for radiocarbon determinations, taken from 5 cm, 150 cm and 265 cm above the base of the 3 m section. The near basal sample was 986(1014)1055 cal BP (SUA-149), around ~332 cal BP older than Wright's basal date. Samples from 150 cm above the base and near the surface returned respective ages of 691(725)734 cal BP (SUA-148) and 573(591)655 cal BP (SUA-147). Bailey argued that inconsistencies between his own and Wright's radiocarbon results were not surprising given the size of the mound and the likelihood that its development was not uniform across the entire feature.

Beaton (1984) also undertook a wide program of radiocarbon dating as well as excavations of three mound sites in the region during the early 1980s. This data has not been published, however resulting radiocarbon determinations are available along with basic contextual data (Stone 1995: 82-83) and these are also included in Appendix 2. At present no additional information on the sample selection methods, site stratigraphy, sample context, rationale behind the dating program or specific locations of sites investigated are available. Despite these shortcomings the work undertaken by Beaton provides a broad overview of the general ages of shell mounds in the Albatross Bay region. *Anadara granosa* was used exclusively for dating purposes and nine basal dates were obtained ranging from 302(356)401 cal BP (ANU 4409) through to 1560(1618)1618 cal BP (ANU 4427) while surface dates ranged from 108(160)245 cal BP (ANU 4411) through to 1266(1306)1342 cal BP (ANU 4428). Six of Beaton's conventional radiocarbon ages were younger than 520±80 BP and therefore too young for calibration and correction for the marine reservoir effect; this indicates use of these sites into even more recent times.

In the late 1980s Tim Stone, a geomorphologist, investigated shell mounds at a number of locations including *Prunung*, *Uningan* and at *Kwamter* (Figure 4-2). At *Kwamter*, he obtained 10 *A. granosa* samples from the same section previously sampled by Bailey and Wright. Stone's samples returned ages ranging from 440(471)503 at 300 cm BS (ANU 8030) to 145(271)209 cal BP near the surface (ANU 8021) (Appendix 2). These suggested that the shell samples were not progressively younger from the base to the top; for example, the 70 cm BS sample returned the oldest age at 532(571)610 cal BP (ANU 8023). This sequence of dates again raised the prospect that there were significant complexities associated with dating shell mounds (cf. Beaton 1985:8).

At *Prunung*, Stone dated and analysed a sequence of shore-parallel beach ridges however did not directly date shell mound deposits themselves. He interpreted all of the deposits at *Prunung* as having been naturally formed, a claim seemingly based on column sampling of natural beach substrates but with no analysis of what archaeologists consider to be shell mound deposits. At *Uningan*, he augured four shell mounds on a coastal marine plain; however, again did not provide detailed compositional data for these instead stating that in regards to the first two mounds he investigated "…both appear to be composed mainly of coarse *Anadara granosa* shell" (1995: 88). For a second pair of sites to the south he noted that the largest mound "…is actually a composite feature consisting of three steep sided conical (*Anadara* dominant) mounds superimposed on two linear shell ridges" that "all appear to be composed of coarse *Anadara* shell" (1995: 89). Stone interpreted the *A. granosa* shell deposits as cheniers, despite the quite large dimensions of several of them (almost 4 m in height) and their dissimilarity to surrounding substrates.

Based on this work Stone (1989) claimed that shell mounds throughout the region as well as others throughout northern Australia had been constructed by a species of scrub hen, *Megapodius reinwardt* scraping up naturally occurring shell (Stone 1989). Stone's (1989, 1991, 1992) initial claims were swiftly rebutted (Bailey 1991, 1994; Cribb 1991) and followed up with further archaeological field research by Bailey, Chappell and Cribb (1994; see also Bailey 1993a) who undertook geoarchaeological research on anthropogenic and natural shell deposits. This work took place on Holocene coastal landforms at *Prunung*, *Kuakanam* and *Idholga* (Figure 4-2). The *Prunung* work was focussed on M509, a large shell mound adjacent to the present shoreline. Here they cleaned the eroded seaward face of the mound and surrounding substrates enabling investigation of a long continuous section of mound stratigraphy and its relationships with adjacent deposits. Results of this work are discussed in more detail in Chapter 7 in relation to excavations undertaken at *Prunung* as part of this thesis, however in short they demonstrated the artificial nature of this deposit compared with the underlying and adjacent sandy deposits which contained shell.

At *Kuakanam* and *Idholga* Bailey *et al*. (1994) excavated small test pits on shell mounds in order to compare the shell deposit with its underlying substrates. At *Kuakanam* they noted the mound substrate consisted of a low sand chenier containing bauxite pisoliths and sparse, mixed shell, which stood in stark contrast to the shell deposit. An *A. granosa* sample obtained from the basal cultural deposits returned an age of 424(456)494 cal BP (ANU 8770). At *Idholga*, three mounds on the samphire plains and one at the margin of the bauxite plateau were investigated. All were noted to have very similar composition however only basic summary data were published. Radiocarbon determinations returned basal age ranges of 2288(2335)2395 cal BP (ANU 8774), 597(634)675 cal BP (ANU 8784) and 997(1059)1119 cal BP (ANU 8773) (Appendix 2). An age range of 1380(1433)1491 (ANU 8782) was obtained from a surface sample from the largest mound in this group which stands at 8.5 m high.

Since 2003 there has been a substantial expansion of data on regional archaeological landscapes as a result of various cultural heritage management studies (Shiner and Morrison 2009). This work has focussed upon systematically surveying bauxite plateaus and immediately adjacent areas as a part of the mine development assessment process. Results of some of this work are discussed in more detail in Chapter 5 however in summary it has seen the identification and recording of a number of small to moderate sized scatters of stone artefacts, a number of earth mound features along with large numbers of culturally modified trees. These latter features have been argued to principally represent historic period activity (Morrison *et al.* In Press.) and are not included in analyses undertaken as part of this project because they do not directly contribute to the research questions being addressed.

One project undertaken within recent years that has specific relevance here is that carried at a *Mandjunggar*, to the immediate east of *Kwamter*, in 2004-05 (Morrison 2005) (Figure 4-2). The project involved controlled excavations on a shell mound (SM:217) that was part of a larger cluster of at least five other mounds and two low density shell scatters. SM:217 was a broad, low dome shaped mound approximately 1.2 m in height and 20 m in diameter, set within moderately dense monsoon vine forest at the landward margin of a narrow, sandy beach ridge plain. Surface estimates suggested its composition consisted principally of *A. granosa* shellfish.

A 1 m by 1 m pit was excavated on the mound at the request of Traditional Owners as part of cultural heritage management work in the area, however the pit size was reduced to 0.5 m in the basal layers due to time constraints (Morrison 2005). The pit was excavated in 3-5 cm arbitrary spits and sieved through 6 and 2 mm sieves. One hundred percent of the 6 mm residues were retained for analysis and quantification along with 25-50% samples of 2 mm residues. Due to time constraints on the project, a sample strategy was used to quantify *A. granosa*; this involved removing all diagnostic *A. granosa* from the coarse sieve residues during field sorting and retaining a 20-25% sample (by weight) for MNI estimates. The remaining 75-80% was weighed and then used for site rehabilitation. The method used to estimate the total *A. granosa* MNI of each spit involved establishing an accurate MNI for the quantified 20-25% sample and based on this determining an average weight per diagnostic valve (regardless of completeness). This figure was used to estimate an MNI of the discarded *A. granosa* (weight of discarded portion/average valve weight of sample) and was then combined with the MNI of the retained sample. This procedure was only used on layers excavated as a 1 m^2 pit, and exclusively applied to *A. granosa*: MNI estimates of all other species and for the units excavated as a 0.5 by 0.5 m pit were based on counts of all diagnostic elements, not samples. This method is similar to those used in this thesis and discussed in more detail in Chapter 5.

The excavations revealed a deposit dominated by layers of coarse whole shell alternated by layers of more fragmented shell with low proportions of fine sediment (Figure 4-3). In short, its stratigraphy was consistent with other excavated shell mound deposits in the region. *Anadara granosa* samples from the upper, middle and basal layers of the mound were submitted for radiocarbon dating and results indicated that the deposit accumulated between 637(672)706 cal BP (Wk16364) and 259(306)359 cal BP(Wk16362) (Appendix 2). Cultural materials principally included shellfish remains (Table 4-2) and quantification of these demonstrated an overall site composition of ~85% *A. granosa* and ~13% *M. hiantina* while other species collectively represented less than ~1% of diagnostic shellfish present. Only four small stone artefacts – three on quartz and one on silcrete – and less than 20 g of non-molluscan materials were recovered; this included two otoliths, six small fragments of crab claw (*Scylla serrata*) and 14 g of non-diagnostic bone.

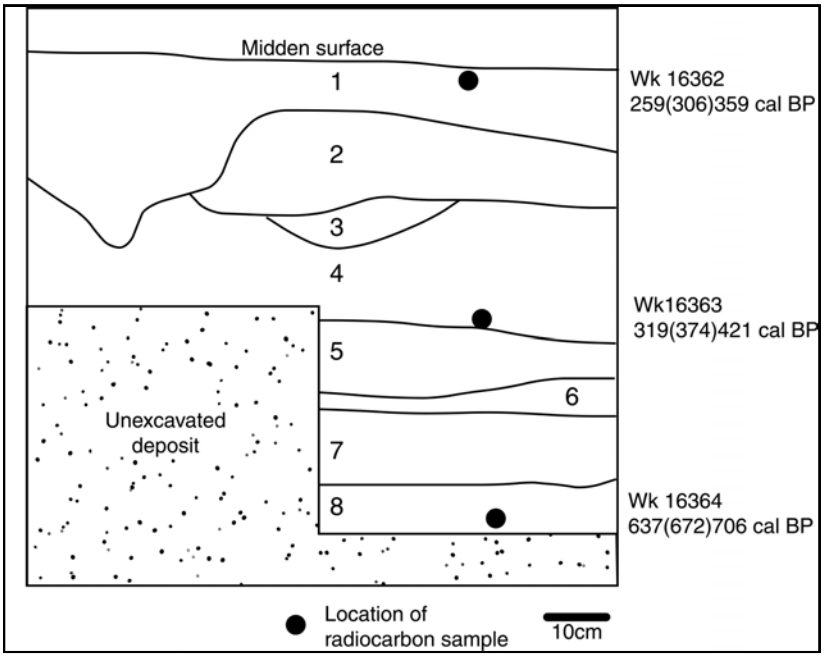

Figure 4-3: Section profile, SM:217, *Mandjunggar*
(from Morrison 2005)
Layer descriptions:

1. Layer of very white shell interspersed amongst large amounts of humic material and fine roots. Significant amount of shell fragmentation
2. Dark friable soil with moderate proportions of fragmented and whole shell. Moderate root numbers.
3. Layer of mostly whole shell (primarily *A. granosa*) in a matrix of fine grey ash. Few fine roots.
4. Layer of mostly whole and very clean and white (not discoloured) *A. granosa* shell. Very low proportions of soil.
5. Layer of mostly whole and very clean and white (not discoloured) *A. granosa* shell. Similar to layer 4 but with a greater proportion of fine dark soil.
6. Layer of coarse shell fragments and grey ash with little or no soil. Similar to layer 8.
7. Layer of whole shell with moderate proportions of soil.
8. Natural sediments into which shell has settled. Fine sandy soil.

Unit	Mean Depth (cm)	Layer MNI	*A. granosa*				*M. hiantina*		All other species	
			Count (No)	*Sample size[1] (%)*	*MNI*	*%*	*MNI*	*%*	*MNI*	*%*
1	4	998	209	22.4	940	94.2	22	2.2	37	3.7
2	3	1009	251	20.0	950	94.1	33	3.2	2	2.7
3	6	1204	281	20.0	1158	96.1	30	2.4	17	1.4
4	5	1348	303	20.1	1315	97.6	19	1.4	14	1.0
5	4	1364	308	20.0	1307	95.9	48	3.5	9	0.7
6	5	1169	319	20.1	1041	89.0	127	10.9	1	0.1
7	4	1375	298	22.4	1053	76.6	319	23.2	3	0.2
8	7	1745	332	21.4	1102	63.1	630	36.1	14	0.8
9	5	1596	340	20.5	1148	71.9	441	27.6	8	0.5
10	12	811	640	100.0	641	79.0	170	20.9	1	0.1
11	7	848	818	100.0	818	96.3	31	3.7	0	0.0
12	13	703	587	100.0	587	83.5	113	16.1	3	0.4
13	2	153	153	100.0	153	100.0	0	0.0	0	0.0
14	6	156	130	100.0	130	83.3	24	15.4	2	1.3
TOTAL	83	14479	-	-	12340	85.2	2004	13.8	136	0.9

Table 4-2: Shellfish composition summary data, SM:217, *Mandjungarr*
Note: *A. granosa* MNI estimated based on count of a sub-sample (see explanation in text). 1) Percent by weight of all diagnostic *A. granosa* recovered in unit

4.2.2 Models and interpretations

As noted earlier, archaeological models for the region have focussed entirely upon the formation and use of shell mound features. In the course of his preliminary work Wright (1971) rejected earlier suggestions by Roth (1901) that the mounds were refuges from mosquitoes, provided security by offering views of the landscape or provided an escape from floods. He instead proposed that they reflected "…an enduring but localised tradition whereby it was culturally desirable to dispose of shells in heaps, taking care to keep the area of disposal constricted" (1971: 135-36) though he did not elaborate on this idea.

It was not until Bailey's (1975b, 1977) research that the question of the role of shell mounds was seriously addressed as part of his broader interest in the role of shell middens in hunter-gatherer economies. Bailey set out to quantify the extent to which shell mound deposits represented past diets and the role of these prominent sites in regional settlement systems. This involved the calculation of shellfish meat weights and calorie yields which when coupled with temporal data allowed for the quantification of the overall dietary contribution of shellfish. On the basis of these analyses he argued that it was entirely feasible that even conservative estimates of the relative calorific contribution of shellfish in local diets of between 3 and 18% were correct (Bailey 1975a, 1977). This was also supported by Meehan's (1982) ethnographic work in Arnhem Land. As Bailey stated (1977: 139):

> …the results demonstrate that the vast quantities of shell in the Weipa mounds could have easily been accumulated by repeated Aboriginal occupation of the area over a period of about 1,000 years without straining existing concepts of Aboriginal population density or technological capacity.

However he also identified the inherent limitations in such a view. For instance, he observed that "…molluscs as a class of food, or shell mounds as a class of site, or both, are grossly over-represented in the archaeological record" (Bailey 1993b: 7).

Bailey's core position regarding the role of mounds in settlement systems has been more recently described as the 'self-selecting' argument (Bailey 1999), a model outlined in most detail in his 1977 paper. The underlying premise of this model was based on Peterson's observations (1973) that earth mounds in Arnhem Land tended to occur in areas which were important subsistence foci during the wet season, but which were often waterlogged. Bailey observed the occurrence of clusters of mounds around Albatross Bay on or near the coastal plains, which during some periods are rich in resources. For example, Bailey observed that (1977a: 140):

> …the high or 'king' tides of the northwest monsoon concentrate marine life in the river estuaries and flood the saltpans with shallow sheets of water in which fish can be easily speared, netted or trapped.

Based on ethnographic data (namely Thomson 1939) Bailey argued that these areas were a focus of activity during the wet season for the purpose of exploiting marine resources, including shellfish. He contended that the mounds provided dry campsites within easy reach of these resources and attributed the occurrence of mound clusters to the influence of prevailing weather conditions or the suitability of specific sites as campsites. For example, when rains were heavy over long periods and storms were frequent, camps were established in more sheltered locations on the margins of the open woodlands. As rainfall and storms lessened, people moved out onto mounds further out on the coastal plains to take advantage of breezes that provided some relief from insects. Finally, as the dry season set in people moved away from coastal areas to take advantage of other resource opportunities.

Questions about the formation and role of shell mound sites were not again taken up until relatively recently in a retrospective paper (Bailey 1999). Bailey expressed some hesitation about whether the self selecting model was the most appropriate explanation of mounds in the region and highlighted the requirement for further detailed research. Since then, the self-selecting model has been the focus of some critique on the basis that it did not adequately account for a number of archaeological variables(Morrison 2000, 2003b). First among these related to the biological characteristics of *A. granosa*, a species with a short lifecycle that can appear and disappear in a local area over relatively short (3-5 year) time spans. Morrison argued that this resource would not provide the regular and reliable food source initially envisaged by Bailey. In addition, a lack of archaeological evidence for alternative shellfish and other resources in the *Kwamter* mound led Morrison to argue that exploitation of *A. granosa* was part of a specific strategy associated with irregular but relatively intensive social gatherings. This argument was supported by ethnographic evidence for such gatherings oriented around local abundances of specific resources. Other factors such as the tendency for many shell mounds to occur on substrates where a mound would provide no obvious functional advantage were also highlighted.

4.3 The Torres Strait Islands

The Torres Strait Islands are in relatively close proximity to Albatross Bay and results from research here provide important context for understanding and interpreting the record at Albatross Bay, particularly in regard to changes in coastal economies since the mid-Holocene.

Excavations at Badu 15 (see Figure 4-1), on the large continental island Badu, suggest that initial permanent occupation took place between 8,000 and 6,000 BP when Badu was one of a series of low hills attached to the Australian mainland (David *et al.* 2004). A second phase of occupation occurred from ca 6,000 until 3,500 BP after sea levels had risen and stabilised, forming the island. During this period David *et al.* argued that occupation consisted only of infrequent, sporadic visits, probably originating from the Australian mainland. Stone artefacts are the only definite cultural materials recovered in these deposits. A third phase commenced after 3,500 BP with a marked change in occupation patterns suggesting permanent occupation of Badu (as an island) for the first time. The primary evidence of this is an increase in stone artefact deposition rates along with a dramatic increase in sedimentation rates consistent with localised burning, clearing and associated erosion. However, no other cultural evidence besides stone artefacts exist from this period.

Recent work at Mask Cave on a small islet off Mabuiag Island immediately to the north of Badu has greatly contributed to improving understandings of the post-4,000 BP record. Research at this site suggests more permanent settlement after 3,800 BP (McNiven, Dickinson, David, Weisler, von Gnielinski, Carter and Zoppi 2006) which is consistent with more regular use of the Badu 15 shelter. This occupation is marked by deposition of small bipolar stone artefacts with the highest densities of these occurring within the past 1,700 years. Faunal materials reflect a marine subsistence focus on fish, shark and ray with small proportions of dugong, turtle shellfish and crustaceans. Similarly, evidence from Badu 19 – an open midden on Berberass Islet at the western tip of Badu Island – suggests occupation from around 4,000 cal BP (Crouch, McNiven, David, Rowe and Weisler 2007). Evidence from this site includes the earliest evidence for dugong and turtle hunting as well as fishing and shellfishing within the Torres Strait.

After 2,600-2,500 years ago there were numerous changes throughout the Torres Strait Islands, including initial occupation of a number of islands, evidence of ceramics and horticulture, and indications of the emergence of a more specialised marine economy than previously seen. Occupation of many areas was primarily focussed on maritime resources and evidenced in sometimes large midden deposits. Carter (Carter 2001; Carter, Barham, Veth, Bird, O'Connor and Bird 2004) has documented substantial use of marine resources at Mer in the eastern islands from

2,500 years ago as well as the appearance of ceramics around 730 years ago. Carter *et al*. (2004) suggested that this, along with phytolith evidence for bananas at Sokoli, was probably indicative of horticulture on the island from 730 BP, or even as early as ca 2,000 years ago. At Badu 19 Crouch *et al.* (2007) documented a dramatic increase in the proportions of fish, dugong, shellfish, flaked artefacts and ochre and at Mask Cave there is an increase in bone discard after about 2,100-2,600 BP (McNiven *et al.* 2006). Sixteen shards of pottery recovered in deposits from Mask Cave were radiocarbon dated to between 2,507 BP and 1,640 BP and preliminary petrographic analysis indicated these were manufactured locally rather than being imported from Papua New Guinea, thus being “the first identified Indigenous pottery tradition for Australia” (McNiven *et al.* 2006).

Within the past millennia it seems clear there have been further changes heralded by the establishment of villages and the appearance of new and unique archaeological deposits such as dugong bone mounds and *Syrinx aruanus* arrangements. These have prompted researchers to argue that societies throughout the Torres Strait underwent major changes within the past 800 years leading to the emergence of the societies known from ethnographic and contemporary oral history accounts (e.g. David and Weisler 2006; McNiven 2006; McNiven and Feldman 2003; McNiven, Wright, Clark, Leach and O'Connor 2008). Barham (2000) has referred to this as the ‘Torres Strait Cultural Complex’.

4.4 Princess Charlotte Bay

Princess Charlotte Bay, on the central east coast of Cape York Peninsula is a broad bay with a series of small continental islands located a short distance from the mainland (Figure 4-1). A series of shore-parallel beach ridges occur on the mainland coast and these are backed by the 300 to 400 m high Bathurst Range. During the early 1980s Beaton carried out field surveys throughout the region and excavated a number of rockshelter and shell mound sites. His work provides a unique overview of occupation patterns of both coastal and hinterland areas during the mid- to late Holocene and because of direct parallels to the Albatross Bay study area, is discussed at some length here. Few other archaeologists have undertaken research in the region but those that have include Minnegal (Minnegal 1980, 1984), Cribb and Minnegal (1989), along with unpublished rock art research carried out by Walsh (see David and Chant 1995: 442-45).

Sites within the Bathurst Range are mostly rock shelters containing rock art and occasional small scatters of marine shells suggesting only casual use of these areas. Scatters of midden deposit, dominated by *A. granosa*, were recorded at a number of springs and at the junctions of creeks or rivers. Two rockshelter sites were excavated for the purpose of determining the length of occupation of the area along with the economic base and material culture of the shelter's inhabitants. These included Walaemini Rockshelter to the north on Round Point, and Alkaline Hill Rockshelter, further to the south (see Figure 4-1).

Walaemini Rockshelter contained shell rich deposits overlaying sterile sands consisting of around 60-75% by weight of *A. granosa.* Nine other shellfish species were recovered, all of which were intertidal or mangrove species; *Saccostrea cucullata* represented 22-28% of the total shellfish composition within the upper units of the deposit. Occasional fish, bird and macropod bones were also recovered along with occasional *P. erosa* shell artefacts. An *A. granosa* sample submitted for radiocarbon dating suggested that the site began forming after 4,760±90 BP (ANU 3041[3]). Beaton interpreted the site as a wet season refuge.

Alkaline Hill Rockshelter is adjacent to a perennial spring and is near the most concentrated part of a series of shell scatter deposits that occur in the immediate area. Three edge ground hatchets were collected from the surface of the open site and excavations inside the shelter itself revealed a deposit that consisted of *A. granosa* dominated shell deposit. Occasional macropod bones and a large number of *P. erosa* fragments thought to be used as tools were also found. Radiocarbon dating of *A. granosa* shells from basal layers indicated that the site started forming around from 3,440±80 BP (ANU 3041[2]).

A total of 16 sites were identified throughout the island groups within Princess Charlotte Bay. Archaeological sites included rockshelters with art and little or no surface deposits, or stratified shell midden facies in aeolian dunes or on alluvial flats. Endaen Shelter and a nearby midden deposit on Stanley Island were the largest and most substantial deposits found on the islands and Beaton excavated a 1 m by 2 m pit inside the rockshelter, revealing approximately 0.5 m of cultural deposits that were mostly composed of shell. The midden deposits included over 20 different intertidal, reef and mangrove shellfish species, with *Terebralia palustrias* and *Lambis lambis* comprising 40% and 20% of the deposits by weight, respectively. Several species of wallaby and occasional fish bones were the only non-molluscan faunal remains

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[3] Beaton (1985: 6-7) gives lab code ANU 3041 for basal radiocarbon determinations on both the Alkaline Hill and Walaemini rockshelters. This is presumably an error.

recovered. Few recognisable artefacts were noted aside from possible shell tools (made on *P. erosa* and *Melo* sp.) and a single bone point. Radiocarbon dating of marine shell from Endaen suggested that the basal layers were deposited at around 2,370±100 BP (ANU 3379).

One hundred scatters and midden deposits along with 38 shell mounds were recorded on and around the chenier ridges between Bathurst Head and the Marrett River, as well as a number of dugong butchering sites near the Marrett River (Cribb and Minnegal 1989; Minnegal 1980, 1984). Thirteen shell mounds were excavated however the only details of South Mound have been reported in detail as it was considered to be representative of other shell mounds excavated. South Mound was estimated to be over ca 535 m^3 in volume and was the second largest site identified in the area. Investigations included excavation of a 1 m by 15 m trench from the site's northern margin into its centre. A 1 m^2 column sample was also excavated and quantification revealed that it was composed of over 96% (by weight and count) of *A. granosa*, with the remaining 4% made up of 22 other species. This prompted Beaton to label the site as an "*Anadara granosa* dump" (Beaton 1985: 7).

Few materials other than shellfish were found in the deposit apart from occasional sea turtle, bone and fish fragments. Beaton did not report the recovery of any artefacts and described the stratigraphy as comprising alternating sediment rich and sediment poor layers, noting no variation in shell fragmentation or species composition within or between these layers. He suggested that the sediment rich layers were comprised of decayed organic material and aeolian silts from nearby supratidal flats that were deposited when the site was not being used. He argued that the sediment rich layers accumulated quite rapidly:

> The mound was formed by rapid deposition of *A. granosa* lenses which give the appearance of being virtually continuous across the site. I suggest that what actually occurred was that numerous small loads of shell, as much as could be carried in a basket, were dumped irregularly over the site area. This was repeated frequently enough during a period of days or weeks for there to be no opportunity for sufficient deposition of non-*Anadara* detritus (natural or human) to accumulate and indicate the margins of the small heaps. The result, after repeated dumping and treading would be a relatively continuous bank of shell lacking in sufficient internal definition to allow the identification of individual dumping events in the form of archaeologically separable lenses. (Beaton 1985:7)

Beaton suggested there were eight individual shell deposition events, each capped by sediment rich layers and developed a generalised model to explain the process of mound formation. His model suggests five developmental phases: (1) deposition of shell and use of the site; (2) abandonment, possibly over several wet seasons; (3) formation of sediment deposits on the site's surface; (4) percolation of these sediments up to 10 cm below the site surface; and finally, (5) subsequent use and rapid deposition of further shell deposits. The program of radiocarbon dating on the South Mound was very detailed and aimed at dating these individual deposition events, however this seems to have been unsuccessful as the uncalibrated dates are sometimes inconsistent (see Beaton 1985: 8). Overall though, the site started forming at ca 1,700 BP and was abandoned permanently from 1,100 BP.

Investigations of 12 other shell mound sites in the Princess Charlotte Bay region suggested the earliest mounds started forming between ca 1,700 and 1,500 BP with the oldest sites situated on the older cheniers further inland. Between ca 1,200 and 800 BP more numerous and larger mounds began developing however mound formation stopped at ca 500-400 BP. Beaton noted that the younger sites were not restricted in distribution to only the younger cheniers, but that they also occurred on the older cheniers. These dates were not corrected or calibrated by Beaton and thus his estimate for the cessation of mound formation at Princess Charlotte Bay is more likely to have been more recent, probably coinciding with the contact period.

4.5 Mainland south east Cape York

Numerous rock shelter sites have been excavated across a large area between Chillagoe and Laura in south east Cape York Peninsula (Figure 4-1). Although none of this work has involved research on coastal archaeological sites, the results are of significance here because they provide a detailed regional record of mid- to late Holocene occupation patterns. This provides important context to understanding trends in coastal contexts discussed elsewhere in this chapter where longer term records are typically absent or poorly preserved.

Sites in the Laura-Cooktown region show many similarities in terms of their mid- to late Holocene cultural histories. Only one new site is occupied in this period, however occupation patterns change at many others that were initially occupied from the early Holocene. David (David 2002) has summarised evidence of occupational and technological trends for this period and this data is reproduced in Table 4-3.

Site	Artefact Deposition[1]	Burrens[2]	Blades[3]	Seed Grinding[4]	Reference to original data
Magnificent Gallery	1,200	1,200		1,200	(Morwood and Jung 1995)
Yam Camp	1,250	1,000	1,000		(Morwood and Dagg 1995)
Echidna Shelter	1,400				(Flood and Horsfall 1986)
Mushroom Rock (west)	1,500	4,000			(Morwood, L'Oste-Brown and Price 1995b)
Mushroom Rock (east)	1,500	2,100-1,700	2,100-1,700		(Morwood *et al.* 1995b)
Early Man Rockshelter	1,800-950	~1,800	5,500-1,000		(David and Chant 1995; Rosenfeld, Horton and Winter 1981)
Green Ant Rockshelter	2,200-1,800	1,400-1,200			(Flood and Horsfall 1986)
Red Bluff	2,300 and 4,500	2,100	2,300		(Morwood 1995b)
Hann River 1	2,400	2,400	2,400		(Morwood 1995c)
Sandy Creek 2	4,000	4000			(Morwood, Hobbs and Price 1995a)
Sandy Creek 1	4,000	1,900	1,900-1,200	1,900	(Morwood *et al.* 1995a)
Red Horse		1,400			(Morwood and L'Oste-Brown 1995)
Giant Horse		<3,800	<3,800	<3,800	(Morwood 1995a)

Table 4-3: Post 5000 BP archaeological changes at sites in the Laura-Cooktown region, south east Cape York Peninsula
(after David 2002)

Notes: All radiocarbon ages are uncalibrated.
1: Period that stone artefact deposition rates increase markedly from previous deposition rates (from Table 7.2 in David 2002: 124). **2**: First appearance of burren adzes (from Table 7.4 in David 2002: 127). **3**: First appearance of blades or microblades (from Table 7.5 in David 2002: 128). **5**: First appearance of specialised seed-grinding stones (from Table 7.6 in David 2002: 129).

All but two sites evidence an increase in artefact deposition rates after the mid-Holocene and of these one was occupied for the first time and can thus be discounted. Of the remaining 11 sites, artefact deposition rates increase from 4,500-4,000 BP at three (Sandy Creek 1 and 2, and Red Bluff) while the remaining sites demonstrate this trend between 2,500 to 950 BP. Red Bluff experienced an initial period of increased stone artefact deposition in the early Holocene (4,500-3,700 BP) followed by reduced use until the latter phase of increased deposition rates after 2,300 BP. The onset of burren adze technology generally occurs at all sites after 4,000 BP with the exception of Echidna Shelter. Significantly, at only three of the 12 sites where burren adzes were recovered do they occur earlier than 2,400 BP. Burren adze finds occur in deposits dating to 4,000 BP at Mushroom Rock (west) and Sandy Creek 2, and slightly later at 3,800 BP at Giant Horse. Burrens occur at Red Bluff, Sandy Creek 1, Hann River 1, Green Ant, Mushroom Rock (east), Early Man, Yam Camp and Magnificent Gallery only between 2,400 to 1,000 BP.

Seed grinding and blade technology are not as widespread throughout the south east region as burren adze technology. Blades are noted for seven of the 13 sites and appear at Early Man Rockshelter sometime between 5,500 and 1,000 BP and sometime before 3,800 BP at Giant Horse. Both estimates are coarse because of difficulties associated with understanding relevant temporal trends in these deposits. Apart from these two problematic sites, it is clear that blade technology occurs at five sites only after 2,400 BP: Yam Camp l, Mushroom Rock (east), Red Bluff, Hann River 1 and Sandy Creek 1. Specialised seed grinding technology occurs at only three sites, appearing before 3,800 BP at Giant Horse, but not until 1,900 BP at Sandy Creek 1 and 1,200 BP at Magnificent Gallery.

Hearth Cave and Mitchell River Cave in the Mitchell-Palmer limestone belt (see Figure 4-1) were occupied from post-LGM times and saw an increase in use after around 3,800 to 3,500 BP (David and Chant 1995: 383-84). At Hearth Cave this period of increased intensity of use seems to only have lasted until 2,500 BP and after this date use levels stabilise. The presence of large amounts of *Alectura lathami* (bush turkey) eggshell fragments suggest this site was probably used on a seasonal basis. Mitchell River Cave shows similar trends from 3,800 BP though it is not clear if use levels at this site stabilise after 2,500 in the same way that they do at Hearth

Cave. Beyond this, Mordor Cave is the only other excavated site in the region. This was used for the first time at around 1,500 BP (David and Chant 1995:385-88) and, as with Hearth Cave, large amounts of *A. lathami* egg shell fragments suggest possible seasonal use.

Stone artefacts at these sites are generally amorphous and few clear diagnostic items were recovered. These include the occurrence of an edge-ground axe at 1,450-1,100 BP and a burren adze slug dating to 1,100-700 BP at Hearth Cave, along with a grindstone found in the lower layers of Mordor Cave (>1,500 BP). The presence of large amounts of ochre at Mordor Cave suggests that rock art painting commenced only with initial occupation of the site at around 1,500 BP.

Excavation of 15 rock shelter sites on and around Ngarrabullgan (see Figure 4-1), a prominent low mountain in the Chillagoe region, provide an excellent insight into local occupation patterns in the late Holocene. The excavations took place at one of three areas: on the plateau or mountain top, amongst the cliffs at the base of the mountain, and finally, in isolated locations away from the mountain (David and Wilson 1999). There is little question that occupational intensities are very low until after 5,000 years ago (David 1991; David and Chant 1995) after which point there is an increase in activity at many sites that had been occupied from earlier times, and also sees many sites occupied for the first time. Quinine Bush Shelter was occupied from around 4,930 BP and Bush Peg Shelter, Painted Ell, Grass Tree Shelter, Hand Shelter, Fig Tree Shelter and finally, Gorge Creek Shelter were only occupied after ca 4,100 BP. David (2002: 124-28) noted that stone artefact deposition rates increase at six sites, sedimentation rates increase at four sites and no formal stone artefact technology occurs at any site. All sites on Ngarrabullgan seem to have been abandoned within the last millennia, with Bush Peg Shelter the most recently abandoned at around 420 BP (David and Wilson 1999).

Test pits excavated at Kookaburra Rock, Courtyard Rock and Dragonfly Hollow in the vicinity of the base of Ngarrabullgan also indicate initial occupation after 4,500 BP. Cultural evidence from all three sites is sparse and intermittent, and none were used after ca 810 BP (David and Wilson 1999: 179). Two sites in isolated locations away from the mountain were also excavated: Initiation Cave, occupied from around 5,290 BP and Lookout Shelter, occupied from around 1,880 BP. Both sites were abandoned between 2,410 and 1,600 BP (David and Wilson 1999).

At Fern Cave near Chillagoe the early to mid-Holocene saw a pattern of decreasing site usage characterised by much lower numbers of artefacts (David 1991; David and Chant 1995). The late Holocene saw an increase in rock painting activity, but it lacks any corresponding changes in the intensity of site use (David 1991; David and Chant 1995: 402). Walkunder Arch, and probably also Pillar Cave, were occupied from the late Pleistocene and at the former there appears to have been a range of technological shifts in stone artefact manufacture and use, though these have not been fully reported (see also Campbell 1982; Campbell 1984; David and Chant 1995). Mardaga-Campbell's (1995) work at Walkunder Arch focussed on excavating living floor surfaces within deposits dating to between 900 and 1,330 BP, 1,300 to 1,530 BP, 2,300 and 2,400 BP and 2,500 and 2,700 BP, respectively. She found that these low intensity occupation events were separated by relatively long periods of time (Mardaga-Campbell 1995:391).

Echidna's Rest is the only site known to have been occupied in the Chillagoe region for the first time during the late Holocene period, and in any case there is some indication that it was occupied from the early to mid-Holocene period (David and Chant 1995: 406). Regardless, there are clear increases in occupational intensity after ca 3,000 BP and after 700 BP formal artefacts appear including seven burren adzes, one thumbnail scraper, several backed flakes and one edge-ground axe fragment.

4.6 Other regions

Beyond Albatross Bay, Princess Charlotte Bay, the Torres Strait Islands and mainland south east Cape York there has been comparatively little intensive research on Cape York. This section reviews work from other regions and also summarises results of rock art research in Cape York and the Torres Strait.

4.6.1 The Aurukun region

Apart from Albatross Bay, the only other location on western Cape York that has been subject to any systematic (published) archaeological research has been in the Aurukun area on the lands of the Wik peoples. Around 25 shell mounds sites have been recorded in the vicinity of the Love River, to the south of Aurukun (see Figure 4-1) along with an unknown (but seemingly larger) number of shell scatters or non-mounded shell deposits (Cribb 1986). The mound sites appear to be restricted to the lower portions of the river however this is not entirely certain. Cribb (Cribb 1986: 143) described these sites as "true shell mounds", primarily because of their similarities to the Albatross Bay shell mounds recorded by Bailey. These sites were up to 3 m in height and typically composed of four shellfish species, with *A. granosa* usually present in very high proportions (> 95% based on surface estimates) and

Telescopium telescopium, *Volema cochlidium* and *Placuna placenta* found in very low numbers. Mounds were commonly located on the margins of marine plains and saltpans, however several examples of sites on the most seaward Holocene dune ridges are also provided. Cribb described only one instance of stone artefacts being identified on a shell mound site; these consisted of a stone axe and several quartz flakes.

Throughout the Holocene and Pleistocene aged dune ridge systems to the north and south of the Love River, Cribb recorded large numbers of shell scatters and midden deposits. These sites were variously composed of *S. cucullata*, *P. erosa*, *V. cochlidium* and, in stark contrast to those sites described above, had few or no *A. granosa* shells present. No shell mounds were reported in these areas. Few sites were recorded to the north and west of Aurukun and those that were included low earth mounds, many containing shell, along with insubstantial shell scatters and middens distributed either on coastal plains or on sandy dune ridges. A core and a number of flakes were located on the surface of the largest of these mounds though otherwise stone artefacts were noticeably absent. An interesting feature of the Aurukun sites is that many of the recorded earth mounds contained little or no shell, suggesting their formation was associated with different types of activities to those associated with shell mounds.

In order to determine whether the distinct vegetation communities on shell mounds may have been partly attributable to cultural practices or domiculture Cribb also investigated the proportions of economic plant species growing on shell mounds today. While an interesting proposition, his results appear to have been inconclusive, showing only a marginal association between shell mounds and species of high economic value. Only a small number of contemporary economic species were found across multiple mound sites, with most species only occurring on one or two mounds (see Figure 9.4 in Cribb 1996b). The abundance of these species were also generally quite low, however despite the data, Cribb (Cribb 1996b; Cribb *et al.* 1988) argued there was nevertheless a high proportion of useful species on shell mounds.

Site type	**Number**	**Percentage of total**
Surface middens	22	38.8
Surface middens on silt	11	16.4
Mounded middens	5	7.4
Shell Mounds	28	41.8

Table 4-4: Frequency of sites by site type, Aurukun region
(after Cribb 1986:143)

Geological context	**Number**	**Percentage of total**
Dune ridge	28	41.2
Silt	27	54.4
Saltpan	2	2.9
River sand	1	1.5

Table 4-5: Frequency of sites according to geomorphological context, Aurukun region
(after Cribb 1986:143)

More recently, surveys undertaken as part of cultural heritage management work around the Norman Creek area (see Figure 4-1), 30 km north of Aurukun, have identified a previously unrecorded group of shell matrix sites (Cochrane 2006b). These consist of 58 shell mounds distributed in a linear pattern along the southern bank of the creek, several kilometres upstream from its mouth. The largest of these measured 120 by 30 m in basal area and up to 2 m in height though the majority of sites were smaller mounds or shell scatters. While excavations were not undertaken, surface observations suggested the shell mound features were comprised predominantly of *Marcia hiantina*. Cochrane noted a lack of stone artefacts in the vicinity of the sites as well as in the Norman Creek area more broadly.

4.6.2 Northern Peninsula Area

In the 1970s Moore excavated several sites in the northern Peninsula Area (NPA) which included excavation of several sites that he had located through reference to detailed ethnographic information available for the area (Moore 1979). These sources suggested that Evan’s Bay had been a prominent meeting place for people hailing from both the mainland and the islands. Subsequent excavations at one site (EB/1) yielded shell, quartz flakes, pumice, cooking stones and a fragment of an edge ground axe. A near basal charcoal sample suggested occupation only began after 610±80 BP (ANU-1366). Excavation of a rockshelter deposit at Red Island Point produced a basal date of 1,120±430 BP and range of stone artefacts, bone and shell (see Moore 1979: 13-15). More recently, extensive research on community cultural heritage management practices has taken place within the NPA (Greer 1995; Greer, Harrison and McIntyre-Tamwoy 2002; McIntyre-Tamwoy 2002); however, this has not included investigation of patterns in pre-contact Aboriginal occupation and therefore is not discussed further here.

4.6.3 Rock art

Rock art represents a major element of the archaeology of Cape York Peninsula, and in particular, of the south east Cape. The following review outlines major spatial and temporal variations in rock art styles in the region.

While David and Chant (1995:501) have suggested that temporal evidence regarding the chronology of engravings and paintings in south east Cape York is largely circumstantial, some general regional patterns are emerging. Firstly, there appears to have been an early to mid- Holocene tradition comprised primarily of engravings and peckings of homogenous non-figurative and track forms. The earliest of these engravings date to ca 13,000 BP at Sandy Creek 1 (Cole, Watchman and Morwood 1995). Morwood and Hobbs (1995a: 765) argued that "one function of this art may have been the 'linking' of local territorial groups in a relatively low-population-density system".

A second, more recent tradition consists primarily of paintings that are argued to date within the past 3-2,000 years, with the continuation of peckings in some areas. David and Chant suggested two major stylistic conventions were observed (see also David 1991; David and Cole 1990; David and Lourandos 1997, 1998, 1999). The first, extending from Ngarrabullgan to Mt Isa, comprises primarily white, linear and non-figurative forms similar to earlier peckings. The latter extends from the Mitchell River north to Princess Charlotte Bay and inland to Bare Hill and is argued to consist of a new range of forms that are mostly figurative and infilled in monochrome and bichrome. Within the northern division David and Chant (1995) noted that there are more numerous traits that vary at a sub-regional level and argued it was indicative of a change from the earlier, relatively homogenous artistic tradition to more highly regionalised one in the mid- to late Holocene. Morwood and Hobbs (1995a), however, are more sceptical and argued that rock paintings have a Pleistocene antiquity as evidenced by pigment found in rockshelter deposits. According to them, taphonomic issues are behind the apparent increase in rock art since the mid-Holocene.

Recent work in the Torres Strait exploring stylistic variation in rock art and portable objects suggests a lack of shared imagery between Cape York Peninsula people and those of the Torres Strait and Papua New Guinea artistic systems (Brady 2008).

Brady has interpreted this as part of the ‘cultural divide’ between horticulturalists and hunter-gatherers (2008: 346) and as such is not detailed here.

4.7 Discussion

The above review points to a suite of archaeological changes at disparate locations across Cape York and the Torres Strait during the mid- to late Holocene. Unsurprisingly, this is most evident in those areas that have been subject to most scrutiny and include south east Cape York, Princess Charlotte Bay and the Torres Strait. Below a synthesis of inter-regional trends and patterns is developed and key explanatory models are reviewed.

Longer term trends are most evident in south east Cape York Peninsula and have been argued to include more intensive site use; increases in the number of occupied sites; introduction of new artefact forms, and possibly more specialised artefact types; new food processing technologies; and finally, increasingly regionalised settlement patterns all associated with a major demographic expansion (David and Chant 1995; David and Lourandos 1997, 1998, 1999; Lourandos and David 1998; Morwood and Hobbs 1995b; Morwood and Hobbs 1995a). Haberle and David (2004) suggested this only occurs after 3,700 cal BP. Rock art evidence from this region has also been argued to be indicative of a trend toward a highly regionalised character of many forms, motifs and colours during the late Holocene and this has implications for our understanding of social organisation in this period (David 2002; David and Chant 1995).

The earliest occupation in the Princess Charlotte Bay region is at Walaemini Rockshelter on the mainland, representing the first unequivocal evidence for use of marine resources in Cape York or the Torres Strait from ca 4,760 BP in the form of abundant *A. granosa* shells. By ca 3,500 BP occupation had also commenced at nearby Alkaline Hill rockshelter where a range of materials were found including *A. granosa* and macropod bones (Beaton 1985). Published quantitative data from these sites is poor in detail however they minimally indicate expansion into newly emerging coastal environments during a period of documented demographic change in nearby mainland south east Cape York. Further work is required in order to document more subtle trends at Princess Charlotte Bay however gross changes at the local level have been widely interpreted as being supportive of regionally inter-linked demographic changes (David 2002; Haberle and David 2004; Lourandos and David 1998; McNiven *et al.* 2006).

Importantly, recent evidence from the Torres Strait indicates initial permanent occupation of the western group of islands at around ~3,800 cal BP as indicated by evidence from Badu 15, Badu 19 and Mask Cave (Crouch *et al.* 2007; David *et al.* 2004; McNiven *et al.* 2006). This has been interpreted as being associated with a demographic expansion of local mainland Aboriginal populations rather than an influx of people from the north (c.f. David *et al.* 2004) and has been linked with similar demographic changes in Cape York and elsewhere (McNiven *et al.* 2006). At Mask Cave, McNiven *et al.* (2006) noted the relative paucity of terrestrial fauna and take this to imply that occupation of the western group of islands by hunter-gatherer people before 2,600 BP was most likely centred upon larger islands with only sporadic and shorter-term use of smaller islands.

Haberle and David (2004:172) suggested that in south east Cape York these cultural transformations were most pronounced between 3,700 and 2,000 years ago and involved “a 3-fold increase in the intensities of site and regional land use”. Shell mounds appeared for the first time on Cape York at ~2,300 cal BP at Albatross Bay (Bailey 1994; see Appendix 2) and from 1,700 BP at Princess Charlotte Bay (Beaton 1985), events that are generally viewed as representing the onset of new, more intensive economic strategies associated with population expansion (David and Lourandos 1997, 1998; Haberle and David 2004; Lourandos 1997; Lourandos and David 1998). In addition, after 2,500 years ago in south east Cape York artefact deposition increases at 11 out of 13 sites where increases occur; burren adzes appear at eight of 12 sites where they occur; blades appear at five of the seven sites where they occur; and finally, seed grinding technology at two of the three sites where it occurs. These new technologies and changing occupation patterns in the south east point to the possibility of links with occupation patterns in coastal areas such as Albatross Bay and Princess Bay.

Significantly, from ~2,600 cal BP a suite of changes occur throughout the Torres Strait including more intensive use of previously occupied islands such as Mabuiag and Badu, as well as evidence for the first occupation of smaller and more remote islands. First noted by Barham (2000), this ‘event horizon’ is also associated with the introduction of a red-slipped pottery tradition, the widespread appearance of intensive shell midden deposits, increased occupational intensity at Mask Cave and Badu 19 and archaeological evidence of maritime specialisation (McNiven *et al.* 2006). Changes toward more specialised marine economies are best documented at

Badu 19 which provides “unequivocal evidence of marine-focussed midden deposition 2,500-2,600 years ago” and the presence of people who “possessed a broad range of marine subsistence skills equal to those recorded ethnographically for the region” (Crouch *et al.* 2007:60). This has been argued to have been associated with a near simultaneous influx of Papuan peoples from the Trans-Fly-Papuan Gulf region, rather than being linked to changes in mainland populations (McNiven *et al.* 2006).

The seemingly parallel suite of changes that occurred at the three Cape York study areas and also in the Torres Strait after 2,700 BP is of special significance here and raises an important question: to what extent are these changes linked? Haberle and David (2004) have argued that the changes in south east Cape York were associated with decreasing bioproduction after the HCO and which is argued to have triggered a series of human responses, not least of which was the fissioning of populations into “new and distinctively smaller land-owning and land-using groups, as evidenced by regionalisation of rock art styles after 3,700 cal yr BP” (Haberle and David 2004:177). A reduction in the size of group territories is argued to have resulted in concomitant changes in production strategies including the use of a broader range of foodstuffs, more intensive use of existing resources, including more marginal resources, all in all indicating what they term a ‘broad spectrum revolution’. As noted, the appearance of shell mound sites at Albatross Bay and Princess Charlotte Bay at this time have been seen as a part of this suite of economic changes, however the character of associated production strategies and their significance for interpretations of broader, long-term archaeological changes remain poorly understood. The approach taken here of viewing shell mounds as one example of a late Holocene production system is of special importance for further considering questions surrounding the timing and nature of these changes both in mainland Cape York and the Torres Strait. This also has potential to contribute to broader debates about what the mid- to late Holocene appearance of shell mounds across northern Australia represents, particularly in terms of models of economic change.

Chapter 5: Methodology

This chapter reviews the methods employed during field survey, excavation and analysis undertaken as part of this thesis. Prior to the commencement of this project, a substantial amount of survey data generated by previous researchers was available. As such, this chapter also outlines methods used to combine the results of this earlier work with those undertaken by the author.

5.1 The regional archaeological database

As part of this research it has been necessary to develop a database to manage, analyse and present the various archaeological survey data that are available for the study area. While detailed summaries and general site locations of all sites are provided herein, the full database is not included as an appendix because Traditional Owner groups who approved the research requested that specific coordinate data about cultural heritage places not be made publically available. At the time of writing no centralised Aboriginal corporation or body exists for the management of cultural heritage data in the region and so a full copy of the database and this thesis have been submitted to AIATSIS under restricted access conditions.

5.1.1 Available data sources

As outlined in Chapter 2, Bailey's field surveys (1972, 1975a) represent the first attempt at systematically recording archaeological sites in the Albatross Bay region. He used a combination of aerial and pedestrian survey to identify and record shell matrix sites focussing on the eastern banks of the Hey River and the northern and southern banks of the Embley River. Importantly, Bailey's research aims only required documentation of shell matrix sites rather than a representative sample of all site types that may have occurred throughout the region. The result was that his surveys focussed upon coastal landforms and in particular, those areas where shell mounds had been previously noted.

The data recorded by Bailey (1975a) included site dimensions, morphology, volume and landscape context or substrate for 304 individual shell matrix features. The primary limitation on using this data is that the locations of individual features were only allocated to a specific mound group, rather than being allocated unique coordinates. Some of these mound groups include up to 40 individual features and therefore the available spatial information is of low resolution. This presumably reflects the specific aims of Bailey's work and also possibly the difficulty of recording the coordinates of sites in a landscape context without any prominent visual reference points on the horizon.

Despite the spatial resolution limitations, Bailey's data on the individual attributes of shell matrix sites in the region are highly useful because of their consistency and extensive nature. A particularly useful aspect of Bailey's work are his detailed calculations for the estimated volume of shell mounds, calculations which other researchers in the region, and across northern Australia, generally have not attempted with the same level of detail.

More than two decades after Bailey's 1972 work, Cribb (Cribb 1996a) undertook a new program of field surveys as part of a cultural heritage management project. These included investigations of areas Bailey had noted during aerial reconnaissance but not examined in detail. While Cribb recorded the dimensions and landscape context of a number of sites unfortunately the potential research value of his data is quite limited because he does not appear to have systematically recorded the sites he visited and his plans are not cross-referenced with site descriptions or labels. Cribb did use a GPS to obtain coordinate data however all attempts by the author at plotting this data using a range of coordinate systems and datums consistently resulted in obvious errors[4]. Consequently, Cribb's hand-drawn maps are the primary source of spatial data. Using these it is possible to identify particular sites to within 100 m of their probable actual location, though unfortunately it is still not possible to cross-reference these with his site descriptions. For these reasons data obtained by Cribb during this period of work are used herein only in a generalised manner for situations where no other data are available.

In 2003 Comalco Aluminium Limited (now Rio Tinto Aluminium) commenced a cultural heritage management program that involved systematic assessment of areas to be disturbed by mining related development, primarily of the *E. tetradonta* woodlands. A limited part of this work focussed upon the fringes of seasonal and permanent freshwater creeks that cross these woodlands, as well as surveys in some coastal landscapes. The results of this work are of high research value because they represent the first systematic attempt at documenting sites in non-coastal landscapes and are therefore of critical importance in understanding broader patterns land-use. The entire Rio Tinto database was not available to the author during the analysis stages of this research. However, selected summary data have more recently become available and are the subject of ongoing research (Shiner and Morrison 2009). Due to access limitations, data on the individual attributes and coordinates of sites

[4] Discussions with Cribb in 2002 could not resolve these issues and he himself was extremely frustrated that the data could not be accurately plotted into GIS software.

recorded as part of mine-related cultural heritage management work are not included in the database used here. However, summary data and the location and general characteristics of concentrations of these features are provided and are referred to as ‘site complexes’, a term more fully discussed below.

5.1.2 Site classification

As indicated in Chapter 1, following the convention of Claassen (1998: 11), the term shell matrix site is used here as a general category for all shell bearing sites in the region in preference to the more general term ‘midden’. Three largely descriptive sub-classifications are used to distinguish between shell matrix sites according to the density of the deposit. These include shell scatters, shell middens and shell mounds with the key distinguishing criteria between scatters and middens being whether the deposit is sufficiently dense to cover 100% of the ground surface at the most concentrated portion of the site. Shell mounds were distinguished from other sites where the deposit formed a distinct mound > 5 cm in height.

A number of further specific terms are used to describe the varying morphological characteristics of shell mounds. These terms and associated definitions are outlined in Table 5-1. Importantly, it should be noted that these terms are simply a description of the morphology of the features in question and do not carry any interpretive value.

Term	Description
Conical	High, steep sided cone-shaped mound. Upper surface is not flat. Circular or ovate base.
Truncated	Similar to a conical mound, but with a flat or truncated upper surface. Circular or ovate base.
Dome	Gently sloping on all faces and resembling a low dome. Circular or ovate base.
Elongated	Mound which is substantially longer than wide. Gently sloping upper surface.
Composite	More complex features comprising several mound types that have coalesced to form a single large body of shell. This category includes features which have distinct peaks on an otherwise low-relief surface (e.g. an elongated mound base with a truncated mound at one end).

Table 5-1: Descriptive terms for shell mounds

Stone artefact scatters are another common archaeological feature in the region (Shiner and Morrison 2009), although few were recorded as part of this research. Instances where only one artefact was noted are referred to as isolated artefacts however spatially discrete incidences of more than one artefact are referred to as stone artefact scatters.

Earth mounds had not been identified in the Albatross Bay region until relatively recently and well after fieldwork toward this thesis had been completed (Cochrane 2006b; Shiner and Morrison 2009). Present data suggests that earth mounds are typically < 1 m in height and < 5-7 m in diameter, occurring on alluvial substrates adjacent to freshwater-marine transitional zones on small tidal estuaries. Their cultural origin is indicated by the presence of archaeological materials on their surface including marine shell, burnt ant bed and stone artefacts; preliminary excavations suggest that they are composed principally of dark fine soil with these same materials throughout (Shiner and Morrison unpublished data). These mounds can probably be classified in the same general category of sites noted by Brockwell (2006) however systematic assessment of those around Albatross Bay are yet to be undertaken.

The final types of archaeological features referred to in the database include mixed surface scatters and site complexes. The former term refers to diverse scatters of marine shell and stone artefacts, though overall such sites occur infrequently. The latter term is commonly used for situations where isolated archaeological features or concentrations of such features (such as artefact scatters or groups of shell matrix sites) are known to occur but where detailed data is incomplete or unavailable. The category is intended to enable generic information about such features to be integrated into the database in order to present a full picture of current knowledge of the regional archaeological record.

5.1.3 Data quality and site numbering

As outlined earlier, the quality of data drawn upon to compile the database is of variable detail and hence a basic schema is used throughout this thesis to grade data available for particular sites or areas. Three data classes are used here in order of most to least detail:

- Class 1: sites recorded in highest detail with specific and consistent attribute data accompanied by high resolution spatial data (detailed site mapping);
- Class 2: sites recorded in high detail with specific and consistent attribute data but with poor quality spatial data (coordinates given within < 1000 m of actual location); and finally,
- Class 3: generalised data for whole groups of sites (such as shell mound groups) or large features (such as stone or mixed artefact scatters) that have been noted or recorded in a preliminary fashion, but which have not been subject to detailed recording.

Bailey's shell matrix site data have been allocated to Class 2 because consistent site-specific information is available however coordinate data is only generalised. Conversely, Rio Tinto cultural heritage data have been included as Class 3 data because access limitations have meant that only basic attribute data are available at time of writing.

In compiling the database, caution has been taken to ensure that multiple sets of data for any particular site are not included whilst also ensuring that the most accurate data available was included. In short, where multiple sets of data occurred for a specific area, those of the highest quality were included in the database in preference to those of lower quality. No attempt was made at combining data recorded in different levels of detail or by different researchers. The selection of data entered into the database was made manually rather than using automated database queries so as to reduce the possibility of errors or duplicate data.

To reduce potential for confusion there has also been a need to reflect these differences in accuracy in the site numbering system employed in the database. New, unique site numbers have been used for all sites in the database rather than attempting to use earlier labelling conventions. All sites were entered in the database with a prefix reflecting the general category of site and a unique numerical identifier. These identifiers are unique for each category and also reflect the different levels of detail available in the data itself. Details of these prefixes are outlined in Table 5-2.

Prefix	Category	Data class	Description
SM	Shell Matrix Site	Class 1 or 2	Site specific data on shell matrix features. No sub-classification for scatters or shell mounds.
SA	Stone Artefact	Class 1 or 2	Site specific data on isolated stone artefact.
EM	Earth Mound	Class 1 or 2	Site specific data on earth mound features.
SC	Site Complex	Class 3	Groups of features for which only very general coordinates or basic/preliminary attribute data are known. This includes stone artefact scatters and groups of shell matrix features.
MS	Mixed Surface Scatter	Class 3	Site-specific data on surface scatters that include a mixture of marine shell and stone artefacts of variable proportions.

Table 5-2: Prefixes used to denote site categories

Sites in each category have been allocated a three digit number starting at 001. Hence, shell matrix sites are labelled as SM:001 onwards, stone artefacts as SA:001 onwards and so on. This is also the case for the more general data in the categories of shell matrix complex (SC:001 onwards) and mixed surface scatters (MS:001 onwards).

5.2 Field survey methods

Owing to the author's involvement in various cultural heritage management projects, a number of opportunities for funded fieldwork were available whilst undertaking this thesis, though such field trips were not primarily aimed at carrying out thesis based research. However, taking on these opportunities greatly increased the amount of funded field time available for field research and enabled the collection of a great deal more data than would otherwise have been possible. Before outlining the general methods used in this work some brief comments on the aims and context of these projects are useful.

The first and most significant project was the two-year Albatross Bay Cultural Heritage Project (ABCHP) (Morrison 2003c) conducted throughout the Albatross

Bay region particularly along the north Mission River, the northern Weipa Peninsula and selected areas of the Hey River. Traditional Owners working with Cribb initiated the project out of a concern that highly culturally significant shell mound features were being damaged (Cribb and Morrison 2001). The primary aims of ABCHP field surveys were to document known shell mound sites and to undertake systematic surveys of areas with high visitation rates. Survey areas were selected by Traditional Owners based on their knowledge and by consulting the results of earlier survey work (Bailey 1972, 1975a; Cribb 1996a). Approximately 16 weeks of survey work and community consultation were undertaken as part of this project.

Limited field surveys were also carried out as part of the *Bweening* Archaeological Salvage Project (BASP) (Morrison 2003a). This in a sense added to work carried out under the ABCHP but was undertaken at the specific request of Comalco Aluminium Ltd. The intent was to document archaeological features in an area that had been inadvertently damaged by mining-related activity on the northern shores of the Mission River. This work was carried out over around three days in 2003 and recording procedures were consistent with those used in the ABCHP.

Field surveys aimed at filling perceived gaps in survey coverage and improving general knowledge of the north Mission River were also carried out for the purposes of the PhD research. These surveys involved several weeks of surveys and were carried out with field assistance from Traditional Owners and an archaeological assistant.

5.2.1 Survey strategy

As noted, field surveys in most cases aimed to visit specific areas identified by Traditional Owners or which were known to have archaeological sites based on previous work. The research goals of these surveys were in many ways secondary to ensuring the work met the goals of Traditional Owners and other stakeholder bodies. Overall this meant that the surveys were initially focussed upon areas with large prominent shell mound sites. In these cases the survey strategy was simply to systematically survey as much of the surrounding area as time and other factors would allow, and in doing so record in detail the location and attributes of all features located. This was undertaken by the author with assistance from one or two younger Traditional Owners.

This initial survey strategy was not ideal from either a research or cultural heritage management perspective as it meant that there was a strong bias towards simply documenting prominent shell mounds. The potential result was thus a failure to identify archaeological features in areas that Traditional Owners were not as familiar with, or where previous research had not taken place. To address this issue the initial survey strategy was revised to include visiting and systematically surveying areas that had some form of public access, regardless of whether they were known to have shell mounds or not. This broadened the scope of the field surveys substantially beyond recording shell mounds to systematic assessment of areas with high visitation. However, the focus of this work remained on coastal landscapes for a range of reasons, not least of which was that these areas were of most concern to Traditional Owners from a management and cultural perspective.

In summary, this strategy allowed for the systematic survey and recording of prominent shell mound groups as well as systematic assessments of areas subject to high visitation. Regardless, there is an explicit bias toward coastal landscapes in the survey data. This is to some extent ameliorated by more recent mine-related cultural heritage management work described above. This involved explicit attention to non-coastal landscapes on the bauxite plateaus and to a lesser extent, the creeks and swamps which are found on these (Shiner and Morrison 2009). At the time of writing this included approximately 10,000 hectares of survey coverage (Justin Shiner pers. comm. 2007). Access to even general results of this work therefore provides a far more representative picture of the archaeology of the region than could have possibly been obtained via the survey time available as part of the thesis research.

5.2.2 Survey and recording methods

After a survey area was identified initial reconnaissance was undertaken in a vehicle with more elderly Traditional Owners. These were generally followed by more detailed pedestrian surveys at a later date with the involvement of a larger number of younger Traditional Owners. The size and extent of the survey areas were usually not predetermined, but were simply based on the time available, the size of the survey team, the mobility of the team and the extent of vegetation coverage. The survey work involved the team systematically traversing the areas that were to be investigated, typically following natural landscape features such as creek margins or vegetation lines. Survey coverage was recorded using a handheld GPS unit along with field notes and sketch maps.

The same general recording procedures were used for all sites recorded by the author, including:

- General details about the recorder, the date the site was visited, photograph numbers, GPS settings, coordinates, and the computer filename under which the GPS data was saved;
- Site type, morphology and composition (for shell matrix sites), dimensions and any other materials present;
- Brief description of on-site and off-site vegetation, landscape context and substrate (samphire plain, bauxite plateau, mangroves, chenier or sand dune/ridge);
- Management information; and finally,
- Preliminary sketches.

A non-differential GPS unit was used to plot the boundaries of all sites >1-2 m in diameter. This technique is generally reported as being only accurate to 30 m however checks on data accuracy were carried out by recording and re-recording the positions of prominent features over a period of several months. For the most part there was rarely more than a 5-10 m discrepancy between recordings taken at different times. This scale of resolution was considered sufficient for the research goals given the very large areas that were being investigated and the large size of many of the features being recorded.

5.3 Excavation and analysis methods

Detailed attention to excavation and analysis methods on shell matrix sites is of critical importance. As Waselkov (1987: 150) has noted, “without a clear idea of the data required from such sites [i.e. shell matrix sites], undirected excavation can easily retrieve enormous quantities of redundant data that still may prove totally inadequate for resolving important research questions”. This is most certainly the case with shell mound sites.

5.3.1 Sampling strategy

Internationally, large-scale open area excavation is considered to be the most appropriate method for sampling shell matrix features because it allows for identification of variations in structure, composition and age across larger features (Claassen 1998; Stein 1992a; Waselkov 1987). Column sampling is sometimes viewed as less than ideal unless an intensive strategy involving numerous column samples is used in order to obtain a more statistically representative sample of the deposit or range of deposits in question (e.g. Waselkov 1987).

Critically, many Traditional Owners view large-scale disturbance of shell matrix sites in the Albatross Bay region as inappropriate and contrary to widely held cultural beliefs. Furthermore, until very recently local mining interests afforded no protection to cultural heritage sites and there are well documented examples of shell mounds and other cultural heritage sites being severely damaged or destroyed (Bailey 1977; Cribb 1996a; Cribb and Morrison 2001; Morrison 2001, 2003a, 2003c, 2005). As one Elder noted during fieldwork for this project, “when those shell mounds get pushed [i.e. bulldozed or damaged], it makes us sick; they need to clean it up otherwise we don’t get any better” (Bernice Mango pers. comm. 2002). Within this context, large-scale disturbance of mound sites is not appropriate however Traditional Owners consider careful low impact excavation appropriate provided this is done in collaboration with, and under the direct supervision of, senior community representatives.

The inability to undertake large-scale excavation was not viewed as a constraint primarily because such a methodology is at odds with the research aims outlined in Chapter 1. Key questions relating to intra-site and inter-site variability in composition and chronology would not have been met through large-scale excavation and analysis of only one or two sites. As such, the sampling strategy employed here was low impact and focussed upon the excavation of column samples from a range of deposits, a strategy that has been successfully employed on shell mound sites across northern Australia (e.g. Bourke 2000; Faulkner 2006; Veitch 1999a, 1999b). Column samples in such cases are around 1 to 2 m^2 in size and on smaller deposits can be as small as 50 cm^2 in size (Bailey 1977; Bourke 2000; Faulkner 2006; Mitchell 1994; Robins *et al.* 1998; Veitch 1999a). This is not to say that heterogeneity in individual shell mound deposits is not an issue or that large-scale excavation would not provide important results. However, at this stage the careful and controlled removal of 50 cm^2 to 1 m^2 column samples from a range of sites was considered to be the best method for addressing key research questions outlined in Chapter 1. Further, Traditional Owners were concerned about the permanent removal of cultural material and thus requested that all cultural materials be returned to the site of origin once analysis was completed.

5.3.2 Excavation procedures

The excavation procedures used as part of this project were informed by results of earlier excavations in the Albatross Bay region (Bailey 1975a, 1977, 1993a, 1993b, 1994) and elsewhere (Beaton 1985; Mitchell 1994; Robins *et al.* 1998; Veitch 1999a). Based on these examples, it was reasonable to suggest that the typical shell mound deposit is poorly stratified, loosely compacted and is primarily composed of large proportions of marine shellfish, with *A. granosa* often the most common species encountered. Stratigraphy consists of layers of clean, mostly whole shells with negligible soil, alternated by shell dominated layers containing slightly greater proportions of soil along with more fragmented shell, ash and charcoal. Other faunal materials recovered typically include small proportions of terrestrial vertebrate bone, crab shell, bones of fish and rays, with the addition of small amounts of dugong and turtle bone at Princess Charlotte Bay.

To deal with the loosely compacted and poorly stratified nature of the deposits the approach to excavating the column samples involved the removal (by hand) of systematic spits generally between 3 and 10 cm in depth. Early attempts to remove these spits according to stratigraphic variations were largely unsuccessful because mound strata were not distinctly defined with stratigraphic changes sometimes observed to occur over as much as 20-50 cm of deposit. This no doubt is a reflection of the loosely compacted nature of the deposits and the evident ease with which fine sediments percolate downwards. Bulk weights of excavated material were recorded before being sieved through 6 mm and 2 mm nested sieves in the field. The gross weights of all sieve residues were recorded and used to calculate the amount of material < 2 mm in size. Only a small sub-sample (generally around 0.25 kg) of sediments that passed through the 2 mm sieves were retained; these were retrieved from a catch tray placed under the sieve.

Six millimetre sieve residues were initially hand sorted in the field to identify any fragile or unique items and these were subsequently removed and separately bagged. The 6 mm sieve residues contained many kilograms of whole shellfish and shellfish fragments of a range of sizes, typically dominated by *A. granosa*. This presented the problem of transportation of very large amounts of material away from the site, and more importantly meant that the large amounts of shell required to rehabilitate each site to the standard required by Traditional Owners would not be available locally. As noted in the previous section, Traditional Owners requested that large amounts of cultural material should not be removed. For these reasons several sampling strategies were developed and applied where transportation of large amounts of excavated materials was a limitation.

The first of these involved weighing bulk 6 mm sieve residues in the field and splitting the sample into two sub-samples, each of which were treated differently in the field. The first, usually about 25-50% by weight of total 6 mm residues, was retained unsorted for detailed lab analysis. The second sub-sample (the remaining 6 mm residues) were hand sorted with diagnostic *A. granosa* valves (see below for diagnostic criterion) removed, weighed, counted and then used for backfill. This had the effect of greatly reducing the weight of 6 mm samples to be removed from the site. This strategy is similar to that reported by Robins *et al*. (1998) and was well suited to resolving the problem of transporting large amounts of material that ultimately yields little information. However, as discussed below, such a strategy raised issues for quantifying the proportions of *A. granosa* in relation to other molluscan species and this issue is discussed further below.

The second sampling strategy developed involved removal and quantification of all diagnostic *A. granosa* shellfish from 6 mm residues in the field and then returning these to the site for backfilling. The remaining 6 mm residues (which lacked diagnostic *A. granosa*) were split into two sub-samples. The first sub-sample, representing 25-30% of the remaining net 6 mm residues, were retained intact for laboratory analysis and detailed quantification. The remaining 70-75% 6 mm sub-samples were hand sorted in the field for bone, artefacts and other uncommon materials and then returned to the site for backfilling. This strategy was rarely employed and only in situations where the removal of cultural materials was required to be kept to an absolute minimum.

The proportion of 2 mm sieve residues recovered varied between sites and even between different spits within a site. Where only small amounts were recovered, particularly when only 50 cm^2 column samples were excavated, all 2 mm residues were retained; however in cases where very large proportions of 2 mm residues were recovered then only small samples (usually 25 – 50%) were retained for further analysis. All 2 mm materials to be retained were transported to the lab for further analysis while those to be discarded were used as backfill.

The only variation to this broad excavation method was that adopted as part of the *Bweening* Archaeological Salvage Project which included mitigation work on shell matrix sites damaged by clearing activities (Morrison 2003a). Here, excavation procedures were the same as described above with one exception: some of the shell matrix sites being investigated had been partially bulldozed leaving discrete spoil heaps of reworked shell matrix deposit. These deposits and the associated spoil heaps occurred upon bauxite laterite substrates well outside of any possible marine influence (see Chapter 7) so it was impossible to confuse the anthropogenic deposits with other natural deposits of shell. While these heaps retained no stratigraphic integrity, they were nevertheless treated as bulk samples that could provide general compositional information. Large amounts of naturally occurring materials were intermixed with shell matrix deposits including soil, vegetation, bauxite pisoliths and ironstone and for this reason only 6 mm sieves were used. The 6 mm sieve residues were weighed, sorted for unique or fragile items and a sample was taken for more detailed sorting (either in the field or the lab). The sample size was often less than 10% because of the very large amounts of 6 mm residues being processed. Spoil heaps were investigated on only a small number of occasions and this data is clearly differentiated from investigations of intact sites.

5.3.3 Laboratory analysis

Flotation was used on all retained 6 mm sieve residue samples in order to remove most vegetative material and charcoal as well as fine soil and dust. The method used for flotation involved mixing a portion of each sample with around 9 L of water and pouring off fine fraction materials (primarily humus and charcoal) into a 1 mm sieve, then draining and thoroughly air drying it. This process was repeated with each batch until no further material was recovered in the 1 mm sieve. The initial step in quantification was the separation of the bulk residues into the primary categories of shellfish remains, non-diagnostic shellfish remains (or shell hash), stone/other artefacts, non-molluscan faunal materials, vegetative materials and unmodified stones. Diagnostic criteria for shellfish are discussed in detail below. Shellfish remains were sorted by genus or species; sorting non-diagnostic shellfish by species was not undertaken because it was considered that a more accurate picture of shellfish representation could be obtained by targeting diagnostic elements, regardless of their size. One hundred percent of most 6 mm residues were sorted and quantified except where the field sampling strategy was applied to remove a proportion of *A granosa* valves as described earlier.

A strategic approach was taken to the investigation of 2 mm residues that allowed sufficient information about key research questions to be addressed without the need to exhaustively analyse all 2 mm samples that had been retained. All 2 mm analysis was undertaken in the lab and was focussed upon the excavation units in each pit with the greatest proportion of combined non-molluscan fauna recovered in 6 mm residues. 2 mm residues were not investigated from other units and sites where no non-molluscan faunal remains were recovered were also not systematically inspected. As with the 6 mm sieve residues, 2 mm residues were subjected to flotation as described above in order to separate heavy and light fraction materials; both of these fractions were systematically inspected. Analysis of 2 mm materials was specifically focussed on the rapid identification of non-molluscan faunal remains, stone artefacts and diagnostic shellfish elements. Shell hash, bauxite pisoliths or other materials in the heavy fraction sub-sample were not quantified. All 2 mm residue finds were kept separate from 6 mm residues; these data are also presented separately at the end of Chapters 6 and 7.

5.3.4 Shellfish analysis

Six millimetre residues were the primary focus of shellfish quantification work. As outlined above, the shellfish quantification process consisted of the removal of all diagnostic elements of all species using a similar methodology to that outlined by Claassen (1998:106-07). All other shellfish remains were placed into a non-diagnostic shellfish category regardless of size or completeness. Unambiguous criteria for identifying diagnostic specimens were used consistently throughout the shellfish analysis and these are outlined in Table 5-3.

Type	Diagnostic criterion	MNI calculations
Symmetrical bivalves	Complete hinge including cardinal teeth, lateral teeth and umbo. Completeness of valve not necessary.	Total diagnostic valves divided by 2
Asymmetrical bivalves	For rock oysters (*S. cucullata*): the presence of a complete hinge on the base or a full adductor scar on the lid (top).	Sum of the most frequent element (i.e. bases or lids)
Gastropods - globular shape	Fragment consisting of intact inductura, umbilicus and umbilical callus.	Sum of diagnostic elements
Gastropods - conic shape	Fragment consisting of a complete spire, specifically the presence of nuclear whorls.	Sum of diagnostic elements

Table 5-3: Shellfish diagnostic criterion

Weights of diagnostic shellfish elements were also recorded, however it soon became apparent during the quantification process that this often led to the over-representation of species with denser shell or greater weights, and the under-representation of lighter species. *Marcia hiantina* is a typical example. This species was often highly fragmented and diagnostic elements (in this case, complete hinges) were often 5 – 10 mm in length and only a few grams in weight; therefore abundance estimates based on weight of these elements alone would be highly problematic if compared with more robust species such as *A. granosa* or *S. cucullata*. Mowat (1994) noted similar issues with *M. hiantina* on shell mounds in the Northern Territory and recommended MNI estimates as the most suitable option for determining species abundance. Results of both techniques are reported here though greater interpretative emphasis is given to MNI estimates.

As noted above, field sampling procedures were used to reduce the overall sample size for reasons outlined above however this has significant implications for calculating shellfish numbers and weights. As outlined, two sampling strategies were used: the first (strategy A) involved removal of all *A. granosa* from 50-75% of 6 mm residues for quantification in the field, with all remaining 6 mm materials retained for detailed quantification. To do this, the MNI of the discarded *A. granosa* was estimated by calculating a mean valve weight for diagnostic *A. granosa* valves in the sub-sample retained for detailed lab analysis. This mean valve weight estimate was then used to calculate the number of valves discarded in the field, and from this an estimate of overall site MNI could be calculated.

The second sample strategy (strategy B) involved removal of all *A. granosa* from 6 mm residues in the field for quantification (weights and MNI) before being used as backfill. The remaining 6 mm material was split into two sub-samples, one of which (25-50%) was investigated in detail in the lab with numbers and weights of all shellfish and other materials in this sub-sample quantified. The second sub-sample (50-75%) was also sorted in the lab, however the focus in doing this was only on non-molluscan materials. Results for these units required adjustment to reflect the fact that while all *A. granosa* had been quantified, only between 25-50% of other molluscan remains had been quantified. To make this adjustment the overall weight and MNI for *A. granosa* was reduced to reflect the percentage of 6 mm residues sorted and quantified in detail. This means that shellfish quantification results for pits sampled in this way are based on a 25-50% sub-sample of the 6 mm residues remaining after the removal of diagnostic *A. granosa* in the field.

5.3.5 Artefacts

There is strong ethnographic evidence that many species of shellfish were used as scrapers, knives, water carriers and so on across Cape York Peninsula (Roth 1984; Schall 1985; Sutton 1994; Thomson 1939). Shellfish species commonly stated to have been used as tools include *P. erosa*, *Melo* spp. and *Nerita lineata* (see Chapter 3). Visual examination was used to identify potential shell artefacts during sorting as most individual shellfish specimens were handled at least twice and this provided a good opportunity to identify any specimens with unusual damage or evidence of use as an artefact. This was not always the case with *A. granosa* because sampling was used in some cases and therefore not all specimens were visually inspected.

Owing to constraints on analysis time, potential shell artefacts were investigated for specific signs of use or modification in only a small number of cases. This involved the use of a binocular microscope (maximum 40 x magnification) or hand eyeglass to look for evidence of edge rounding, polishing, striations or even deliberate retouch. Evidence of use was ranked using a simple scale with ‘0’ for little confidence, ‘0.5’ for moderate confidence and ‘1’ for high confidence. Information recorded for potential shell artefacts included the species of shell, the location of the damage, completeness of the shell specimen and the type of damage.

Because of the low numbers involved it was possible for all bone fragments to be examined for use as tools. This included simple visual examination and use of a binocular microscope.

Attributes of stone artefacts recorded included raw material, artefact type, dimensions, completeness, breakage type and the amount of cortex. This followed conventions outlined by Holdaway and Stern (2004).

Chapter 6: The regional archaeological record

This chapter outlines the nature of the contemporary archaeological landscapes of Albatross Bay with a specific focus on analysing the archaeological database to identify key spatial patterns in site distribution of significance to the research questions proposed in Chapter 1. As outlined in the previous chapter, the database incorporates information about archaeological sites identified during surveys carried out by the author, as well as the those recorded by others working in the region. The majority of this chapter is concerned with spatial patterns in shell matrix site distribution reflecting the overall focus of the thesis on questions relating to these sites. However, shell matrix sites only represent one element of the archaeological landscape in the study area and as such other data on other site types in the region, primarily stone artefacts and earth mounds, are also considered.

6.1 The archaeological database

The following discussion briefly outlines the content of this database and sources of earlier data that have been incorporated into it. Summary data for all sites and features entered in the database are provided in Appendix 3. General information on other sources of survey data for the region have been discussed in Chapters 4 and 5 along with the survey methods used in this project. Locations of specific areas surveyed as part of thesis-related field research are highlighted in Figure 6-1.

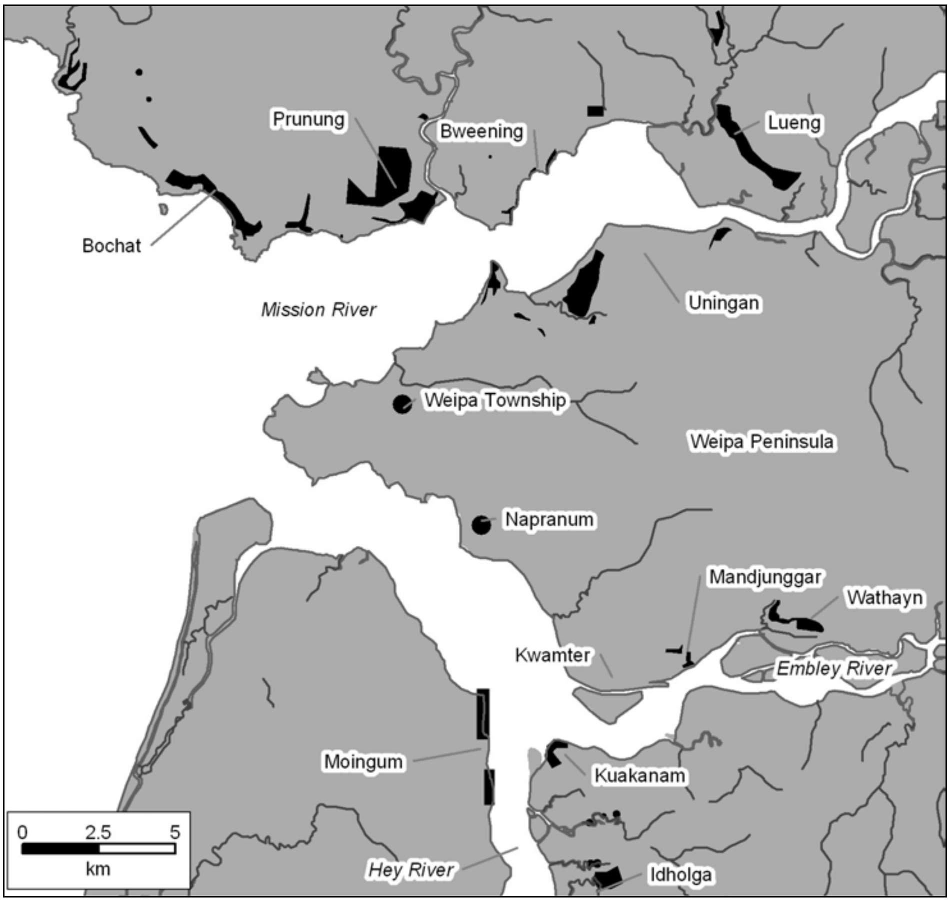

Figure 6-1: Field survey coverage

The database includes a total of 498 sites for which site specific and consistently recorded class 1 and 2 data are available, plus a further 53 examples where less detailed class 3 information is available (Figure 6.2). Table 6.1 summarises this data, which has been divided into the areas of Pine River, north Mission River, Weipa Peninsula and the Hey River.

Classification	Total	Pine River	North Mission River	Weipa Peninsula	Hey River
Class 1 and 2 data	498	15	114	138	231
Shell Matrix Features	477	15	113	118	231
Shell Scatters	*88*	*6*	*61*	*14*	*7*
Shell Middens	*6*	*1*	*2*	*1*	*2*
Shell Mounds	*383*	*8*	*50*	*103*	*222*
Earth Mounds	21	-	1	20	-
Class 3 data	54	25	7	8	14
Shell Mound Groups	44	24	-	6	14
Shell and Artefact Scatters	2	-	2	-	-
Artefact Scatters	8	1	5	2	-

Table 6-1: Overview of archaeological sites according to general location

Only limited data is available from the Pine River area and the bulk of this is more general class 3 data. Fifteen individual shell matrix sites have been recorded on the northern Andoom Peninsula (Figure 6-2) while a further 24 groups of shell mounds have been noted but not yet recorded in this area. All of the shell matrix sites reported across this area appear to be dominated by *A. granosa*. A single scatter of stone artefacts mostly consisting of small, broken quartz and silcrete flakes and which includes up to 150 artefacts, primarily small quartz and silcrete flakes has also been recorded here. Overall, the small number of recorded sites for the Pine River area directly reflects the disproportionate amount of survey work carried out here compared with areas closer to Weipa.

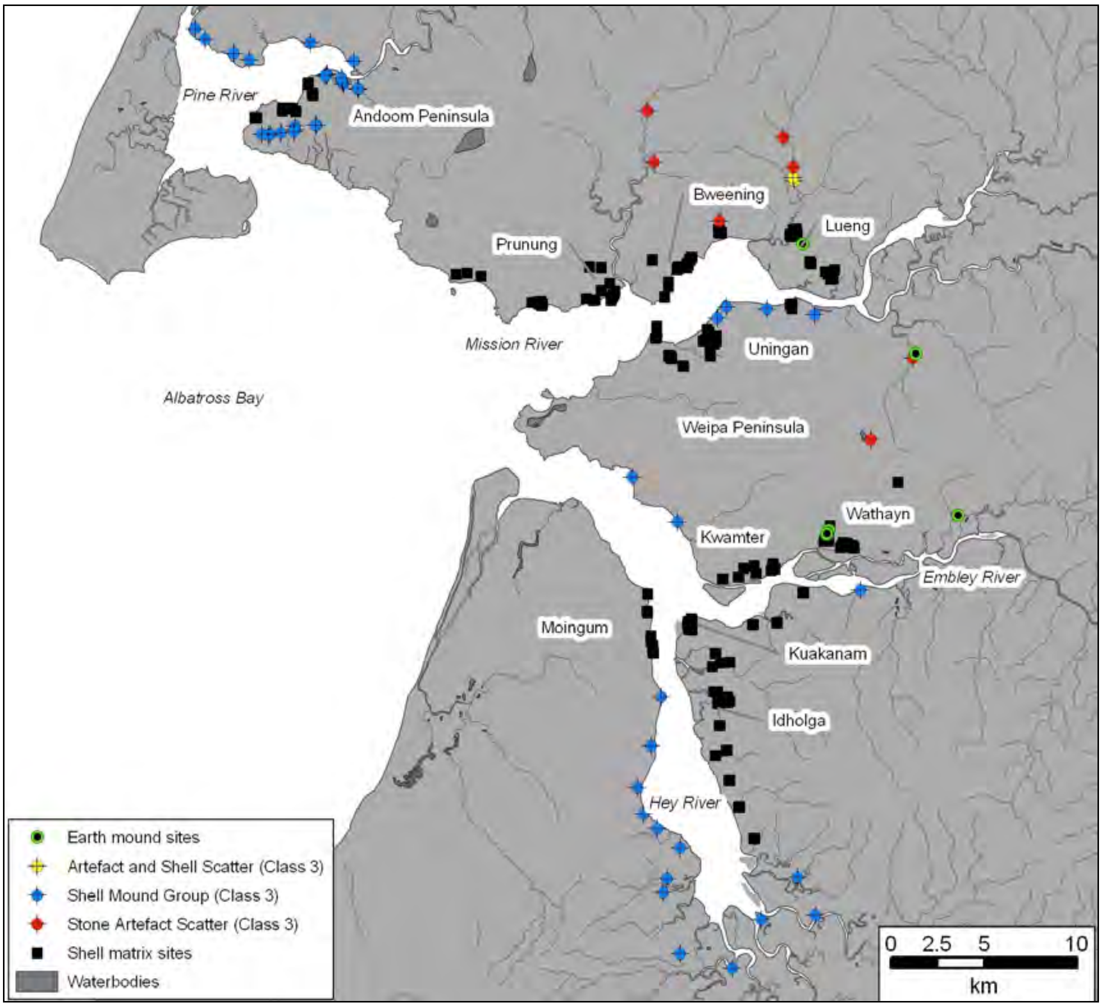

Figure 6-2: Locations of archaeological sites and features, Albatross Bay region

Conversely, many more sites are known to occur around the north Mission River area. A total of 61 shell scatters and 50 shell mounds make up the bulk of the 114 individually recorded sites with the remaining three sites comprising shell middens. All shell mound groups known to occur in this area have been recorded in detail, principally as a result of work carried out as part of this thesis. A number of surface scatters of artefacts and or shellfish were also recorded during Rio Tinto-Alcan surveys however these are entered in the database as class 3 data due to lack of detail; collectively these scatters contain more than 1,000 individual artefacts (Justin Shiner pers. comm.. 2007).

The archaeology the Weipa Peninsula is also relatively well understood. Previous work here indicates that while isolated stone artefacts and occasional light shell scatters are found across the bauxite plateau, the bulk of archaeological sites that occur away from coastal regions are found within close proximity to water sources (Shiner and Morrison 2009). Several high density artefact scatters have been recorded particularly in the vicinity of a large permanent lake on the central Weipa Peninsula. Another significant find in recent years has been the discovery of three complexes of between five and nine earth mounds with associated scatters of marine shell, stone artefacts and traces of burnt termite mound. A total of 103 shell mounds, 14 shell scatters and a single shell midden have been recorded on the Weipa Peninsula, with the bulk of these occurring on the southern margins along the Embley River. Six shell mound groups and several artefact scatters are also included in the database as class 3 data.

Finally, work on the Hey River has focussed almost exclusively on shell mound groups and the database reflects this. A total of 231 shell matrix sites have been recorded in detail, and these include seven shell scatters, two shell middens and 222 shell mounds, These principally occur on or adjacent to the extensive coastal plains on the eastern Hey River and southern Embley River. The locations of a further 14 shell mound groups are also known and these represent an unknown number of individual sites. However, given the high number of sites comprising other shell mound groups in this area, these may well represent a further several hundred shell mounds and scatters.

In summary, for the entire study area detailed site specific data is available for a total of 498 individual archaeological sites, a total comprised of 21 earth mounds, 88 shell scatters, six shell middens and 383 shell mounds. Less detailed but nevertheless useful information is available for 54 other class 3 features and this includes 44 shell mound groups, the bulk of which are on the western and southern shores of the Hey River and the northern areas of Pine River. Eight quite substantial artefact scatters are also known to occur across the region, with most of these occurring in the north Mission River area. Two combined marine shell and artefact scatters have also been recorded here. The largest proportion of sites occur in the Hey River region, however this is also a disproportionately large geographic area and our understanding of the range of sites other than shell mounds in this area is very limited. More substantive understandings of the regional archaeological record are available for the Weipa Peninsula and the north Mission River areas where archaeological investigations have been more detailed and as a result a greater variety of shell matrix and other features are known to occur.

6.2 Shell matrix sites

Eighty-eight shell scatters, six shell middens and 383 shell mounds sites and a further 44 shell mound groups have been recorded in and around Albatross Bay and its estuaries. This includes 217 of the 304 sites originally recorded by Bailey and a further 264 recorded by the author between 2000 and 2006. Some of the sites recorded by Bailey have been re-recorded by the author as part of this project in order to obtain more detailed spatial data about them. The following discussion summarises key aspects regarding the location and characteristics of these sites. It also encompasses – where possible – the more generalised information available regarding the 44 shell mound groups that have been recorded throughout the region.

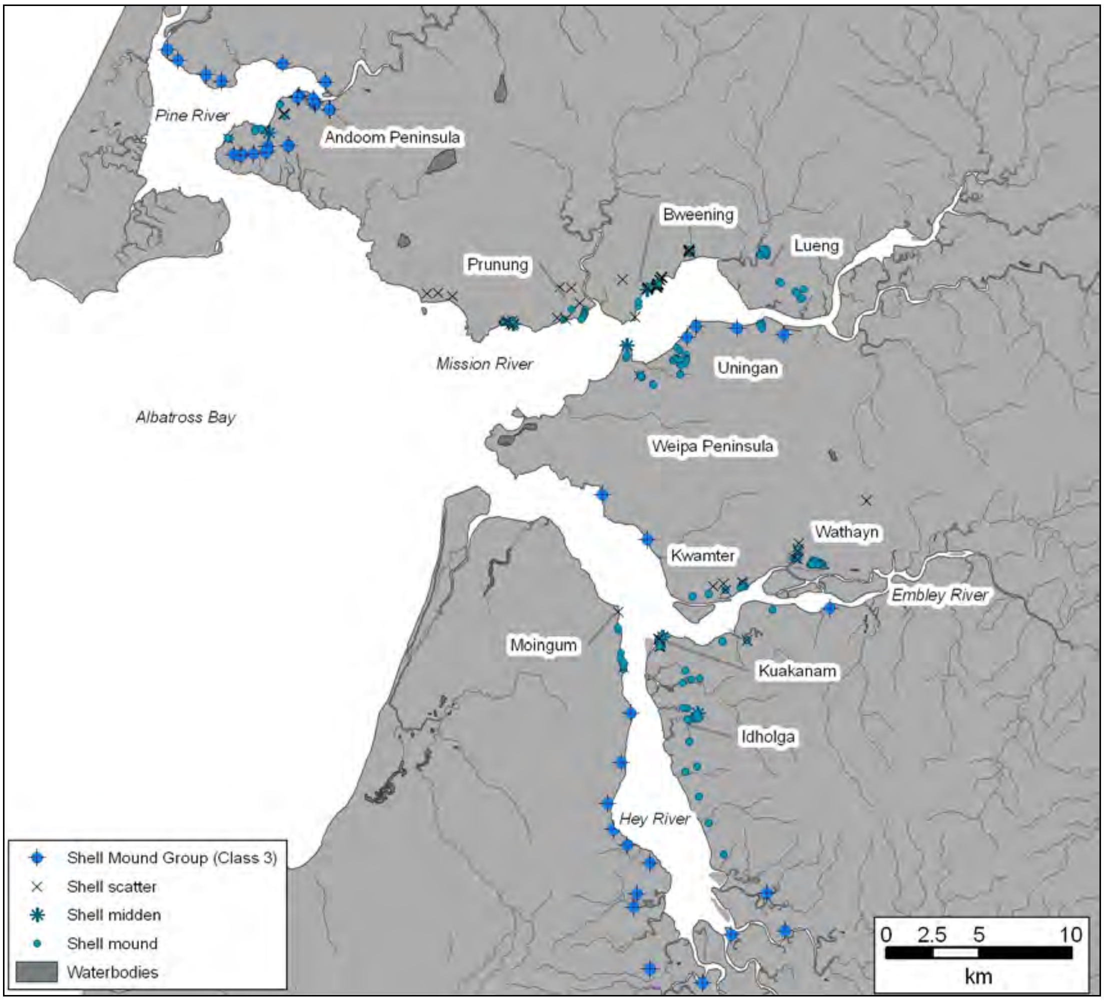

Figure 6-3: Locations of shell matrix features, Albatross Bay area

6.2.1 General characteristics

The general characteristics of shell matrix sites in the study area are relatively well understood as a result of Bailey's work however new data presented here refines various elements of our understandings of the characteristics of these sites. Table 6-2 summarises data on the height of shell matrix and as this shows around 50% (n=241) are between 0.1 and 1 m. A total of 18% (n=90) of all shell matrix sites were non-mounded and almost all of these were shell scatters. While sites between 1.01 m and

2 m in height are also present in reasonable proportions (around 15%, n=73), collectively all sites over 2.01 m in height represent only about 15% of all shell matrix sites recorded in the region.

Height (m)	Number	Percentage
<0.1	90	18.87
0.1-1	240	50.52
1.01 - 2	73	15.30
2.01 - 3	26	5.45
3.01 - 4	17	3.56
4.01 - 5	12	2.52
5.01 - 10	14	2.94
10.01 - 15	4	0.84
	477	100

Table 6-2: Heights of all shell matrix sites

Four hundred and forty of the total 477 shell matrix sites recorded have accurate data on basal dimensions and summary data for sizes of these is shown in Table 6-3. Around 44% (n=195) of sites have basal areas less than 50 m^2 in total with over half being less than 20 m^2. The number of sites with larger basal areas decline relative to increasing size, hence sites with basal areas between 50.01 m^2 and 400 m^2 represent almost 39% of sites (n=176) while those with basal areas greater than 600.01 m^2 represent only around 17% of all sites (n=76).

Base area (m^2)	Number	Percentage
<20	103	23.41
20.01-50	92	20.91
50.01-100	60	13.64
100.01-200	56	12.73
200.01-400	54	12.27
400.01-600	22	5.00
600.01-800	14	3.18
800.01-1000	6	1.36
1000.01-1500	14	3.18
>1500	19	4.32
Total	440	100

Table 6-3: Basal dimensions of shell matrix sites

6.2.2 Distribution

The key trend regarding the distribution of shell matrix sites within the region is that they tend to be found close to tidal estuaries. Table 6-4 and Figure 6-4 highlight this trend and draw on data compiled using the ‘proximity analysis’ function on GIS software to compare site locations with tidal estuary locations as marked on 1:50,000 series topographic maps. Over 50% (n=138) of the 259 sites for which we have accurate spatial data are within 250 m of a tidal estuary and 83 of these are less than 100 m from a tidal estuary. A further 30% (n=79) are within a distance of 250.01 m to 500 m and less than 5% (n=13) of recorded sites occur more than 750 m from a tidal estuary. Importantly, and as outlined in Chapter 2, the position of shorelines within Albatross Bay have likely shifted in many areas due to infilling; as such, many sites are likely to have been located closer to past shorelines than they are today.

Distance	Number	Percentage
<100 m	83	32.05
100.01 - 250	55	21.24
250.01- 500	79	30.50
500.01-750	29	11.20
750.01-1000	8	3.09
>1000	5	1.93
Total valid cases	259	100

Table 6-4: Distances of shell matrix sites from tidal estuaries

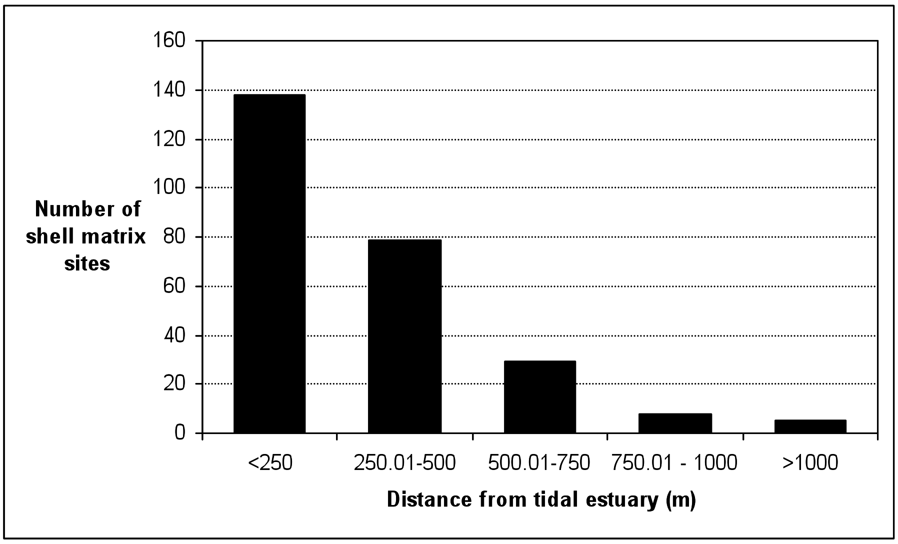

Figure 6-4: Distances of shell matrix sites from tidal estuaries

6.2.3 Morphological characteristics

Morphological data consistent with the categories used here are available for only 217 (54.5%) of the 483 shell matrix sites recorded in the area and this data is summarised in Table 6-5. Sites that are not mounded make up a reasonable proportion of the total number of sites for which morphological data is recorded. Scatters comprise around 33% (n=87) of the total 217 sites with recorded morphological data and non-mounded sites represent less than 2% (n=5) of these. Of the other categories, dome shaped mounds comprised around 40% (n=106) and elongated mounds represent around 12% (n=33) of sites with morphological data. Other categories were infrequently recorded but composite sites represented about 7% of valid cases (n=19) and truncated, ring-shaped and conical mounds were all recorded in very small numbers.

In discussing morphological characteristics of shell matrix sites it is useful to separate those that are mounded from those that are not: resulting data is outlined in column 4 of Table 6-5. Of all the recorded mounded shell matrix sites for which morphological data is available, dome mounds represent around 63% of cases (n=106), elongated almost 20% (n=33) and composite sites around 11% (n=19). This highlights the fact that almost all mounded shell matrix sites are dome shaped or elongated or occur as composite structures of multiple overlapping mounds.

Morphological category	**Count**	**Percentage - known morphology only**	**Percentage - mounded sites only**
Shell Scatter	87	33.46	
Dome	106	40.77	63.10
Elongated	33	12.69	19.64
Composite	19	7.31	11.31
Truncated	7	2.69	4.17
Ring	1	0.38	0.60
Conical	2	0.77	1.19
Non-mounded	5	1.92	-
Unknown morphology	217	-	-
Total - Known Morphology Only	*260*	*100*	-
Total - Mounded Sites Only	*168*	**-**	*100*
All Cases	477	-	-

Table 6-5: Morphological characteristics of shell matrix sites

6.2.4 Surface composition estimates

One of the most common characteristics of shell matrix features in the study area is the very high number of cases where *A. granosa* is the primary shellfish species noted on their surface. While this characteristic was well illustrated by Bailey (1994) information for previously unrecorded sites presented here further highlights this pattern. Data on surface composition for sites that have been recorded in detail are summarised in Table 6-6. As this shows, of the 477 recorded sites, some 97% (n=465) have surface shellfish composition which consists mostly of *A. granosa*. Of these, around 80% (n=383) are shell mound sites and a further 16% (n=76) are shell scatters. Importantly, no shell mounds have been recorded in the region whose composition is anything other than primarily *A. granosa*, although it should be noted that survey work near Aurukun has identified shell mound sites whose dominant species appears to be *M. hiantina*, however these sites are not included in the database (but see Section 4.6.1).

While most shell scatters are principally composed of *A. granosa*, these sites also evidence most variation in terms of their shellfish composition. Five scatters are composed of similar proportions of *A. granosa* and *S. cucullata*, three are predominantly *P. erosa* and two are dominated by a combination of either *S. cucullata* or *Volema cochlidium*. A single scatter was recorded whose composition was defined as mixed, and in this case the site in question consisted of very low but variable proportions of a range of species. Composition data is not available for one site recorded by Bailey on the southern Weipa Peninsula.

Site Type	***A. granosa***		***A. granosa* and *S. cucullata***		***P. erosa***		***S. cucullata* or *V. cochlidium***		**Mixed or Unknown**	**Totals**
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	
Shell Mounds	383	80.29	-	-	-	-	-	-	-	383
Non-Mounded	6	1.26	-	-	-	-	-	-	-	6
Shell Scatters	76	15.93	5	1.05	3	0.63	2	0.42	2	88
Total	465	97.48	5	1.05	3	0.63	2	0.42	2	477

Table 6-6: Dominant shellfish species estimates for shell matrix features based on surface observations

6.2.5 Substrates

Table 6-7 provides information regarding the substrates on which various categories of shell matrix site occur and from which a number of important points can be derived. Almost 59% (n=281) of all shell matrix sites occur on bauxite plateaus, a further 19.5%% (n=93) on coastal plains, around 10% (n=48) on low ridges on coastal plains, 9.01% (n=43) on sand dune ridges and finally, less than 3% (n=12) on muddy mangrove sediments within mangrove forests. Arguably, the categories of coastal plain, mangrove and low ridges on coastal plains could be combined given that these are three very similar substrates in geomorphological terms. If combined into a single category of ‘coastal plain substrates’, these represent around 31% (n=148) of all shell matrix sites in the region.

It is also instructive to distinguish between site categories and substrate and this information is outlined in Table 6-7. Shell mounds on bauxite plateaus are the most frequent category and these represent almost 44% (n=209) of all shell matrix sites in the region. The second most frequent category are shell mounds on coastal plains, which represent around 19% (n=90) of all sites. Almost 15% (n=69) of all shell matrix sites are shell scatters occurring on bauxite plateaus and 8.6% are shell mounds occurring on ridges on coastal plains. At this point it is difficult to meaningfully compare the frequency of shell scatters and shell mounds according to substrates because there is little question that shell mounds are overrepresented in the database at the expense of less prominent or visually obvious – and therefore less frequently recorded – shell scatters.

Site Category	**Coastal Plain**		**Bauxite Plateau**		**Mangroves**		**Sand Dune Ridges**		**Ridge on Coastal Plain**		**Total**	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All Shell matrix features	93	19.50	281	58.91	12	2.52	48	10.06	43	9.01	477	100.00
Shell Scatters	3	0.63	69	14.47	-	-	14	2.94	2	0.42	88	18.45
Non-mounded deposits	-	-	3	0.63	-	-	3	0.63	-	-	6	1.26
Shell Mounds	90	18.87	209	43.82	12	2.52	31	6.50	41	8.60	383	80.29

Table 6-7: Shell matrix site substrates as proportion of all shell matrix sites

Table 6-8 summarises shell matrix sites according to site category and demonstrates that around 78% (n=69) of shell scatters occur on the bauxite plateaus while almost 16% (n=14) are located on sand dune ridges. Shell scatters have not been recorded as occurring within mangroves and have only been infrequently recorded for coastal plains or ridges on coastal plains. For shell mounds, almost 55% (n=209) occur on bauxite plateaus, 23.5% (n=90) on coastal plains, 10.7% (n=41) occur on low ridges on coastal plains and finally, around 8% (n=31) occur on sand dune ridges.

Site Category	**Coastal Plain**		**Bauxite Plateau**		**Mangroves**		**Sand dune ridges**		**Ridge on Coastal Plain**		**Total**	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Shell Scatters	3	3.4	69	78.4	-	-	14	15.9	2	2.3	88	100
Non-mounded deposits	-	-	3	50	-	-	3	50	-	-	6	1.26
Shell Mounds	90	23.5	209	54.5	12	3.13	31	8.1	41	10.7	383	100

Table 6-8: Shell matrix site substrates relative to site type

Table 6.9 summarises shell matrix site substrate in relation to height classes in order to highlight the way that sites within specified height ranges are distributed in relation to substrate type. The first notable pattern in this data is best illustrated by Figure 6.5 which shows the relationship between the heights of sites on the bauxite plateaus compared with those on coastal plains. Around 76% (n=69) of sites <0.1 m in height (primarily shell scatters) are distributed on the bauxite plateau along with around 63% (n=152) of those between 0.1 m and 1 m. Indeed, as Figure 6.5 shows, as shell matrix site height increases, the proportion of sites located on the bauxite plateau decreases. Conversely, on coastal plains the proportion of smaller sites is much lower with only around 15% (n. 37) of those between 0.1 and 1 m occurring here however the proportion of sites on coastal plains increases with size. For example, all sites over 10.01 m in size (n=4), ~85% of those between 5.01 and 10 m (n=12) and ~58% of those between 4.01 and 5 m (n=7) occur on the coastal plains. Importantly the overall number of larger sites is disproportionate to the number of smaller sites but this in itself is significant. Put simply, larger mounds almost exclusively occur on coastal plains while there is a strong tendency for smaller sites to occur on bauxite plateaus. Furthermore, there are fewer larger sites on the coastal plains versus a larger number of smaller sites on the bauxite plateaus.

Height (m)	**Coastal Plain**		**Bauxite Plateau**		**Mangroves**		**Sand Dune Ridges**		**Ridge on Coastal Plain**		**Total**
	No	%	No	%	No	%	No	%	No	%	
0	2	2.22	69	76.67	-	-	17	18.89	2	2.22	90
0.1-1	37	15.35	152	63.07	6	2.49	16	6.64	30	12.45	241
1.01 - 2	12	16.44	40	54.79	1	1.37	11	15.07	9	12.33	73
2.01 - 3	13	46.43	12	42.86	-	-	1	3.57	2	7.14	28
3.01 - 4	6	40.00	5	33.33	1	6.67	3	20.00	0	0.00	15
4.01 - 5	7	58.33	3	25.00	2	16.67	-	-	-	-	12
5.01 - 10	12	85.71	-	-	2	14.29	-	-	-	-	14
10.01 - 15	4	100.00	-	-	-	-	-	-	-	-	4
Total	93		281		12		48		43		477

Table 6-9: Shell matrix site substrate in relation to maximum height range

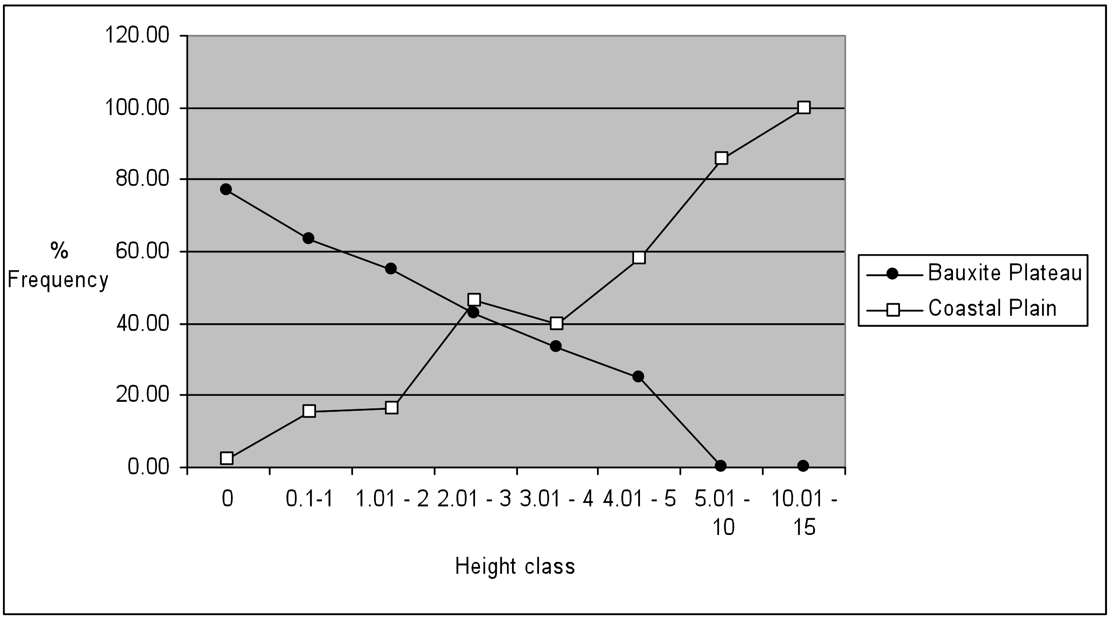

Figure 6-5: Comparison of shell matrix site height on bauxite plateau and coastal plains

It is also useful to compare base area sizes of shell matrix sites with substrate types (see Table 6-10). As discussed earlier, 75.5% (n=365) of all shell matrix sites recorded in detail have basal areas less than 600 m^2 and of these 202 are less than 200 m^2 and 103 between 200.01 m^2 and 400 m^2. The substrates on which the majority of sites in these three size categories occur is therefore significant; as Table 6-10 shows, almost 72% (n=145) of sites between 1 and 200 m^2 occur on bauxite plateaus compared with around 14% (n=29) on coastal plains. Similarly, for sites in the 200.01-400 m^2 and 400.01-600 m^2 categories, 58.2% (n=60) and 51.6% (n=31) respectively occur on bauxite plateaus compared with around 17% (n=18) and 13% (n=8), respectively on coastal plains. This indicates that sites with smaller basal areas are far more likely to occur on bauxite plateaus than coastal plains or other substrates.

However, although there are overall fewer sites with larger basal areas it is clear there is much less of a tendency for sites with large basal areas to occur more frequently on coastal plains. While ~28% to ~37% of sites over 800.01 m^2 occur on coastal plains, ~22% to ~57% of sites in these categories also occur on bauxite plateaus. In short, substrate type seems to have little clear influence on the frequency of sites with larger basal areas.

Base Area	**Coastal Plain**		**Bauxite Plateau**		**Mangroves**		**Sand Dune Ridges**		**Ridge on Coastal Plain**		**Total**	
m^2	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1-200	29	14.40	145	71.80	6	2.97	10	4.95	12	5.94	202	100
200.01-400	18	17.48	60	58.25	-	-	13	12.62	12	11.65	103	100
400.01-600	8	13.33	31	51.67	3	5.00	10	16.67	8	13.33	60	100
600.01-800	11	45.83	10	41.67	-	-	1	4.17	2	8.33	24	100
800.01-1000	4	28.57	8	57.14	1	7.14	1	7.14	-	-	14	100
1000.01-1500	10	37.04	6	22.22	1	3.70	5	18.52	5	18.52	27	100
>1500	13	30.95	17	40.48	1	2.38	8	19.05	3	7.14	42	100
No data	-		4		-		-		1	-	5	-
Total	93		281		12		48.00		43		477	

Table 6-10: Summary of shell matrix site base area sizes with substrate types

One final issue worth considering is the morphology of sites occurring on different substrate types, though importantly less data is available because morphological classifications are only available for sites which have been recorded by the author. Table 6-11 summarises available morphological data in relation to site substrate for 217 sites. The categories of most interest include dome shaped shell mounds (n=106) and to a lesser extent, elongated mounds (n=36) and composite mounds (n=19). Sites that have been categorised as scatters (n=87) have been discussed earlier.

Over 54% of dome mounds (n=58) are located on bauxite plateaus and a further 15% (n=16) and 17% (n=19) respectively occur on coastal plains and sand dune ridges. For elongated mounds ~54% (n=18) occur on bauxite plateaus and a further 24% (n=8) were recorded on sand dune ridges while only four were recorded on coastal plains. Although only 19 composite mounds were recorded it is significant that nearly half these (42%, n=8) were found on coastal plains. Sites with other morphological characteristics were found in insufficient numbers to warrant any useful comparisons.

Morphology	**Coastal Plain**		**Bauxite Plateau**		**Mangroves**		**Sand Dune Ridges**		**Ridge on Coastal Plain**		**Total**	
	No	%	No	%	No	%	No	%	No	%	No	%
Dome	16	15.09	58	54.72	3	2.83	19	17.92	10	9.43	106	100
Elongated	4	12.12	18	54.55	3	9.09	8	24.24	-	-	33	100
Composite	8	42.11	3	15.79	1	5.26	5	26.32	2	10.53	19	100
Truncated	2	28.57	2	28.57	2	28.57	-	-	1	14.29	7	100
Ring	-	-	1	100	-	-	-	-	-	-	1	100
Conical	1	50	1	50	-	-	-	-	-	-	2	100
Non-mounded	-	-	3	60	-	-	2	40.00	-	-	5	100
Scatter	3	3.45	68	78.16	-	-	14	16.09	2	2.30	87	100
No data	59	27.19	127	58.53	3	1.38	-	-	28	12.90	217	100

Table 6-11: Shell matrix site morphology in relation to substrate

6.3 Earth Mounds

At time of writing, 21 earth mounds have been recorded in the region (see Figure 6-2 and Table 6-12) and these are subject to ongoing research with a focus on whether they are anthropogenic or natural features (Shiner and Morrison 2009).

Most of the known earth mounds occur in three principal locations on the Weipa Peninsula with a single site (EM:172) located on the north Mission River, near *Lueng*. The latter site is somewhat unique among the earth mounds recorded to date because it occurs on alluvial sediments near the margin of the bauxite plateau and does not occur adjacent a freshwater swamp. The site has a much higher shell component than most other earth mound sites (predominantly *A. granosa*) with no stone artefacts located nearby.

Site No.	Length (m)	Width (m)	Height (m)	Substrate Type	Shellfish	Shellfish Numbers	Artefacts Present	Artefact Numbers
172	15	15	1.2	Alluvial plain	Ag	Moderate	No	
480	27	17	0.2	Alluvial plain	Ag, Pe	Low	Yes	Low
481	11	8	0.3	Alluvial plain	Pe	Low	Yes	Low
70	21	15	0.3	Alluvial plain	Pe, Ag	Low	Yes	Low
72	22	13	0.8	Alluvial plain	Pe	Low	Yes	Low
77	9	9	0.5	Alluvial plain	Ag, Pe	Low	Yes	Low
484	8	8	0.2	Floodplain margin	Pe	Low	Yes	3
485	10	7	0.2	Floodplain margin	Pe	Low	No	
486	8	6	0.2	Floodplain margin	Pe, Vc	Low	Yes	1
487	12	10	0.3	Floodplain margin	Pe	Low	No	
488	4	4	0.2	Floodplain margin	Pe	Low	No	
489	6	5	0.2	Floodplain margin	Pe	Low	No	
490	12	10	0.3	Floodplain margin	Pe	Low	No	
491	12	8	0.2	Floodplain margin	Pe	Low	No	
492	15	10	0.4	Floodplain margin	Pe	Low	No	
493	20	8	0.3	Floodplain margin	Pe	Low	Yes	1
494	8	8	0.4	Floodplain margin	Pe	Low	No	
495	10	10	0.2	Floodplain margin	Pe	Low	No	
496	10	10	0.5	Floodplain margin	Pe	Low	No	
497	12	8	0.3	Floodplain margin	Pe	Low	No	
498	12	8	0.25	Floodplain margin	Pe	Low	No	

Table 6-12: Summary of data on recorded earth mounds
Notes: Shellfish species (column 6) Ag = *Anadara granosa*, Pe = *Polymesoda erosa*, Vc = *Volema cochlidium*

The remaining three groups of earth mounds occur in similar environmental contexts on the Weipa Peninsula. Typically, they are found on alluvial sediments alongside broad narrow creeks or small swamps and are also usually located a short distance from tidal areas. Almost all earth mounds recorded to date occur on substrates that are seasonally flooded, though at times individual mounds are found on low natural ridges within these areas. The earth mounds in these three groups are typically low in height (usually < 0.5 m), less than about 20 m in diameter with ovate basal area and gently sloping upper surfaces. Apart from EM:172 mentioned above, the sites within each group occur in fairly close proximity to one another and form small clusters.

Preliminary results of excavations and auguring on around 20 earth mounds on the southern Weipa Peninsula (Shiner and Morrison In Prep.) suggests that mounds are almost always composed of very fine sediment with low but variable proportions of cultural materials. In some cases, particularly with smaller mounds, these sediments are similar to those of the surrounding substrates however in larger sites the sediment is often much darker in colour. A limited range of materials have been recovered during excavations and auguring including burnt termite mound, small proportions of a restricted range of marine shellfish (most commonly *P. erosa* and less frequently *A. granosa*), moderate scatters of artefacts and in one case, an historic period brass button. Shellfish proportions vary considerable. On some large mounds, concentrated midden deposits occur around the mound margins however most sites have low-density surface scatters and low frequencies of shellfish throughout the deposit. Artefact scatters are similar to others reported on the Weipa Peninsula.

6.4 Stone artefacts

As previously noted, detailed data on stone artefacts in the study area are not presently available for analysis. The Rio Tinto cultural heritage database includes information on over 2,000 artefacts in the region (Justin Shiner pers. comm. 2007) with around 1,319 recorded on the Weipa Peninsula alone (Shiner and Morrison 2009). The archaeological database analysed here contains basic data on locations, raw material and artefact type of around 1,079 artefacts in the region, particularly those occurring in larger concentrations. Locations of major scatters are shown in Figure 6-2 and summary data on the general character of these sites is provided in Table 6-13. Importantly, the data discussed here excludes many smaller artefact scatters or isolated artefact finds known to occur.

Small quartz pebbles are the most common raw material from which stone artefacts have been made. These nodules are most likely of local origin and appear to have been laid down prior to the formation of the bauxite laterite substrates and are found embedded in mottled yellow and grey clays which underlie the deep pisolitic bauxite (Shiner and Morrison 2009). They are typically found in erosional areas at the margin of the bauxite plateau or adjacent to gullies and creeks. Silcrete is also found with some regularity in stone artefact scatters in the region, though it is not as frequently recorded as quartz. Significantly, no natural occurrences of this material occur on the bauxite plateaus or underlying substrates. The nearest potential sources of this material are to the east on the upper reaches of the Mission and Embley Rivers and in the foothills of the Iron Range approximately 40 km west of the township of Weipa. Other raw materials reported for the region include quartzite, sandstones, mudstones, cherts, basalt, andesite and other unidentified fine-grained metamorphics.

Name	Type	Dominant materials	Number	Landscape Context
Lueng south	Artefact and Shell Scatter	Stone artefacts and marine shell (*Polymesoda erosa*)	unknown	Bauxite plateau margin, adjacent to seasonal creek. Mangroves and coastal plains nearby
Lueng south	Artefact and Shell Scatter	Stone artefacts and marine shell (*Polymesoda erosa*)	unknown	Bauxite plateau margin, adjacent to seasonal creek. Mangroves and coastal plains nearby
Wandrupayne	Stone Artefact Scatter	Silcrete and Quartz	150	Alluvial substrates adjacent to permanent lake and swamp
Lueng north	Stone Artefact Scatter	Silcrete and Quartz	156	Bauxite plateau margin, adjacent to seasonal creek
Lueng south	Stone Artefact Scatter	Silcrete and Quartz	225	Bauxite plateau margin, adjacent to seasonal creek. Mangroves and coastal plains nearby
Bweening	Stone Artefact Scatter	Silcrete and Quartz	27	Bauxite plateau, short distance to seasonal creek and shell mound group
Sunrise Creek	Stone Artefact Scatter	Silcrete and Quartz	379	Alluvial plateau adjacent to seasonal creek
Prunung Creek north	Stone Artefact Scatter	Silcrete and Quartz	35	Bauxite plateau adjacent to seasonal creek
Prunung Creek south	Stone Artefact Scatter	Silcrete and Quartz	23	Bauxite plateau adjacent to seasonal creek
Weipa Peninsula north	Stone Artefact Scatter	Quartz and silcrete	84	Alluvial plain adjacent to creek on exposed surface. Area likely to be heavily saturated with water during wet months.

Table 6-13: Stone artefact scatters

On the Weipa Peninsula, the most substantial artefact scatter found to date occurs at Wandrupayne, a large permanent lake. While only approximately 150 artefacts have been recorded, work in the area has not been exhaustive and many more surface artefacts – and subsurface deposits – are also likely to occur. Artefacts typically occur within 100 m of the lakeside however heavy sedimentation and lack of erosion points to a high likelihood of sub-surface artefact deposits. The only other major artefact scatter so far found on the Weipa Peninsula occurs in the vicinity of the northern group of earth mound discussed earlier where Cochrane (Cochrane 2006a) recorded 84 artefacts. He found that the dominant raw materials were quartz (n=67) and silcrete (n=12) with the assemblage predominantly comprised of flakes, broken flakes and cores.

More recently, all stone artefacts (n=1319) from the Weipa Peninsula have been subject to preliminary analysis (Shiner and Morrison 2009), including the artefacts included in the archaeological database analysed for this project. As discussed above, raw materials were predominantly quartz (67%) and silcrete (29%) and the range of artefacts mostly included complete and broken flakes and cores with minimal evidence of retouching. The high proportion of quartz was considered to reflect its local availability, however the high proportion of silcrete artefacts with cortex and also broken cores points to the possibility that silcrete nodules were transported before reduction (Shiner and Morrison 2009:53). Finally, ~81% of artefacts were located within 250 m of a water source pointing to less intensive activity on areas of bauxite plateau away from water sources.

North of the Mission River a number of more substantial artefact scatters have been recorded and basic details included in the database. On Sunrise Creek, a tributary of the Pine River, an assemblage of 379 artefacts principally manufactured from quartz and silcrete have been recorded along several hundred metres of the creek bank. A second extensive scatter of artefacts – and in some areas marine shell (*P. erosa*) – occurs alongside *Lueng* Creek, a tributary of the Mission River (Figure 6-2). The largest concentration of artefacts here (n=156) occurs at the confluence of a number of smaller seasonal creeks however the remainder occur further to the south adjacent to an area of more permanent freshwater and also within short distance (<500 m) of saltpans and *Rhizophora* sp. mangrove forests. Other smaller scatters of artefacts have been recorded at *Bweening* and at several locations on *Prunung* Creek.

A number of stone artefacts from the study area are held in the collections of the Queensland Museum, Brisbane, and were recorded by the author during a visit undertaken in 2004 (Table 6-14). The majority of these were collected by Bailey in 1972 from the surfaces of shell mounds on the eastern Hey River and northern Embley River areas however some were also recovered during excavations at *Kwamter*. Visitors to the Weipa Presbyterian Mission prior to 1966 also deposited a number of items in the Queensland Museum collection, however beyond this their specific provenance is unknown. Bailey's collection appears to have focussed upon more unique items rather than the smaller nondescript artefacts that have been recorded throughout the region since 2003.

The collection includes a relatively limited range of raw materials including silcrete, basalt, quartzite, sandstone and an unidentified fine-grained metamorphic material. The most common artefact type was distinctive edge ground implements, including four without waists and three with waists. These ranged between 62 and 85 mm in length and 54 and 69 mm in width and all occurred on either basalt or quartzite. The collection also included five large silcrete cores each with all but one having only one flake scar along with a single silcrete angular fragment. In addition, several sandstone grindstone fragments along with two pounders with extensive edge damage were recorded.

Artefact Type	Provenance	Raw Material	Length (mm)	Width (mm)	Thickness (mm)	Flake Scars (No.)	Use Damage or wear
Angular Fragment	SM 461 - surface (1972)	Silcrete	74	55	48		
Core	Weipa Mission (1972)	Silcrete	92	62	35	1	
Core	Site 121 (1972, East Hey) #	Silcrete	139	110	67	1	
Core	Site 146 (1972, East Hey) #	Silcrete	97	93	66	>3	
Core	SM 401 - surface (1972)	Silcrete	101	73	62	1	
Core	SM 440 - surface (1972)	Silcrete	76	57	48	1	
Edge ground implement	Urquhart Point*	Basalt	88	65	38		Minor impact damage
Edge ground implement	Site 144 (1972, East Hey) #	Quartzite	86	69	47		
Edge ground implement	SM 438 - surface (1972)	Quartzite	86	69	42		
Edge ground implement	Weipa Mission (ca. 1915)*	Quartzite	62	56	39		Striations parallel to ground edge
Edge ground implement with waist	Weipa Mission (1914)*	Basalt	83	54	47		Striations parallel to ground edge
Edge ground implement with waist	Weipa Mission (1914)*	Basalt	64	61	35		Striations parallel to ground edge
Edge ground implement with waist	SM 280 - surface (1972)	Basalt	85	65	42		Moderate distal impact damage
Grindstone fragment	Site 144 (1972, East Hey) #	Sandstone	153	121	53		
Grindstone fragment	Site 123 (1972, East Hey) #	Sandstone	94	52	36		Moderate use wear on surface
Nondescript	SM 459 - surface (1972)	Fine grained metamorphic	66	50	37		Minor distal impact damage
Nondescript	SM 395 -	Ironstone	71	63	39		

	surface (1972)						
Pounder	SM 438 - surface (1972)	Quartzite	87	65	43		Extensive distal and moderate proximal impact damage
Pounder	SM 451 - surface (1972)	Basalt	77	77	36		Extensive distal and moderate proximal impact damage

Table 6-14: Surface artefacts from the Weipa area held in the Queensland Museum collections
Note: Artefacts whose provenance is marked with # are in areas where shell matrix features were rerecorded as part of this project. The provenance of those marked with * are not known.

6.5 Summary

Our understanding of the character of the archaeological landscape in the Albatross Bay region has increased substantially in recent years. A larger number of shell matrix sites have now been recorded as a result of the addition of information from areas not previously surveyed. Further to this, the contribution of information about probable anthropogenic earth mounds and stone artefact scatters provides crucial insights into broader patterns of landscape use beyond locales in which shell matrix sites are found. To date however investigation and analysis of these types of sites have been largely preliminary in nature.

Around 18.4% of all shell matrix sites in the region are low density shell scatters while 80.2% are shell mounds. This is significant because shell scatters have previously not been considered in any detail in the region. Bailey (1994:115) highlighted the fact that of the 291 shell mounds in his database, over half (51.2%) were ~0.5 m in height, and mounds under 1 m in height represented 70.2% of sites. Despite the inclusion of 186 previously unrecorded shell matrix sites (including non-mounded sites) the data presented here does not significantly alter this statistic:

~ 31% of shell matrix sites are > 1 m in height while sites < 1 m in height represent around ~70% of all shell matrix sites. A similar situation occurs with site basal areas for there are fewer sites with larger basal areas and more sites with smaller basal areas; 70.6% of all shell matrix sites have basal areas less than 200 m^2 and 82.9% less than 400 m^2.

No shell mounds principally composed of shellfish other than *A. granosa* have yet been recorded within Albatross Bay, though as noted in Chapter 4 sites with more variable composition have been recorded in the Aurukun region to the south. This is in contrast to shell scatters that evidently have more variable shellfish composition, but which have a far lower density of shellfish remains present. This raises several significant questions: firstly, do shell scatters simply reflect incipient shell mounds and secondly, to what extent do surface composition estimates accurately reflect the actual shellfish composition of shell mounds? Both questions are addressed in the following chapters.

Site distribution patterns are also of interest here; ~84% of sites occur within 500 m of tidal estuaries which is significant in relation to understanding the production strategies associated with their formation. Further, as Bailey observed, many shell mounds occur as part of clusters however the issue of clustering is difficult to understand based on present data. It seems clear that many clusters contain sites that are not contemporary, for example dating by earlier researchers on the Hey River at *Imbuorr*, and on the Mission River at *Lueng* and *Uningan* suggests some degree of successional development. For this reason, addressing the issue of temporal relationships between sites within clusters is a key issue taken up in subsequent chapters.

Another significant issue relating to shell matrix site distribution is the relationships between substrate and site attributes. Overall, 59% of all shell matrix sites occur on bauxite plateaus, while 19.5% occur on coastal plains, 10% occur on low ridges on coastal plains and 9.01% on distinct dune substrates. Of these, shell scatters have been recorded exclusively on bauxite plateaus (78%) and dune substrates (16%) while 55% of recorded shell mounds occur on bauxite plateaus, 23.5% on coastal plains, 10.7% on low ridges on coastal plains and 8% on sand dune substrates. The restricted distribution of shell scatters to bauxite plateaus and sand dune substrates may highlight preservation biases on coastal plains where sediment deposition rates may be higher thus resulting in light shell deposits being buried.

A very clear trend in the data is that shell mounds in larger height classes almost exclusively occur on coastal plains while those smaller in height are more common on bauxite plateaus. The numbers of sites on both substrates is consistent with this for there are overall more sites on the bauxite plateaus while there are fewer sites on the coastal plains. Basal area data is also consistent with this for sites with smaller basal areas occur more frequently on bauxite plateaus. In other words, the pattern of shell mound distribution could be summarised thus: coastal plains have few sites which tend to be of greater height while bauxite plateaus tend to have many sites with relatively smaller basal areas and which are low in height. Available morphological data suggests that most of the dome shaped mounds occur on bauxite plateaus and this is consistent with the generally small basal area and low height of sites on these substrates. Conversely, 42% of composite shell mounds occur on coastal plains and this is consistent with the fewer but overall taller sites that occur in these areas.

Patterns in the distribution of other types of archaeological sites are less well understood. Sites which consist principally of stone artefacts have been recorded across the region and while information for lower density scatters is not available, the location of more substantial scatters along creeks and waterways indicates that these were likely key areas in regional settlement patterns. It is significant that many of these are some distance from the coast. Detailed analysis of patterns of stone artefact distribution, artefact characteristics and raw material types across the region will provide important information on mobility patterns and production strategies in the future. However the data available here is extremely limited and this constrains the extent of analysis of the implications of such features for our understanding of production systems associated with shell mound formation. Suffice to say that the sheer fact that these scatters have been identified is of high significance to our understandings of indigenous economies in the late Holocene.

The small number of earth mound sites recorded in the region also provides important context for consideration of shell matrix sites. These low mounds of earth have been recorded mostly at three locations on the Weipa Peninsula. Information on those recorded to date suggests that they tend to occur on alluvial plains adjacent to the transitional zone between tidal saline and freshwater portions of small intertidal creeks. Little other than stone artefacts and a limited range of marine shell – most frequently *P. erosa* – have been recorded though there is some indication of burnt termite mound on some sites. Further investigations at these sites may potentially yield information on production strategies used in these areas.

Chapter 7: *Bweening*

The *Bweening* area is located on the north Mission River (Figure 7-1) and is the first of the two localities where excavations were undertaken as part of this project. This chapter begins with a brief description of the archaeology of the immediate area and then outlines specific issues that excavations here set out to address, however the bulk of the chapter presents the results of excavations and analysis of nine shell matrix sites in the area.

Bweening is the name of a clan estate of the *Thanakwithi* People, the core area of which includes Rhum Point and an area west along the coastline for about 1.5 km to *Prunung* Creek (Figure 7-1). Along this stretch of coastline the bauxite plateau terminates abruptly at the shoreline of the Mission River, forming a 3-5 m sheer escarpment. No geomorphological or palaeoenvironmental research is known to have been undertaken in this area however it is evident that the coastline is eroding at the escarpment face, primarily through wind and wave action. Consequently, a dominant feature of the coastline is a series of exposed rocky headlands alternated by small areas of narrow sandy beach. Intertidal mudflats extend several hundred metres from shore and are exposed on low tides (Figure 7-2). Inland of the coastline, a broad low relief bauxite plateau occurs with *Prunung* Creek and a small unnamed creek to the west being the only two drainage systems of note in the immediate area (Figure 7-1). The vegetation on the plain consists of open *Eucalyptus tetradonta* woodland (Figure 7-3).

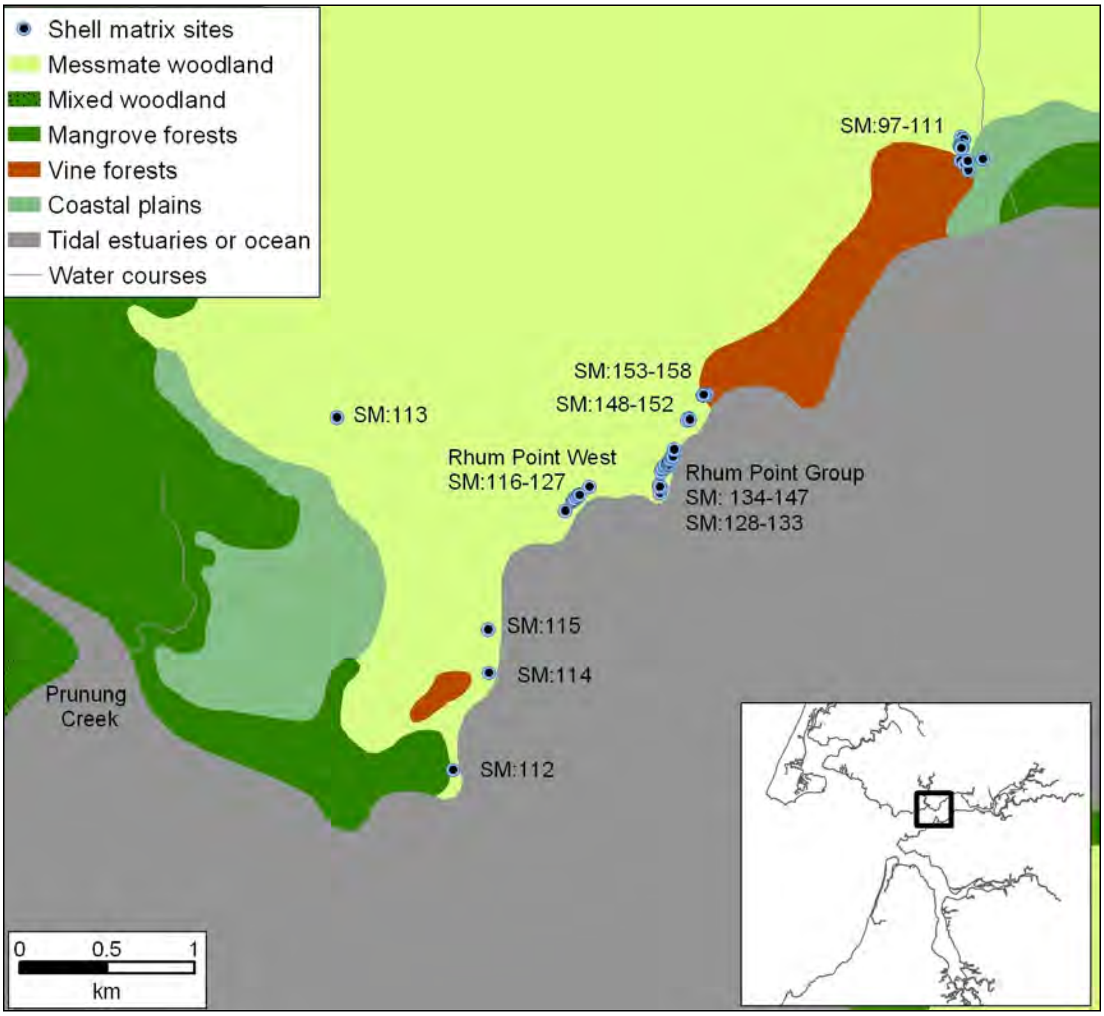

Figure 7-1: The *Bweening* study area showing the distribution of sites between Rhum Point and *Bweening* Point

Figure 7-2: Rhum Point, viewed from the west and taken from *Bweening* Point

Figure 7-3: Messmate woodland at *Bweening*, senior Traditional Owner Ms Bernice Mango burning off wet season vegetation

7.1 Background

A key reason for the choice of *Bweening* as a study area is that there is little question shell matrix deposits here are of human origin. This is due to the fact that these deposits occur exclusively on the elevated margin of the bauxite plateau, well above the influence of coastal geomorphological processes. The largest concentration of shell matrix sites at *Bweening* occurs at Rhum Point (Figure 7-4) where a group comprised of 19 discrete deposits were recorded. The largest of these is SM:147, a shell mound 75 m long, 15 m wide and up to 1.5 m in height, however four smaller (< 0.5 m high) shell mounds also occur nearby (SM:140, SM:136, SM:145 and SM:137). The remaining sites at Rhum Point are discrete scatters of *A. granosa* with small basal dimensions (< 1-2 m). All of the Rhum Point sites occur adjacent to a point where the escarpment forms a steep slope rather than a sheer cliff (Figure 7-5), providing the only easily traversable access route down the escarpment to the beach, within the immediate area.

Figure 7-6 shows the distribution of a second concentration of archaeological features approximately 500 m to the west of Rhum Point and that occur behind a dense stand of dry notophyll vine forest. SM:116, SM:117 and SM:126 were the only concentrated shell matrix deposits and the remaining sites were low density shell scatters. The final two features in the *Bweening* study area were small shell mounds SM:114 and SM:115 both of which are relatively isolated from the Rhum Point and Rhum Point West groups of sites.

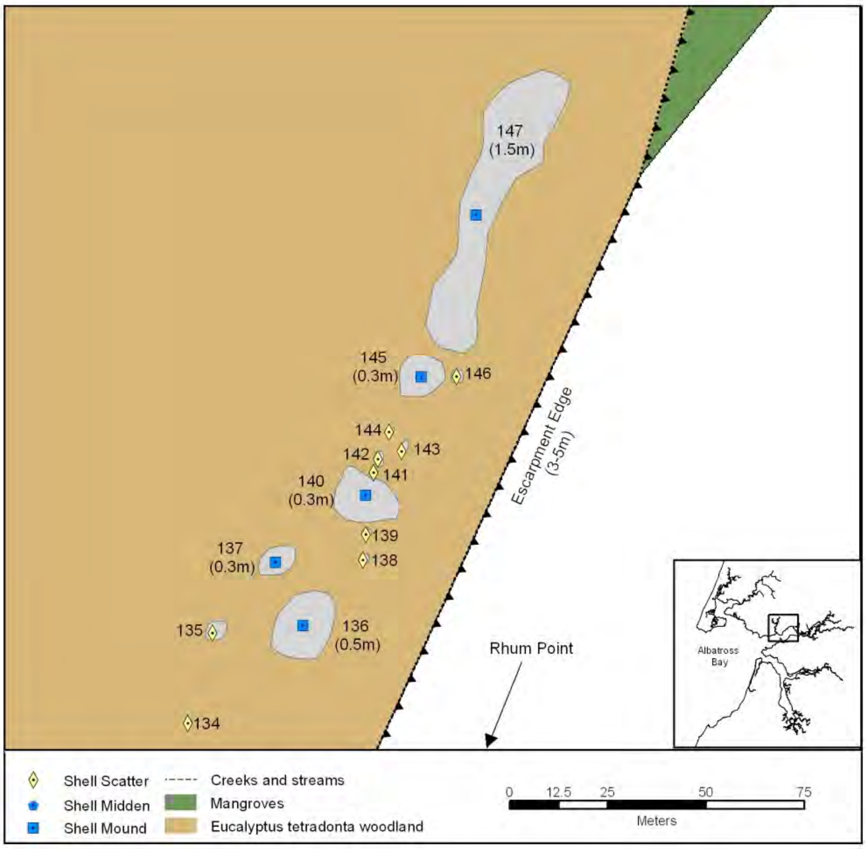

Figure 7-4: Rhum Point Archaeological Features

Excavations at *Bweening* set out to address a number of specific issues and the first related to the question of anthropogenic versus natural formation. The *Bweening* locality offers an important opportunity in this regard because of the fact that shell matrix sites here exclusively occur outside of the influence of coastal geomorphological processes. However, while it is implausible that shell deposits themselves have natural origins, the question of whether non-mounded anthropogenic shell deposits have been scraped up by scrub hens to form distinct shell mounds is not so easily dismissed. Hence, excavation work at *Bweening* sought to explore the internal structure, composition and developmental history of a range of shell matrix sites of different sizes and morphologies in order to consider possible influences on their formation. Work here also set out to acquire baseline data against which comparisons with sites in more dynamic environments could be made.

Figure 7-5: SM:147 overlying escarpment margin (taken from south west)

A second reason for carrying out excavations at *Bweening* was because shell matrix sites here occur in a substantially different environment to other previously excavated sites in the region. As described, all of the sites at *Bweening* occur in open woodland with restricted areas of vine forest and mangrove forest nearby. Conversely, the mound at *Kwamter* excavated by Bailey and Wright is located adjacent to freshwater swamps, occurs near areas of dune woodland and extensive mangrove forests and is located a short distance from seasonally flooded coastal plains. Thus, the *Bweening* area provides new data on the composition of shell matrix sites from a different environmental context to other sites previously investigated in the region. This is of interest because a key issue not yet resolved in the broader study area is whether composition of these sites varies considerably in different environmental or resource settings.

A third key reason for excavating sites at *Bweening* is because of the diversity of different shell matrix site types within a relatively limited geographic area. As described, these range between low-density surface scatters 1-2 m in diameter through to elongated shell mounds up to 1.5 m in height; they occur both as part of the main cluster of sites at Rhum Point and also as more isolated deposits some distance away. Investigation of such a suite of sites generates new data on the spatial and temporal patterns in shell matrix site accumulation along with a broader understanding of variation in discard rates and composition between these sites.

The excavations on shell matrix features at *Bweening* were carried out in November 2002 and this work took place prior to the discovery in 2003 of other sites in the area. This most notably includes a complex of shell matrix sites (SM:97-111) to the north east of Rhum Point near the unnamed creek (Figure 7-1), as well as stone artefact scatters on the upper reaches of *Prunung* Creek. Ten days were available for excavations and community consultation in the area and laboratory work was undertaken in early 2003. Radiocarbon dates are provided here as calibrated age spans at one standard deviation, however full details of radiocarbon determinations – including conventional radiocarbon ages – are provided in Appendix 5.

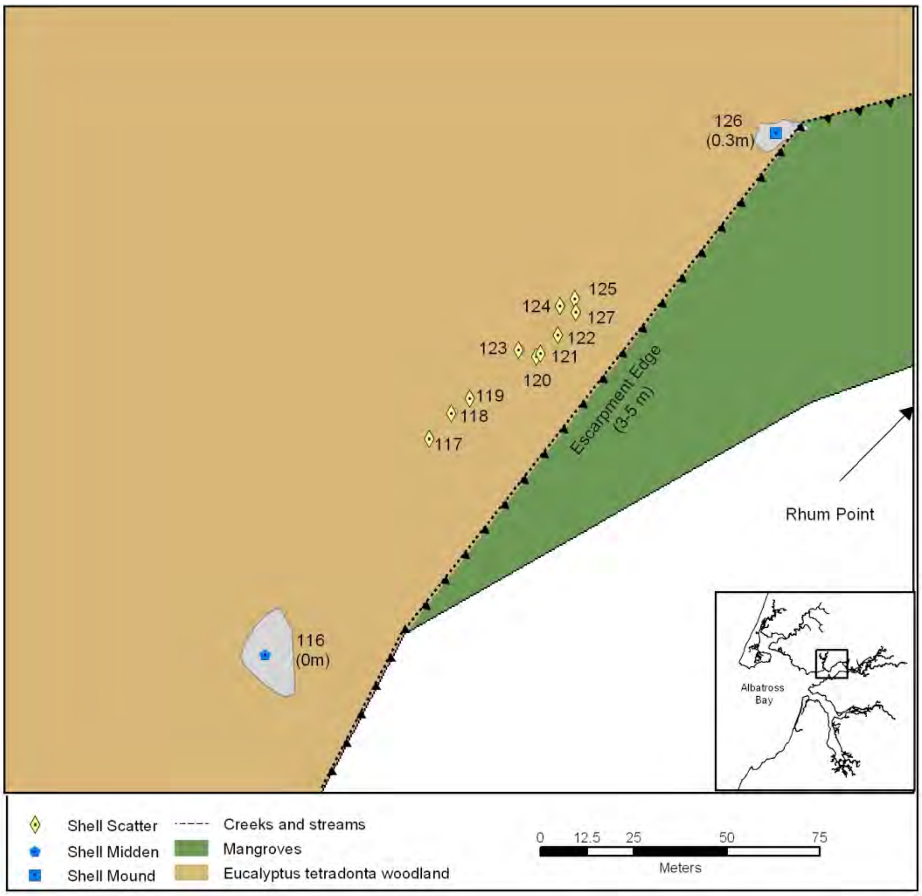

Figure 7-6: Archaeological features, Rhum Point west

Figure 7-7: Dry notophyll vine forest in the vicinity of shell scatters at Rhum Point west (taken from the north east)

7.2 SM:137

7.2.1 Description

SM:137 is a discrete shell matrix site which forms part of the cluster of sites that occur a few hundred metres to the north of Rhum Point (Figure 7-4). The site was damaged by earthmoving equipment during poorly planned clearance work as described elsewhere (Morrison 2003a). Work here included excavation of a shallow test pit 0.5 m^2 in size to obtain samples for radiocarbon dating and analysis of intact deposits, as well as extensive sieving and hand sorting of spoil heaps containing the dislocated shell matrix deposits. Results are distinguished below by using SM:137a to describe the controlled test pit and SM:137sh to describe the work on the spoil heaps containing shell matrix deposits.

Field inspections suggested that SM:137 was approximately 6 m by 9 m in basal area and probably less than 25-30 cm in height prior to disturbance. The overall quantities of displaced deposits were relatively limited and do not indicate that this was a large site prior to being damaged. The track that incurred the damage to SM:137 also cleared an area several metres in width adjacent to the western margin of SM:136. While there were no intervening in situ deposits of shell on the exposed surface, there were small proportions of what were assumed to be displaced shell on the surface. It is possible therefore that SM:137 and SM:136 were not distinct deposits prior to the disturbance and in fact may have been one larger site.

7.2.2 Stratigraphy and composition

The SM:137a test pit was excavated to a total depth of 27 cm BS and consisted of an upper layer of loosely packed (but *in situ*) whole and fragmented marine shell in a matrix of fine brown soil. This overlay the natural substrate consisting of ironstone nodules and bauxite pisoliths in fine compact reddish soil. Summary data for the SM:137a test pit (Table 7-1) show that the proportions of diagnostic shellfish were highest in XUs 1 and 2 and decrease significantly in XUs 3 and 4. This decrease in shellfish proportions was accompanied by increased proportions of bauxite pisoliths and reddish soil and collectively represented the primary stratigraphic variation in the test pit.

Summary data for the SM:137sh (spoil heaps) are not included here. These deposits were mixed with soil, stones and vegetative material scraped up from the surrounding ground surface.

	XU1	XU2	XU3	XU4
Unit depth (cm)	5.7	5.7	8.5	6.9
Gross weight (g)	17500	21000	20500	6500
6 mm residue (g)	3300	3468	1099	407
2 mm residue (g)	2410	2885	4871	1568
Soil (g)	11790	14647	14530	4525
Stones and rocks (g)	633	594	840	385
Charcoal (g)	1	2	-	-
Non-diagnostic shell (g)	1817	1776	152	23
Diagnostic shell (g)	827	1073	101	6

Table 7-1: Summary data, SM:137a

7.2.3 Dating

A single sample of *A. granosa* shell was obtained during the excavation of SM:137a from the interface between the substrate and the lowest undisturbed shell deposits. The sample returned an age of 918(971)1014 cal BP (Wk12155) which is considered to represent the commencement of site accumulation. No estimation of the upper age of this site was possible owing to removal of the upper deposits.

7.2.4 Shellfish analysis

Data on shellfish composition was obtained from both SM:137a and SM:137sh. Because of the far larger sample, SM:137sh data are seen here to be more representative of overall shellfish composition, however comparison with the undisturbed deposits excavated in SM:137a are nevertheless useful. Results of quantification of diagnostic shellfish recovered in SM:137a are shown in Table 7-2 and Figure 7-8. As is clear, XUs 3 and 4 have overall low total proportions of shellfish (n=13 and n=2, respectively) however data for XU 1 and XU 2 indicate that *A. granosa* and *S. cucullata* are represented in broadly similar proportions.

	Total MNI	*Anadara granosa*			*Saccostrea cucullata*			All other species		
		MNI	Weight	MNI %	MNI	Weight	MNI %	MNI		MNI%
XU1	68	37	569	54.41	31	192	46	12	66	15
XU2	116	46	599	39.66	70	412	60	9	63	7
XU3	13	7	72	53.85	6	22	46	1	7	7
XU4	2	-	-	-	2	6	100	-	-	-

Table 7-2 SM:137a shellfish composition

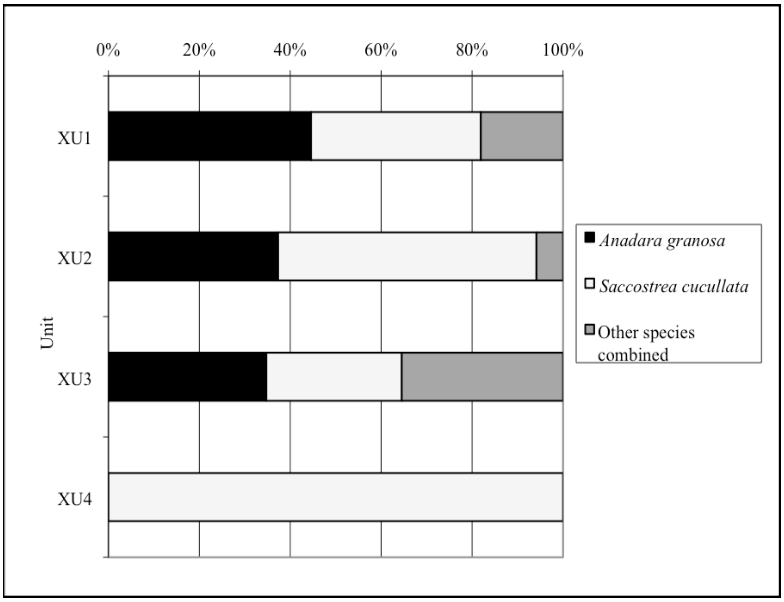

Figure 7-8: MNI data for SM:137a

Shellfish composition data for SM:137sh are shown below in Table 7-3 which illustrates that the sample comprised 39.6% (n=687) *A. granosa* and 55.39% (n=961) *S. cucullata* by MNI. Other species minimally represented included *M. hiantina*, *N. lineata*, *V. cochlidium*, *P. erosa* and *T. telescopium*, all with a total combined MNI of 5.01% (n=87). This data is seen to be more representative of the shellfish composition of SM:137 as a whole than the results for SM:137a because of the larger sample size, despite its lack of integrity.

Species	Total		*Anadara granosa*		*Saccostrea cucullata*		All other species	
	MNI	Weight (g)	MNI	Weight (g)	MNI	Weight (g)	MNI	Weight (g)
Total	1735	8862	687	5280	961	3349	87	233
Percentage	100	100	39.60	59.58	55.39	37.79	5.01	2.63

Table 7-3: SM:137sh shellfish MNI and weight data

7.2.5 Stone artefacts

Six stone artefacts were recovered in the sorting of the materials in the SM:137sh samples, including four on quartz and two on silcrete (Table 7-4). No formal tool types were identified.

Raw material	Type	Cortex %	Length (mm)	Width (mm)	Thickness (mm)
Quartz	Angular Fragment	1-49	15	9	6
Silcrete	Pebble	50-100	44	32	16
Quartz	Angular Fragment	1-49	26	15	7
Quartz	Flake	0	16	12	5
Quartz	Flake	0	21	13	5
Silcrete	Pebble	50-100	4.8	3.7	2.8

Table 7-4: Stone artefacts, SM:137sh

7.3 SM:140

7.3.1 Description

SM:140 is a small shell mound located within the complex of mounds and shell scatters at Rhum Point (see Figure 7-4). The site has maximum basal dimensions of 16 m by 9 m and is up to 30 cm in height. It lies a few metres from the edge of the escarpment and was only minimally disturbed by the earthmoving equipment that had damaged the nearby SM:137 site. The impacts to SM:140 were restricted to a small area of the northern margin; a single 0.5 m^2 test pit was excavated on undisturbed portion of the site.

7.3.2 Stratigraphy and composition

SM:140 was excavated to total depth of around 24 cm before culturally sterile bauxite laterite substrate was reached. The deposit comprised large accumulations of whole and fragmented shellfish set within a matrix of fine, dark organic soil. In section, the deposit was considered to consist of two primary layers: the upper 15 cm consisted of large amounts of highly fragmented shell differentiated from a lower layer ~10 cm in depth with similar shellfish composition but larger proportions of fine ashy sediment. These are very coarse divisions only and no clear lenses or strata were identified. Summary data for SM:140a are provided in Table 7-5.

	XU1	XU2	XU4
Unit depth (cm)	7.15	6.38	10.9
Gross weight (g)	19500	20000	27000
6.5 mm residue (g)	6950	9000	11500
Stones and rocks (g)	472	322	897
Charcoal (g)	-	1	2
Non-diagnostic shell (g)	2910	2499	1642
Diagnostic shell (g)	3211	2409	1985

Table 7-5: Summary data, SM:140a

7.3.3 Dating

A single sample of *A. granosa* valves were collected from the basal layer of SM:140 for radiocarbon determination. This returned an age span of 459(489)518 cal BP (Wk1378).

7.3.4 Shellfish analysis

Quantification by MNI of the shellfish retrieved in the 6 mm sieve residues of SM:140a indicated that *A. granosa* was not consistently the dominant species across all three spits. XU1 and XU2 were both composed of approximately one third *M. hiantina*, 15-27% *A. granosa*, and 16-22% *S. cucullata*. *A. granosa* was only marginally the dominant species in XU3. Other species recovered include *N. lineata*, *P. erosa*, *V. cochlidium* and *Balanus* sp. Summary data for SM:140a are provided in Figure 7-9 and Table 7-6.

	XU1	XU2	XU3
A. granosa MNI	215.56	132	225
%	43.94	21.96	63.65
M. hiantina MNI	177.50	193	107
%	36.18	32.11	30.27
S. cucullata MNI	85.50	265	16.50
%	17.43	44.09	4.67
Other species MNI	12	11	5
%	2.45	1.83	1.41
Total (all Species)	490.56	601	353.50

Table 7-6: SM:140 shellfish MNI data

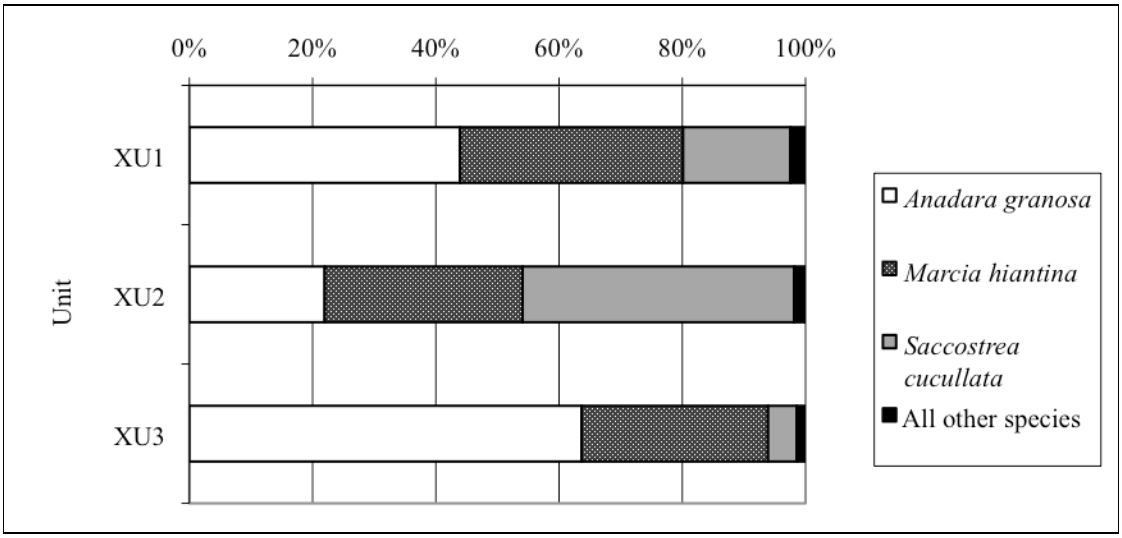

Figure 7-9: SM:140 shellfish MNI as percentage of total unit MNI

7.3.5 Stone artefacts

Two silcrete artefacts were recovered from the surface of SM:140 prior to excavation. One of these was an unmodified broken pebble and the second was a core with one flake scar. No artefacts were recovered from the excavated deposits.

7.4 SM:147

7.4.1 Description

SM:147 is the largest shell mound within the Rhum Point complex and sits atop the gradually sloping margin of the escarpment overlooking the Mission River (Figure 7-4), measuring 75 m long, 20 m wide and up to 1.5 m in height.

The mound has had deposit removed from it some time in the recent past[5] causing damage to a small portion of the site. However, the remaining deposit appears relatively undisturbed with several medium to large trees growing through it. Past disturbance had exposed a section approximately 1.3 m long across the densest part of the remaining deposit. Investigations at SM:147 involved cleaning back and recording this section, and then retrieving samples for radiocarbon dating and small sediment samples; no bulk samples of deposit were retrieved for analysis. This section, after cleaning, measured 1.5 m across and ~1.25 m in depth.

7.4.2 Stratigraphy and composition

The stratigraphy of SM:147 is illustrated in Figure 7-10. The deposit is best described as consisting of layers of mostly whole shellfish with little sediment alternated with layers differentiated only by more fragmented shell and the presence of larger proportions of sediment. The dominant shellfish species was *A. granosa*, though other species including *S. cucullata*, *M. hiantina*, *P. erosa* and *N. lineata* were also observed. Several small distinct lenses occurred within the section, one of a dense accumulation of ash and charcoal, and the other a lens of fine brown soil; both also contained large proportions of shell.

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[5] This site is one of a series around the Albatross Bay area that have been quarried on a small scale in recent times. The quarried shell is thought to have been used as fill on boggy sections of dirt tracks, or when crushed, as an additive to concrete mixes (Morrison 2003c).

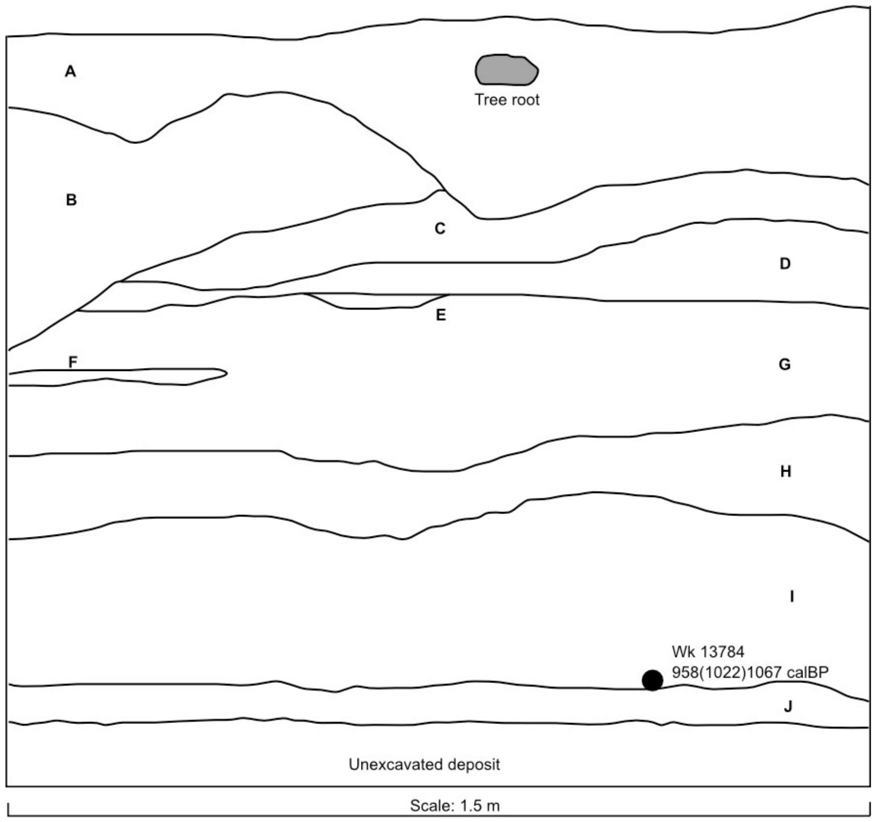

Figure 7-10: SM:147 Stratigraphic profile

Layer descriptions:

A) Dense shell with matrix of fine black sediment containing frequent fine to medium roots. Heavily fragmented shell
B) Loosely packed shell with little to no sediment. No roots and shell very white to yellow in colour
C) Loosely packed shell in a matrix of fine ashy sediment with frequent roots.
D) Very fine yellow/grey ash containing lower proportions of shell compared with other layers. Occasional fine roots.
E) Thin lense of charcoal
F) Thin layer of brown sediment containing smaller proportions of shell compared with other layers. Lacks roots.
G) Broad layer of shell containing large proportions of ash and fine brown soil.
H) Loosely compacted shell with moderate proportions of fine ashy sediment.
I) Loosely compacted shell with moderate proportions of fine ashy sediment, lighter colour than layer H with a tinge of red to yellow.
J) Bauxite laterite substrate.

7.4.3 Dating

Several samples of *A. granosa* were obtained from SM:147 for radiocarbon determinations. One sample from the basal cultural layer produced an age span of 958(1022)1067 cal BP (Wk13784). This site had also previously been dated by

Beaton with a resulting determination of 486(525)553 cal BP (ANU 4421) (Stone 1995: 83 (Fig 3)); however no context on the location of this sample was provided.

7.5 SM:136

7.5.1 Description

SM:136 is a small shell mound within the Rhum Point group of sites (Figure 7-4) and measures approximately 18 by 14 m and up to 50 cm in height. Apart from minor damage to its margins caused by clearance activities SM:136 is largely intact.

A north-south trench measuring 2 by 0.5 m was excavated across the middle of SM:136. This was excavated as four adjoining 0.5 m pits, rather than as a single trench. The materials recovered from all four pits were quantified and analysed in detail, however only data from one of these – SM:136a – is presented here as the other three had similar composition and stratigraphy and Pit A is considered to be representative of these. The purpose of excavating a trench was to obtain a partial cross-section of a low shell mound deposit.

7.5.2 Stratigraphy and composition

SM:136a was excavated in five spits to a depth of ~32 cm below surface. This pit, along with the three adjacent pits, comprised an upper layer (A) of loosely compacted shell in a dark earthy matrix that overlay a layer (B) with less soil and more whole shellfish remains. Culturally sterile deposits (C) occur below this layer at approximately 20-25 cm below surface. The section drawing for SM:136 (Figure 7-11) suggests the upper layer has not accumulated horizontally, but rather, as a broad dome. This has seen the lower cultural layer completely covered over by the upper layer. Summary data for SM:136a are shown in Table 7-7 below.

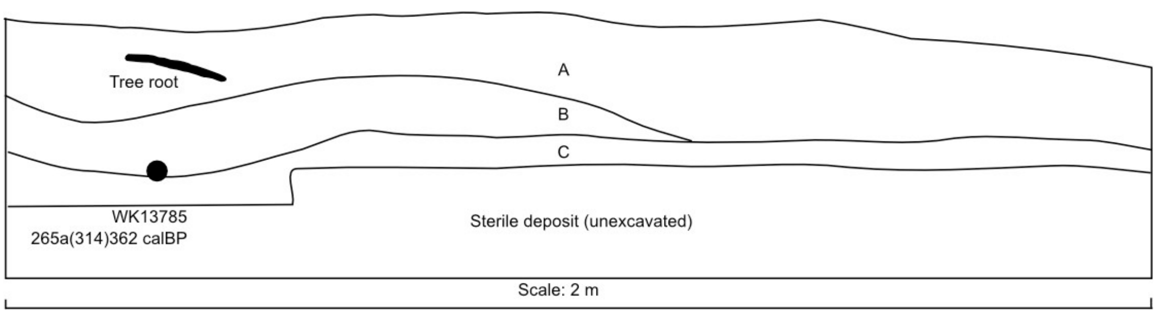

Figure 7-11: Section drawing, SM:136

A) Loosely compacted shell with large proportions of dark earth sediment. Highly fragmented shell and frequent fine to medium sized roots.
B) Loosely compacted shell with low proportions of light red and orange coloured sediment. Occasional bauxite nodules and lower proportions of sediment compared with A.
C) Sterile layer. Highly compacted bauxite laterite substrate.

	XU1	XU2	XU3	XU4	XU5
Spit depth	6.25	6.02	5.9	6.12	6.85
Gross field weight	19000	18000	18500	18000	23500
Gross 6 mm fraction	9498	10888	11566	10644	6705
Rock and stones	171	179	51	222	2379

Table 7-7: SM:136a summary data

7.5.3 Dating

Three samples of *A. granosa* were collected from the SM:136 section however only one of these was submitted for dating. This sample was obtained from the basal layer of the site and returned an age span of 265a(314)362 cal BP (Wk13785).

7.5.4 Shellfish analysis

Shellfish data from SM:136a are presented in Table 7-8 and Figure 7-12. As shown, *A. granosa* did not comprise as significant a proportion of the MNI for each layer as was the case with other sites. It was, however, still the most frequently occurring shellfish species at 76% in XU 5 steadily dropping to around 50% in XU 1. *Marcia hiantinaÕs* contribution is initially low at a little under 14% in XU 5 however over time this increases to almost 35% in XU 1. A slightly greater proportion of sub-species are also found in the upper layers when compared with the basal layers.

	XU1	**XU2**	**XU3**	**XU4**	**XU5**
A. granosa MNI	393.32	508.89	577.27	623.84	278.74
%	50.22	51.34	59.61	70.64	76.18
M. hiantina MNI	274.00	282.00	276.50	156.00	48.50
%	34.98	28.45	28.55	17.66	13.26
S. cucullata MNI	36.50	84.00	43.00	44.00	16.00
%	4.66	8.47	4.44	4.98	4.37
Other species MNI	79.42	116.36	71.67	59.28	22.63
%	10.14	11.74	7.40	6.71	6.19
All Species	783.24	991.24	968.44	883.12	365.87

Table 7-8: SM:136a shellfish MNI data

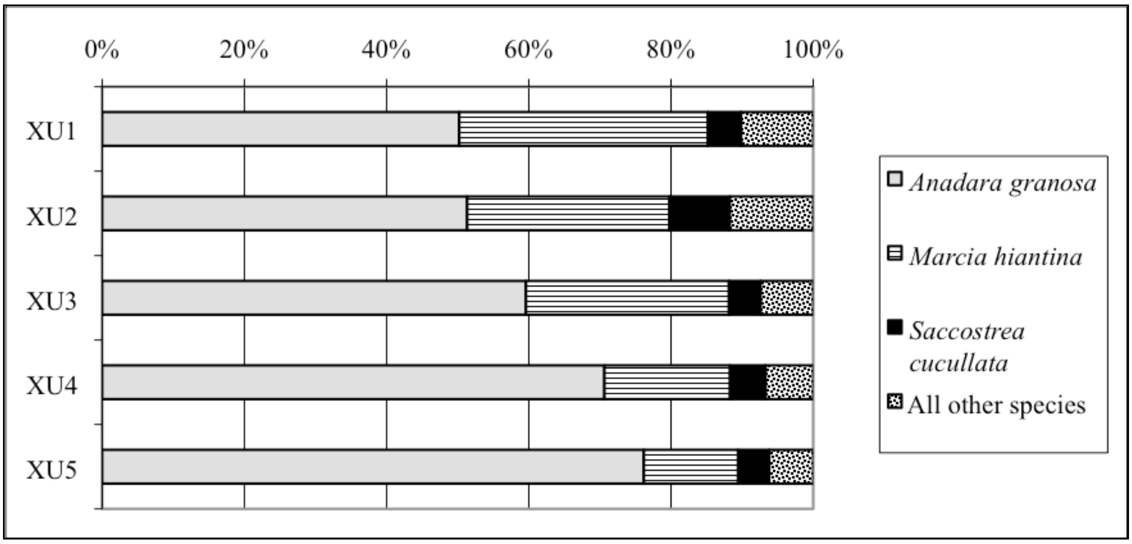

Figure 7-12: SM:136a Shellfish MNI as percentage of total unit MNI

7.5.5 Artefacts

Five stone artefacts were recovered from SM:136 with three of these located in SM:137a and the remaining two in the immediately adjacent pit SM:136b (Table 7-9). These included a single small mudstone flake, two quartz flakes, and a small quartz nodule. A small quartz pebble core with a single flake scar was also recovered.

Raw material	Artefact Type	Length (mm)	Width (mm)	Thickness (mm)	Description	Pit	Unit
Quartz	Flake	11	7	3	Angular fragment	SM:137b	XU2
Mudstone	Flake	15	9	4	Angular fragment	SM:137b	XU2
Quartz	Core	40	38	21	Pebble core, 1 flake removed	SM:137a	XU4
Quartz	Flake	15	8	7	Angular fragment	SM:137a	XU1
Quartz	Nodule	24	14	13	Small angular nodule	SM:137a	XU2

Table 7-9: Stone artefacts, SM:137

7.5.6 Other faunal materials

A total of four small fragments of crab claw (*Scylla serrata*) were identified within the test pits excavated on SM:136. These were all very small at less than 10 mm long and collectively weighed less than 20 g. No other non-molluscan faunal remains were identified.

7.6 SM:126

7.6.1 Description

SM:126 is a small shell mound located at the edge of the escarpment near the Rhum Point West area (see Figure 7-4) in which two pits measuring 0.5 x 0.5 m were excavated. The surrounding vegetation is open woodland with a dense stand of dry notophyll vine forest situated at the foot of the escarpment. SM:126 itself is elongated and measures approximately 16 by 7 m in basal dimensions and up to

20 cm in height. Pit SM:126a was excavated on an area of the site previously disturbed by earthmoving equipment. Results from this pit are not discussed here because the deposits were highly disturbed and minimal cultural material was recovered. The second pit, SM:126b, was placed on an undisturbed area of the mound close to the deepest deposits.

7.6.2 Stratigraphy and composition

Approximately 18 cm of deposit was excavated before a culturally sterile layer was reached in SM:126b. The substrate consisted of highly compacted lateritic soil with frequent bauxite pisoliths. The overlying deposit was a homogenous unit of whole and fragmented marine shell set within a matrix of fine, friable dark soil. After fine soil and stones were removed shellfish made up the bulk of the deposit (Table 7-10); no other cultural materials were recovered.

	XU1	**XU2**	**XU3**	**XU4**	**XU5**	**XU6**
Unit depth (cm)	2.8	2.3	2.8	2.5	3.7	3.2
Gross weight (g)	8500	8500	7500	9500	9500	10500
6 mm weight (g)	3193	3996	3440	3633	1480	719
2 mm weight (g)	818	422	398	778	1467	2363
Stones (g)	64	12.5	20	31	255	546
Charcoal (g)	12	8	6.5	15	14	0.5
Soil (g)	4011	4418	3838	4411	2947	3082
Non-diagnostic shell (g)	1610	678	658	837	356	59
Diagnostic shell (g)	1445	3362	2672	2441	809	103

Table 7-10: Excavation data, SM:126b

7.6.3 Dating

Two samples of *A. granosa* from SM:126b obtained from the lowermost and uppermost portions of the section were submitted for radiocarbon determinations. The lower determination returned a calibrated age of 472(503)530 cal BP (Wk12156) while the upper was 445(475)506 cal BP (Wk12157). The calibrated age spans suggests the site was deposited in short time period of ~24-85 cal years.

7.6.4 Shellfish analysis

Anadara granosa was the dominant species of shellfish by MNI, comprising between 82% and 93% of the MNI for each unit (see Table 7-11 and Figure 7-13). *S. cucullata* was the next most frequently occurring species, comprising at most 12% of the MNI of any unit. Other species recovered included *M. hiantina*, *P. erosa*, *T. telescopium* and *Balanus* sp.

Unit	**Layer MNI**	***Anadara granosa***		***Saccostrea cucullata***		**All other species**	
		MNI	*%*	*MNI*	*%*	*MNI*	*%*
XU1	197	184	93%	7	3%	7	4%
XU2	321.5	300	93%	11	6%	11	5%
XU3	270.5	233	86%	25	12%	13	7%
XU4	232	192	83%	16	8%	25	13%
XU5	64	57	88%	2	1%	6	3%
XU6	11	9	82%	1	1%	1	1%

Table 7-11: SM:126b shellfish data

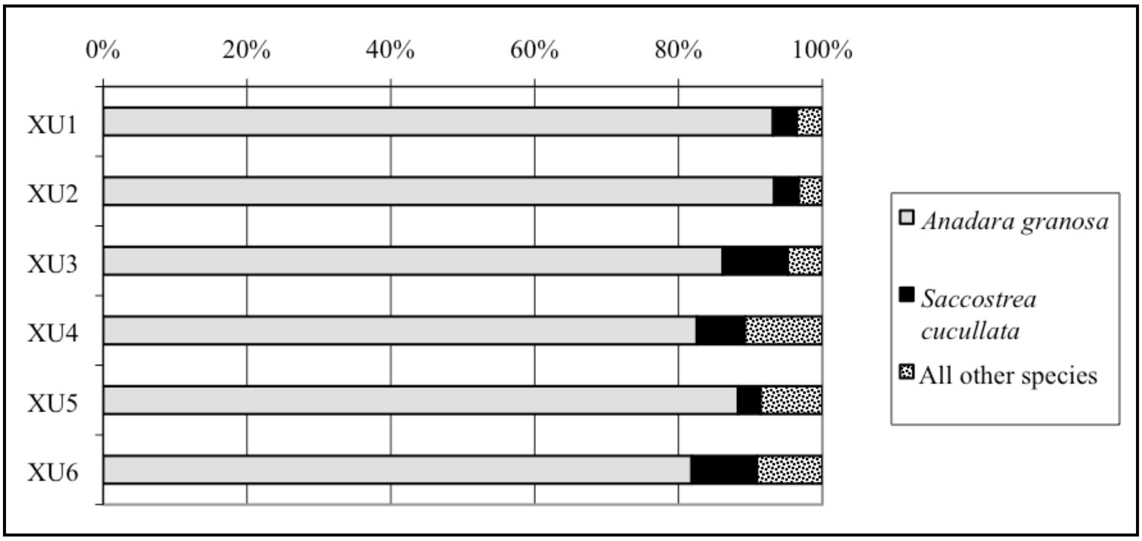

Figure 7-13: SM:126b Shellfish MNI as percentage of total unit MNI

7.7 SM:123

7.7.1 Description

SM:123 is one of ten small shell scatters clustered in a linear pattern over an area < 60 m by 10 m in area and oriented along the edge of the escarpment at Rhum Point West (Figure 7-6). All ten scatters are between 1 and 1.5 m in diameter and surface materials are primarily *A. granosa*. The vegetation at the edge of the plateau is open woodland while at the foot of the escarpment a 10-15 m stand of dry notophyll vine forest occurs. Sparse mangroves occur on the seaward side of this forest, followed by extensive mudflats exposed at low tide. Single 0.5 x 0.5 m test pits were excavated on three of these shell scatters. Two of these (SM:118 and SM:124) had been heavily disturbed by the clearance work and contained little cultural material and are thus not discussed further here (but see Morrison 2003a). Results of excavations of the third site (SM:123a) are reported here.

7.7.2 Stratigraphy and composition

Less than 5 cm of deposits were excavated on SM:123a before the sterile, compact bauxite laterite substrate was reached. The cultural deposits – consisting primarily of compacted whole and fragmented shellfish remains – were restricted to the upper 2-3 cm of this deposit. No artefacts or non-molluscan faunal remains were recovered. Bulk data for this pit are shown in Table 7-12.

	XU1	XU2
Unit depth (cm)	2.1	1.4
Gross weight (g)	9500	7500
6 mm weight (g)	3096	1315
2 mm weight (g)	1666	432
Stones (g)	83	275
Charcoal (g)	9	13
Soil (g)	4762	1747
Non-diagnostic shell (g)	1394	432
Diagnostic shell (g)	1532	586

Table 7-12: Bulk data, SM:123 test pit

7.7.3 Dating

A sample of *A. granosa* shells were removed from the basal layer of test pit SM:123a for radiocarbon determination, returning an age span of 135(183)253 cal BP (Wk12158).

7.7.4 Shellfish analysis

Predictably, only small proportions of shellfish were recovered in SM123a. As Table 7-13 illustrates, *A. granosa* was the most frequently occurring species with an MNI of 95 in XU 1 and 40 in XU 2. Other species recovered included *S. cucullata* and *N. lineata*.

Species	XU1	XU2
A. granosa MNI	95	40
%	83.3	88.9
S. cucullata MNI	18	4
%	15.8	8.9
N. lineata MNI	1	1
%	0.9	2.2
All species	114	45

Table 7-13: SM123a shellfish composition

7.8 SM:116

7.8.1 Description

SM:116 is a small shell mound situated adjacent to the escarpment overlooking the Mission River 50 m to the south west of the Rhum Point West group of sites (Figure 7-6). Here the plateau is vegetated by open woodland and there is a ~4 m sheer drop down to the shoreline where a narrow sandy beach occurs. Two 0.5 by 0.5 m pits were excavated on this site. SM:116a was excavated on an area previously damaged by clearance activity and only 4 cm of highly disturbed shell matrix deposit was recovered; this pit is not discussed further here (but see Morrison 2003a). The second test pit, SM:116b, was excavated on an undisturbed area of SM:116 where the deepest deposits were expected to be found.

7.8.2 Stratigraphy and composition

SM:116b was excavated to a depth of 18 cm before the sterile bauxite laterite substrate was reached. The shell matrix deposit was between 6 and 15 cm in depth, the variation due to a natural depression in the substrate towards the south west. The deposits comprised dense accumulations of whole and fragmented shell in a matrix of very fine, loose soil. Bulk data for SM:116b are shown in Table 7-14, below.

	XU1	XU2	XU3	XU4	XU5	XU6
XU Depth (cm)	3.2	2.8	2.7	2.9	2.7	3.4
Gross weight (g)	10000	10000	9500	9000	9000	10000
6 mm weight (g)	2882	1975	729	528	275	229
2 mm Weight (g)	1277	1195	2011	1601	1502	1683
Stones (g)	20	94	340	198	181	200
Charcoal (g)	-	2	1	1	1	-
Soil (g)	5841	6830	6760	6871	7223	8088
Non-diagnostic shell (g)	1416	717	153	80	25	15
Diagnostic shell (g)	1414	1132.5	231.3	198	23	15

Table 7-14: SM:116b bulk data

7.8.3 Dating

One sample of *A. granosa* was removed from the base of SM:116b for radiocarbon determination and returned a calibrated age span of 361(409)466 cal BP (Wk12159).

7.8.4 Shellfish analysis

The shellfish composition of SM:116b was strongly dominated by *A. granosa*, as shown in Table 7-15 and Figure 7-14 . MNI values were all higher than 96%, although it should be stated that the actual MNI of all diagnostic shellfish was at most 215 individuals in any layer.

Species	XU1	XU2	XU3	XU4	XU5	XU6
A. granosa MNI	212	151	35	27	9	3
%	99	97	96	96	100	100
Other species MNI	3	4.5	1.5	1	-	-
%	1	3	4	4	-	-
Totals	215	156	36.5	28	9	3

Table 7-15: SM:116b shellfish composition

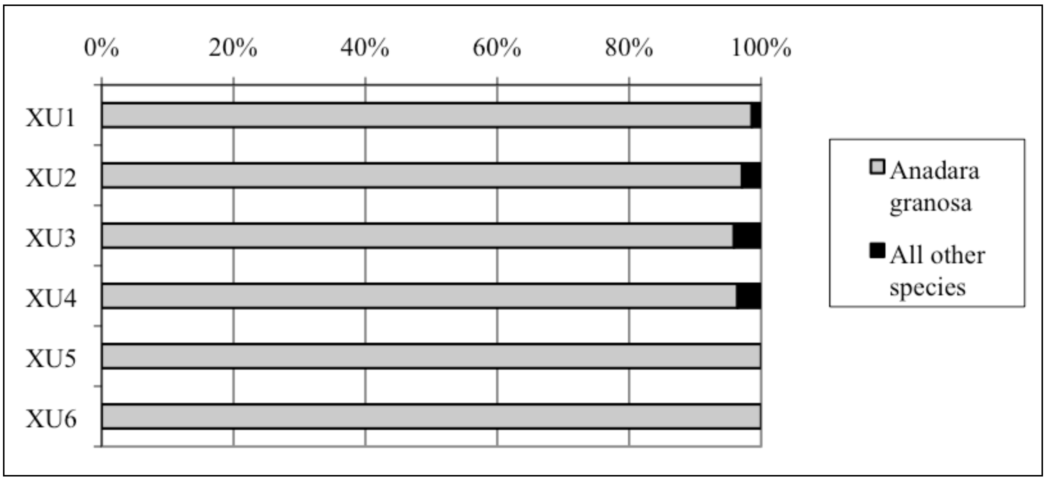

Figure 7-14: SM:116 Shellfish MNI as percentage of total unit MNI

7.8.5 Stone artefacts

A single, small angular quartz fragment was recovered in the shell midden deposit. This artefact measured 6 mm in length and 12 mm in width. No other artefacts were recovered.

7.9 SM: 115

7.9.1 Description

SM:115 is located approximately 800 m to the south west of the Rhum Point West group of sites and 8 m from the escarpment edge within open woodland (Figure 7-6). Prior to excavation this site had been heavily damaged by earthmoving equipment. However, the site had been recorded the year prior to this event and originally measured 30 m in diameter and up to 30 cm in height (Morrison 2003a). Work on SM:115 aimed to recover information about the site after it had been damaged and included excavating a single test pit into the remaining few centimetres of intact deposit. Because of the extent of damage to this site, careful attention was paid to the spoil heaps where the bulk of the disturbed shell matrix deposit had been pushed. All data discussed below was generated via analysis of the spoil heaps and data resulting from the excavation itself are not presented here (see Morrison 2003a).

7.9.2 Stratigraphy and composition

No meaningful data on the stratigraphy and composition of SM:115 are available because of the extent of damage to the site however summary data resulting from the sieving work on the spoil heaps are provided in Table 7-16. It should be noted that the weight values for the spoil heaps, discarded soil and 6 mm samples are inflated due to the high degree of intermixing of anthropogenic deposits with naturally occurring soil, ironstone, bauxite pisoliths and vegetation as a result of site disturbance. A 6% sample (45 kg) of the 6 mm materials was retained for more detailed analysis and sorting.

Material	Weight (kg)
Gross Weight	1059
Discarded soil	308
Gross 6 mm weight	751
6 mm analysed	45.58
Non-diagnostic shell	29.13

Table 7-16: SM:115 summary data

7.9.3 Dating

As noted above, a single radiocarbon dating sample of *A. granosa* valves was obtained from 4 cm below the ground surface during the controlled excavation of pit SM:115a. These shells were firmly set within the bauxite laterite substrate and overlain by compacted shell matrix deposits. This strongly suggested that these basal deposits had not been disturbed by the clearance activity that had removed the bulk of the upper deposits of the site. The resulting age span for the basal layer of SM:115 was 285(341)383 cal BP (Wk12160).

7.9.4 Shellfish analysis

The 6% sample of 6 mm residues obtained from sorting of the spoil heaps from SM:115 yielded large proportions of *A. granosa* with only very low proportions of other shellfish species. The MNI for *A. granosa* recovered in the sample represented 95.5% of the total shell sample. *Saccostrea cucullata* and *M. hiantina* were the next most frequently occurring species (1-2%) along with a range of other subspecies that occurred in very low proportions.

Species	MNI	%
A. granosa	1472	95.52
S. cucullata	31	2.01
M. hiantina	20	1.30
P. erosa	1	0.06
V. cochlidium	4	0.26
N. lineata	5	0.32
T. telescopium	4	0.26
Land snail (unidentifiable species)	1	0.06
Ellobium sp.	1	0.06
Balanus sp.	1	0.06
Total MNI	1541	

Table 7-17: SM:115 shellfish MNI

7.9.5 Stone artefacts

Four stone artefacts were recovered from the 6 mm sieve residues (Table 7-18), including some identified during sorting both in the field and the lab. These included three small quartz flakes and a small quartz split pebble. No other artefacts were recovered despite the very large amounts (~1059 kg) of 6 mm residues that were hand sorted in the field.

Raw material	Artefact Type	Cortex (%)	Length (mm)	Width (mm)	Thickness (mm)	Comments
Quartz	Split pebble	50-100	40	20	15	
Quartz	Flake	1-50	12	8	3	Bulb of percussion and striking platform
Quartz	Flake	1-50	14	12	6	Striking platform only
Quartz	Flake	50-100	26	16	9	No diagnostic features

Table 7-18: Stone artefacts, SM:115

7.9.6 Faunal materials

A single, small fragment of mud crab (*S. serrata*) claw measuring less than 10 mm in length was recovered during the sorting of the 6 mm residue sample. No other faunal materials were recovered.

7.10 SM:114

7.10.1 Description

SM:114 is a broad, low shell mound deposit approximately 35 m in diameter that lies immediately adjacent to the escarpment overlooking the Mission River (Figure 7-2). The surrounding vegetation is a mixture of open woodland and closed dry notophyll vine forest. A narrow sandy beach and tidal mudflat occurs at the foot of the escarpment.

Sometime during the 1970s a small hut was built approximately 15 m to the north of SM:114. This was removed in 2002 and in the process minor damage was inflicted upon the northern and western margins of SM:114. Three test pits were excavated on SM:114. Two of these (SM:114a and SM:114b) were on disturbed portions of the site yielding little useful data and are thus not discussed further here. The third, SM:114c, was located on an undisturbed area of the site and whose results are reported here.

7.10.2 Stratigraphy and composition

SM:114c was excavated to a depth of 18 cm before the culturally sterile bauxite laterite substrate was reached at approximately 16 cm below surface. The upper 16 cm of deposit consisted of loosely packed whole and fragmented shellfish remains dominated by *A. granosa* in a matrix of fine, friable soil; summary data for the site are shown in Table 7-19. No distinct strata were identified within SM:114c.

	XU1	XU2	XU3	XU4
Unit depth (cm)	5.15	6.12	6.2	1.8
Gross weight (g)	18500	19000	23500	6000
6 mm weight (g)	5229	5270	5124	835
2 mm weight (g)	3095	3619	4228	-
Stones (g)	1250	1758	3605	749
Soil (g)	10176	10111	14148	5165
Non-diagnostic shell (g)	2813	1252	607	44
Diagnostic shell (g)	1059	2140	813	38

Table 7-19: SM:114c excavation data

7.10.3 Dating

A single sample of *A. granosa* was obtained from the base of SM:114c for radiocarbon determination. This returned a calibrated age span of 338(404)461 cal BP (Wk12161).

7.10.4 Shellfish analysis

Anadara granosa was the dominant shellfish species recovered in the SM:114c test pit, (Table 7-20 and Figure 7-15). This varied between 87% and 100% of the total MNI for each excavation unit. Other species recovered included *S. cucullata*, *N. lineata*, *M. hiantina* and *V. cochlidium*.

Species	XU1	XU2	XU3	XU4
A. granosa MNI	95	262	103	7
%	87	96	94	100
Other species MNI	6	7	2	-
%	6	3	2	-
Total	109	272	109	7

Table 7-20: SM:114c Shellfish composition

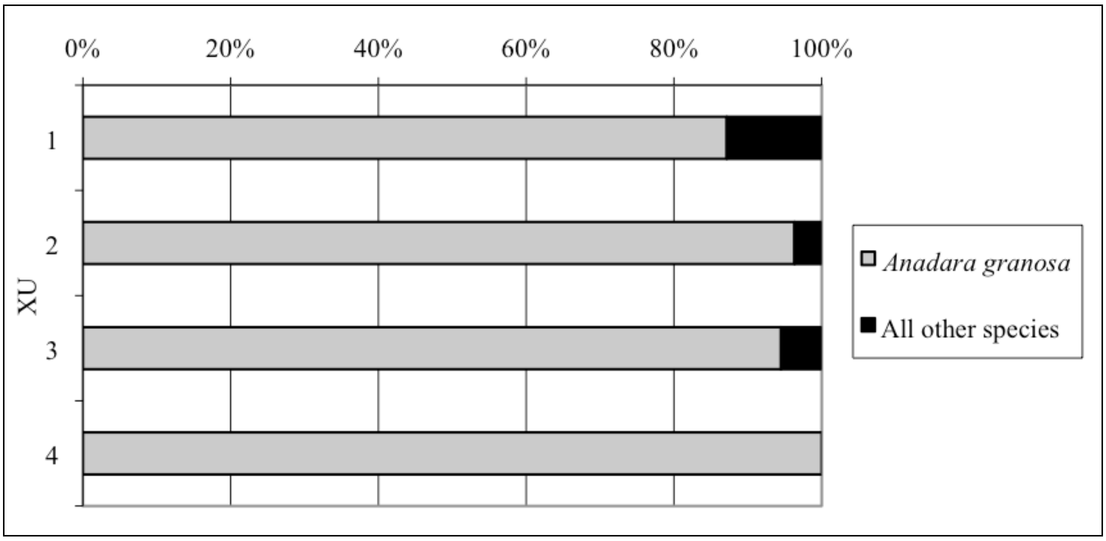

Figure 7-15: SM:114 Shellfish MNI as percentage of total unit MNI

7.10.5 Stone artefacts

Two small quartz fragments less than 1.5 mm in length were recovered in SM:114c. Both had no diagnostic features, were highly angular and had little to no cortex visible. No other artefacts were recovered.

7.11 Two millimetre residue analysis

As outlined in Chapter 4, a strategic approach to the sampling of the 2 mm sieve residues was used. In summary, 2 mm residues were only investigated in cases where non-molluscan faunal remains were recovered in 6 mm residues for the same excavation unit. Most of the sites at *Bweening* were relatively shallow and only one Ð SM136a Ðyi elded any non-molluscan faunal materials; for this reason only 2 mm residues from SM:136a were systematically investigated for non-molluscan faunal materials. Two units were selected for sorting and quantification work.

It is probably no coincidence that SM:136a was the deepest deposit excavated at *Bweening* and also yielded the greatest proportions of non-molluscan faunal materials. Pit A on this site was excavated to a depth of 32 cm with a total of 97 kgs of material excavated. A total of 1860 g of 2 mm residue was obtained from XU 1 and 1250 g from XU 4, all of which was sorted for charcoal, stone artefacts, bone, crab or other diagnostic shellfish species. Summary data is provided in Table 7-21.

XU	**2 mm weight**	**Charcoal/ vegetation**	**Crab**		**Ceriths**		**Land snails**		***M. hiantina***		**Trochus**	
	g	g	No.	g	MNI	g	MNI	g	MNI	g	MNI	g
1	1860	55	4	< 0.5	1	< 0.5	17	< 2	27	14	1	< 1
4	1250	31	-	-	2	< 0.5	15	< 1	24	7	-	-

Table 7-21: Summary of results of two millimetre analysis, SM136a

No bone and only three small fragments of crab shell weighing a combined total of 0.5 g were recovered from 2 mm residues sampled from SM:136a. Ceriths and a single complete but very small trochus shell were also recovered, the latter less that 0.5 mm in length. Around 51 diagnostic *M. hiantina* shellfish (MNI) were identified and in total weighed less than 21g.

These results add little to our understanding of composition of SM136a, except to say that there is no archaeological evidence for anything beyond very minor amounts of non-molluscan fauna in this site. Given that no such materials were recovered in the 6 mm component of other sites or in inspections of accompanying 2 mm residues it is concluded here that this is likely to be the case for other sites excavated at *Bweening*. The presence of small proportions of *M. hiantina* in 2 mm residues are of minor significance, particularly when these are incorporated into those for the 6 mm shellfish MNI data (Table 7-8). The combination of *M. hiantina* data for both 2 mm and 6 mm residue increases the overall proportion of this species by 2.16 % (from 34.98% to 37.14%) in XU1 and by 2.18% (from 17.66% to 19.84%) in XU4. In short, it is argued here that 6 mm residue analysis provides a sufficiently robust estimate of *M. hiantina* proportions for the purposes of this project.

7.12 Discussion

Excavation of the nine shell matrix sites on the *Bweening* coastline provides a relatively broad range of data within which a number of significant trends and patterns can be observed. This concluding discussion presents a brief synthesis of these results, identifies and discusses key findings, and finally, outlines issues for consideration in subsequent chapters.

7.12.1 Spatial and temporal patterns

All of the more substantial shell matrix deposits within the *Bweening* study area now have basal radiocarbon determinations, although a number of low density scatters were not investigated. Summary data on calibrated basal dates for shell matrix deposits in this area are presented below in Figure 7-16.

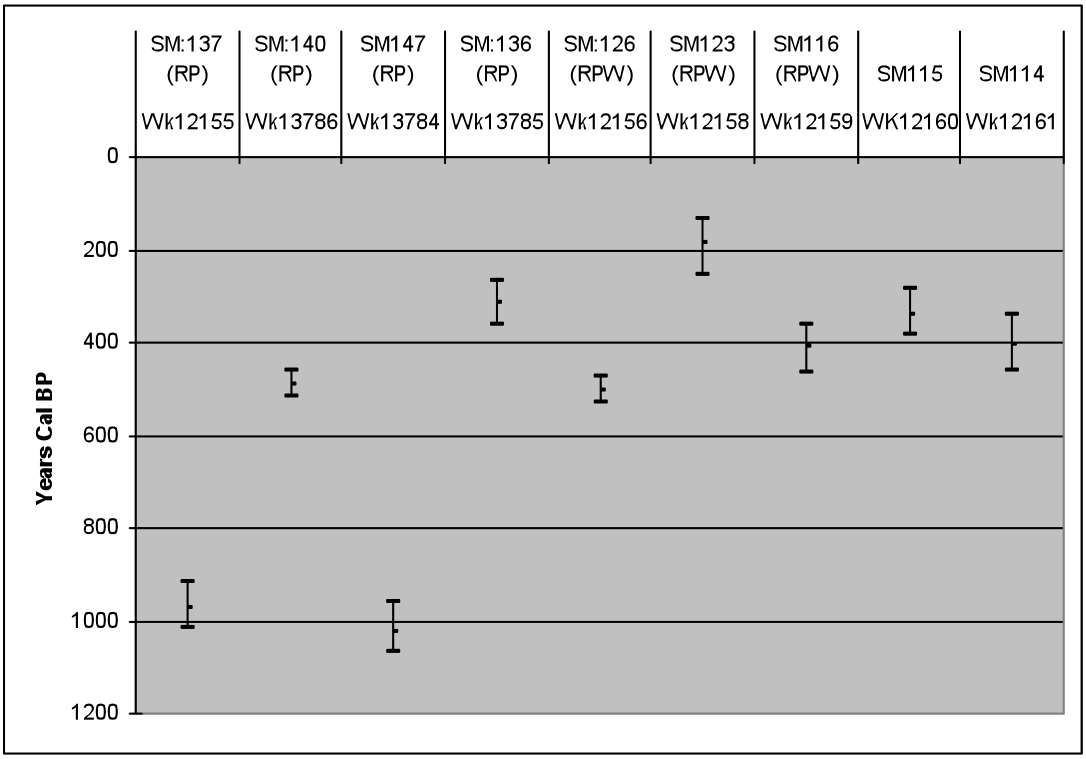

Figure 7-16: Basal calibrated age spans for sites excavated at *Bweening*
Note: RP = Rhum Point; RPW = Rhum Point West. Basal determinations only.

The earliest features in the *Bweening* study area are SM:137 and SM:147 at Rhum Point with calibrated age spans of ~918-1067 cal BP. SM:147 is the largest feature in the study area and the larger volume of deposit is consistent with it having an earlier age than other more minor shell matrix deposits. SM:137 was extensively damaged prior to excavation taking place however the fact that the sample was removed from its remaining undisturbed deposits suggests that this determination is a reliable estimate for the onset of site formation. Figure 7-16 clearly illustrates that the majority of *Bweening* coastal sites commenced forming after ~510 cal BP. It is unlikely that any of the undated features have basal ages earlier than this because as noted above these were all low density deposits.

The Rhum Point data indicates that initial shellfish discard was focussed upon SM:147, with minor deposition occurring in the vicinity of SM:137. There is some indication that SM:137 may represent an earlier phase of the nearby SM:136 for, as noted earlier, there is some possibility that both 'sites' were part of the same deposit prior to disturbance in the area. If this is the case then it suggests that initial discard in the vicinity of SM:137 may have gradually shifted towards the south east and towards the shoreline. The SM:136 basal age span is consistent with this scenario [265(314)362 cal BP (Wk13785)]. Shellfish deposition in the vicinity of SM:140 appears to have commenced around 459(489)518 cal BP (Wk13786).

After around ~510 cal BP there was a greater intensity of discard in the vicinity of SM:136 and SM:140. It is likely that the numerous small shell scatters around SM:140 were deposited during the period in which this site was forming. This concentration of activity may represent the early stages in the formation of a new, elongated shell mound similar to SM:147.

Three basal determinations were obtained from the group of sites at Rhum Point West. Of interest here is the equidistant arrangement of groups of sites approximately 100 m apart with the northern-most site SM:196, a central concentration of 10 small shell scatters (SM:117-127), and a midden site SM:116 to the south. All of these features appeared only after around ~503 cal BP, the earliest being SM:126 [472(503)530 cal BP (Wk12156)], followed with the commencement of SM:116 [361(409)466 cal BP (Wk12159)] and the more recent formation of the low density shell scatter in the central group of sites [135(183)253 cal BP (Wk12158]. Significantly, an upper determination on the northern shell mound suggests it was abandoned around or after 445(475)506 cal BP (Wk12157), or prior to the commencement of either SM:116 or SM:123.

Although dates for the cessation of site deposition are limited, the sequence of site formation at Rhum Point West may suggest initial discard to the north at SM:126 followed by abandonment, with a subsequent focus on SM:116, 200 m to the south west. No upper age is available for SM:116 however a short period of usage is likely because it consists of relatively little deposit compared to the larger SM:126. The implication of this is that SM:116 was also used for a short period before deposition focussed in the area around SM:123. As outlined earlier, this feature is one of 10 very similar low density scatters of *A. granosa*; it is argued here that this similarity in location, composition (primarily *A. granosa*) and size suggests that these features are of a similar age to SM:123. As with Rhum Point, the large concentration of shell scatters at Rhum Point West are interpreted here as representing the early stages of formation of a more substantial midden or shell mound. In short, there is strong evidence that the deposits at Rhum Point west were deposited in succession and over a period of approximately 300 years.

The two remaining features dated in the *Bweening* study area are SM:114 and SM:115. These two sites were relatively isolated, being ~250 m apart and several kilometres south of the Rhum Point West group of sites. Both are also relatively young at 338(404)461 (Wk12161 – SM:114) and 285(341)383 (Wk12160 – SM:115), respectively. This is the same period in which the bulk of *Bweening* coastal sites commenced forming.

A unique feature of the archaeology of the *Bweening* coastline is that a number of inconspicuous, low density shell scatters and middens occur within the context of more substantial shell mound deposits. They were investigated here in order to consider whether these lower density shell scatters represent the early stages of shell mound formation. The *Bweening* data suggest this is highly likely: at Rhum Point West the positioning of SM:117-119 and SM:120-125 and SM:127 broadly suggest a pattern of concentrated deposition at several distinct areas. Each of these concentrations have basal dimensions of around 18-20 m, a size similar to many shell mounds in the broader study area, and surface observations and excavations of site SM:123 indicate a dominance of *A. granosa*.

This tendency toward the formation of larger shell mound features also appears to be operating on a larger scale, and this is evidenced at Rhum Point. SM:147 is an elongated mound approximately 1.5 m high, ~75 m long and oriented parallel with the escarpment edge. Similarly, SM:138-144 all occur within an area ~60 m in length and are also oriented with the escarpment edge. Significantly, discard appears to have been initially focussed on distinct areas as illustrated by the formation of SM:140 and SM:136, both roughly circular deposits of shell less than 30 cm in height. Dating of SM:126 – a site similar in basal dimensions and height – suggests that deposition of these materials took place in a few decades or so (based on mid-points of calibrated age spans).

The examples give a broad indication of the discard patterns that contributed to the development of larger shell mounds at *Bweening*. At this point they are not considered to be directly applicable to other shell mound sites in the broader region, which as outlined in earlier chapters range significantly in basal dimensions and form. However, the most significant point indicated by the *Bweening* data is that deposition was focussed on spatially discrete areas which initially led to small groups of concentrated shell scatters that later may have coalesced to form low, dome shaped shell mounds. However, at different times discard activity appears to have shifted and became focussed upon entirely new locales within close proximity to prexisting mounds. As indicated by the Rhum Point data, it also seems highly likely that discard was probably contemporaneous at a number of locales in any particular area.

7.12.2 Shell matrix site stratigraphy

Comparison of the stratigraphic data for shell matrix features excavated at *Bweening* indicates strong similarities in sites of similar sizes. Shell matrix features observed at *Bweening* can be distinguished into three broad groups based on observed stratigraphic patterns.

Firstly, light shell scatters have essentially no stratigraphic variation. The SM:123 shell scatter had relatively simple stratigraphy consisting of low proportions of shellfish set within natural substrates.

The second stratigraphic pattern occurs on low shell mound sites and consists of a dense layer of shellfish remains up to 30 cm thick overlying natural strata. Such sites had little evidence of internal layering apart from several instances of a thin layer of highly fragmented shell across the site surface. These features also had a distinct interface between natural substrates and the shell matrix deposits. Sites with these sorts of characteristics included SM:140, SM:126, SM:116 and SM:114. Although largely destroyed, it is likely that SM:136 and SM:115 would have also fallen into this category based on their size, form and what is known about their composition.

The third broad stratigraphic characteristic noted at *Bweening* is perhaps best termed as ‘classic’ shell mound stratigraphy. These include deposits that are comprised of alternating layers of sediment rich and sediment poor deposits, all dominated by very large proportions of shellfish remains. The two excavated examples at *Bweening* are capped by a surface layer of more fragmented shell with greater proportions of fine roots. These include SM:146 and SM:140.

Stones and rocks were recovered in all shell matrix sites, with proportions of these materials generally increasing with proximity to the natural bauxite substrates. Two types of stone were encountered in these deposits: bauxite pisoliths and ironstone. Both of these materials are common on the bauxite plateaus and likely to have been incorporated into the deposits through intermixing with natural substrates.

Preservation of charcoal in 6.5 mm sieve residues is relatively poor across all sites at *Bweening*. The largest proportions of charcoal were noted in SM:126.

7.12.3 Shellfish analysis

Shellfish remains were the primary cultural material recovered in excavations of shell matrix features at *Bweening*. Composition data for individual sites has been discussed in detail above and for this reason what follows is primarily concerned with comparing the proportions of dominant species across all sites.

The most frequently occurring species across all *Bweening* sites are *A. granosa*, *M. hiantina* and *S. cucullata*; summary data are provided below (Table 7-22 and Figure 7-17). Importantly, to compare MNI data across all sites in this way ignores variation in shellfish representation over time at particular sites. Not all sites are appropriate for considering changes in shellfish composition over time because of the limited depth of deposits or the use of spoil heap data (i.e. SM:123 [shell scatter], SM:137 [spoil heap] and SM:115 [spoil heap]). However, in sites with appropriate data, it is evident that the proportions of shellfish species for the entire pit are consistent with the data for each excavation unit. For example, in no instances are specific dominant species entirely replaced by other species over time.

Location	Rhum Point						Rhum Point West						Other			
Site Number	**SM:137sh**		**SM:136a**		**SM:140**		**SM:126**		**SM:123**		**SM:116**		**SM:115**		**SM:114**	
	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%
A. granosa	687	39.60	2382	63.69	357	29.19	974	88.87	135	84.91	437	97.76	1472	95.52	467	93.96
M. hiantina	2	0.12	1037	27.73	478	39.08	38	3.47		-	1	0.22	20	1.30	8	1.61
S. cucullata	961	55.39	224	5.99	367	30.01	61	5.57	22	13.84	4	0.89	31	2.01	15	3.02
P. erosa	2	0.12	2	0.05	-	-	2	0.18	-	-	1	0.22	1	0.06	-	0.00
N. lineata	58	3.34	84	2.25	18	1.47	12	1.09	2	1.26	-	-	5	0.32	1	0.20
V. cochlidium	20	1.15	2	0.05	3	0.25	3	0.27	-	-	1	0.22	4	0.26	5	1.01
T. telescopium	5	0.29	-	-	-	-	6	0.55	-	-	-	-	4	0.26	-	-
Combined other	-	-	9	0.24	-	-	-	-	-	-	3	0.67	4	0.26	1	0.20
Overall MNI	1735	100	3740	100	1223	100	1096	100	159	100	447	100	1541	100	497	100

Table 7-22: Shellfish composition data for *Bweening* sites

The largest variation in the most frequent shellfish species occurs in the three sites at Rhum Point. Uniquely, the SM:137 deposits are marginally dominated by *S. cucullata* (55%) and *A. granosa* is less well represented, although still present in substantial quantity (39%). SM:140 has similar proportions of *A. granosa*, *S. cucullata* and *M. hiantina*, although the latter is present in slightly greater proportions overall. SM:136a is dominated by *A. granosa* however *M. hiantina* comprises a significant proportion of deposits overall at almost 30% of total MNI.

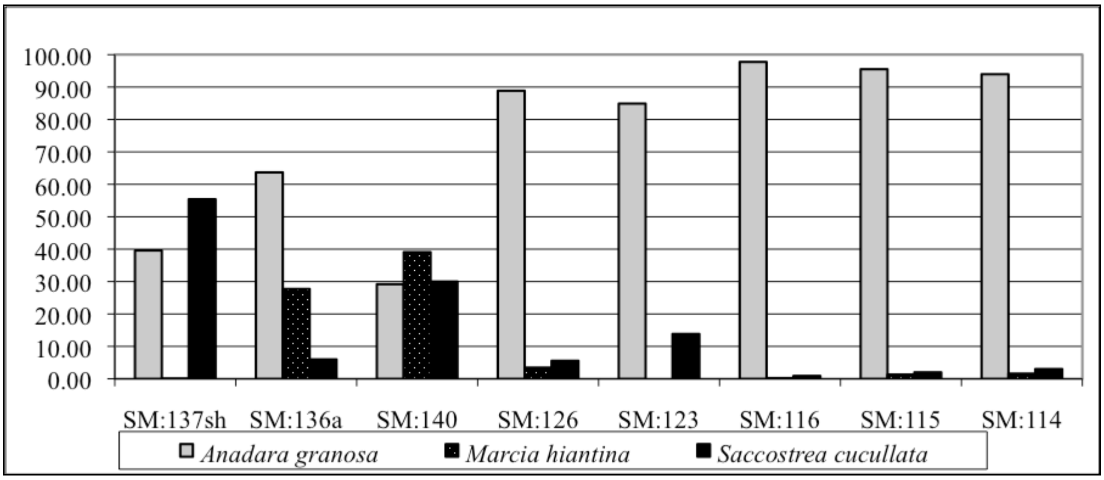

Figure 7-17: Dominant shellfish species by MNI for *Bweening* sites
Note: sub-species are not represented on this figure Ðsee Table 22

Figure 7-17 clearly shows that all sites away from Rhum Point are predominantly composed of *A. granosa*, which represents between 84-97% of total shellfish MNI. The proportions of sub-species in these sites, in all cases, were less than 10-15%. The highest proportions of other species were noted in the shell scatter SM:123 which consisted of only around 159 individuals. This raises a significant question: why do the sites with the largest variation in dominant shellfish species occur at Rhum Point? Similarly, is there an environmentally-oriented explanation for the more substantial deposits at Rhum Point compared with other areas along this part of the coastline?

Both *A. granosa* and *M. hiantina* inhabit the lower intertidal mudflat zone. In contrast, *S. cucullata* is more frequently found in the intertidal zone around rocky headlands, rock-strewn shorelines and the seaward margins of some mangrove forests where it attaches itself to mangrove roots. *Nerita lineata*, *P. erosa*, *V. cochlidium* and *T. telescopium* commonly inhabit the intertidal zone of mangrove forests with the latter three species found on the muddy substrates while *N. lineata* lives on mangrove roots. As described earlier, extensive mudflats occur along the entire coastline in the *Bweening* study area, from *Lueng* Creek in the north east to *Bweening* Point and beyond, and across all areas extending 100 m or more offshore at low tides. Conversely, rocky headlands, rock strewn shorelines and mangrove communities are more restricted in their distribution, with the area around Rhum Point evidencing the largest examples of such a microenvironment.

Based on this observation, it is a plausible that a relationship exists between the variety of species present in the Rhum Point shell matrix features and the proximity of nearby mangroves and rocky headlands. This implies that access to a broader resource base was an influential factor in the development of shell matrix sites at *Bweening*, however it is not considered to have been the determining one. The shell matrix features at Rhum Point West and further towards *Bweening* Point contain very low proportions of species other than *A. granosa* (>95% by MNI) suggesting that access to this species in these areas was a key motive for their development. While the total volume of deposits is on the whole less than those at Rhum Point, this does serve to further illustrate an important point: shell mound development at *Bweening* was not reliant upon a broad resource base. This suggests that shell matrix features were primarily associated with activities focussed upon shellfish collection rather than use of other types of resources. Clearly though, the issue of non-molluscan species needs to be resolved before making such a claim.

7.12.4 Stone Artefacts

Overall only 19 stone artefacts were recovered at *Bweening* and all but two of these were found during the excavations (Table 7-23). Quartz was the most frequently encountered raw material type (n=14) with silcrete (n=2) and mudstone (n=1) less common. Ten of the items were flakes, with nine of these made on quartz and one on mudstone. Mean flake length was 15 mm and width was 9.7 mm. Five unmodified blocks were recovered, two of which were quartz and two were silcrete. Two small angular fragments of quartz were identified and it is likely these are simply stone artefact debitage given their small size. Two cores were recovered with one each on silcrete and quartz.

Locale	Site	Raw Material	Artefacxt Type	Cortex (%)	Length (mm)	Width (mm)	Thickness (mm)
Rhum Point	SM:136a	Quartz	Flake	0	11	7	3
		Mudstone	Flake	0	15	9	4
		Quartz	Core	50-100	40	38	21
		Quartz	Flake	0	15	8	7
		Quartz	Unmodified	50-100	24	14	13
	SM:140	Silcrete	Unmodified	50-100	88	69	46
		Silcrete	Core	50-100	82	78	57
	SM:137sh	Quartz	Angular Fragment	1-49	15	9	6
		Silcrete	Unmodified	50-100	44	32	16
		Quartz	Angular Fragment	1-49	26	15	7
		Quartz	Flake	0	16	12	5
		Quartz	Flake	0	21	13	5
		Silcrete	Unmodified	50-100	4.8	3.7	2.8
Other	SM:115	Quartz	Unmodified	50-100	40	20	15
		Quartz	Flake	1-49	12	8	3
		Quartz	Flake	1-49	14	12	6
		Quartz	Flake	50-100	26	16	9
	SM:114c	Quartz	Flake	1-49	12	8	5
		Quartz	Flake	0	8	4	3

Table 7-23: Stone artefact data, *Bweening*

Table 7-23 illustrates a feature of the overall distribution of stone artefacts; the majority were recovered at either Rhum Point or the southern sites SM:115 and SM:114 while none were located at Rhum Point West. However, while the lack of artefacts – surface or otherwise – at Rhum Point West is worth noting, it is not considered to be unusual given that significantly less deposit was excavated at Rhum Point West sites than at other sites in the study area. Artefact numbers are low in all sites excavated at *Bweening* and lack of artefacts at Rhum Point West is therefore most likely due to the greater proportion of deposits excavated at these locations rather than a reflection of low artefact discard rates at any particular locale.

It is important to consider the results of the work on the spoil heaps resulting from the destruction of SM:115 and SM:137. As noted earlier, fieldwork on these two sites was mitigative in focus with a key aim being to hand sort the 6 mm residues in order to retrieve all non-molluscan cultural materials. It was estimated that over 80% of the original deposits were hand sorted during this work, suggesting that the majority of artefacts over 6 mm in size were recovered. In short, the artefact counts for SM:137sh and SM:115 are considered to be representative of the overall site composition and the overall low numbers of these items again suggests low numbers of artefacts in these deposits at *Bweening*.

7.12.5 Non-molluscan faunal materials

Very little bone, crab shell or other non-molluscan faunal materials were recovered from the *Bweening* sites. Four small fragments of crab claw (probably *S. serrata*) were identified across all test pits excavated on SM:137 and a single fragment of crab claw was recovered in the SM:115 spoil heap work. No other non-molluscan faunal materials were identified. Importantly, systematic investigation of 2 mm residues from two units of SM136a clearly indicates that proportions of diagnostic non-molluscan fauna do not increase when smaller sieve residues are investigated.

7.12.6 Anthropogenic versus cultural formation

As noted at the beginning of this chapter, investigations indicate it is highly improbable that shell deposits along the escarpment margin at *Bweening* were deposited through natural processes. However, what remains to be resolved is whether the mounded shell deposits in particular have been influenced by the nest building activities of the scrub hen, *Megapodius reinwardt* (cf Stone 1995). It is argued here that this is not the case.

Firstly, there is a clear similarity in composition and contents across all of the sites excavated and this indicates all sites have been subject to similar formation processes, regardless of size. Only a small number of sites were distinctly mounded and the composition and stratigraphy of these is broadly consistent with less substantial sites. The key stratigraphic difference between shell matrix sites of different sizes is in the distinctive alternating layers of humic or sediment rich shell on the one hand, and sediment poor layers on the other. Larger sites evidence both strata in a broadly alternating pattern however smaller sites tend to have a single coarse layer of sediment rich shell deposit, occasionally with a shallow ‘cap’ of surface deposits consisting of heavily fragmented shell and soil. It is feasible however that this variation is the result of longer and more complex depositional histories in more substantial sites and does not imply that they have been influenced by nesting scrub hens.

Further support for cultural formation of shell mound deposits is the low frequency of materials originating on the adjacent ground surface within mound deposits. Bauxite pisoliths and ironstone nodules do occur, however typically in low proportions and mostly increase with proximity to the original ground surface. There is also an overall lack of humic materials in shell mounds required to provide the warmth needed for incubation of eggs.

A second key reason that shell mound deposits at *Bweening* are considered to be cultural relates to their morphology. At Rhum Point for instance, the largest site SM:147 is elongated and is not considered likely here that this site has been modified as a result of megapodes due to its elongated form and large basal dimensions. Bird mounds are typically ovate or circular in basal dimensions and not known to be as elongated as large as SM:147 (Morrison, field observations; see also Stone 1995). Further, the smaller shell mounds which are around 30 cm in height are considered here to be far too low in height to be bird mounds. They appear as broad, flat dome shaped mounds rather than the distinctively truncated or conical shape of bird mounds.

7.12.7 Summary

The broad picture that the work at *Bweening* has generated provides substantial insight into formation processes of shell matrix features. A key result of this work has been the development of a greater understanding of temporal relationships that exist between the range of shell matrix features that occur in a restricted geographic area. As observed, use of the Rhum Point area commenced as early as 1000-900 cal BP though the bulk of shell matrix features were only deposited after around 500-400 cal BP. Temporal data suggest that some of these features developed simultaneously however this was not always the case. For example, Rhum Point West appears to indicate sporadic use over a period of around 300 cal years and demonstrates that pre-existing deposits of shell do not always automatically attract subsequent discard events. The two outlying sites SM:114 and SM:115 are less than 500 m apart – indeed are almost within view of one another – yet these developed as distinct deposits perhaps less than 100 years apart.

In isolation, artefact data from *Bweening* provides relatively little information on the types of activities carried out in the vicinity of shell matrix features. Small quartz flakes were the most frequently recorded artefact type, however a limited range of other items were also found although in total the numbers are too small to be statistically meaningful. It is suggested here that the restricted numbers and range of artefacts at *Bweening* may signal that a restricted range of activities took place in the vicinity of shell matrix sites, a question further considered below.

A further critical issues is whether the very low proportions of bone across all sites at *Bweening* are due to a taphonomic bias or reflect a more specialised production strategy focussed on shellfish as has been suggested elsewhere (Morrison 2003b). In any case, it is an important question that has substantial implications for our understanding of these sites and as such it is a question taken up in more detail below.

Although it is necessary to further consider the distinct possibility of a bias against the preservation of bone, it seems likely at this point that the shell matrix features at *Bweening* were primarily associated with the exploitation of shellfish. Some are almost exclusively dominated by the species *A. granosa* however the most substantial deposits with the earliest basal ages occur at Rhum Point where *A. granosa* is one of three species which dominate deposit composition. The broader molluscan resource base available at Rhum Point (mudflat, mangrove and rocky shores) is therefore thought to have provided additional incentive for repeated use of this area over a longer period of time. Importantly, the shellfish data for *Bweening* also supports the argument that the development of shell matrix features was not only associated with access to a broad resource base. The *A. granosa* dominated deposits west of Rhum Point support this argument because they seem at this point to be a record primarily associated with the collection and discard of a restricted range of shellfish species and little else.

The formation and use of shell matrix features at *Bweening* appears to have been oriented around the collection of shellfish from adjacent resource areas, followed presumably by preparation and consumption in the vicinity of shell mound sites. At this point it is difficult to develop arguments about the characteristics of these activities or events, however what seems likely is that following collection shellfish were transported to favoured locations resulting in more substantial deposits. It also appears that the previous deposits of shell attracted repeat deposition rather than the creation of new deposits in the immediate area. If this latter scenario were the case then the archaeological record at Rhum Point for instance – where most deposition has occurred – would presumably consist of more numerous but smaller deposits of shell because there are no geographic constraints which may have restricted deposition to particular areas, thus leading to formation of mounds. Further to this, the *Bweening* escarpment provides ample opportunity for shellfish remains, once eaten, to be discarded over the escarpment edge. In short, there is a clear preference for mound building at Rhum Point and this can not be explained by reference to constraints in the available area for shell deposition. This therefore suggests a cultural preference towards the deposition of shell in mounds and implies some degree of intentionality in their formation. Yet these discard events were not all focussed on the creation of a single larger deposit but numerous smaller ones. While local factors such as the location of trees for shade, wind direction, view and so on may influence choice of discard locations – and there is also a temporal dimension in the form of successional mound development – it is difficult to escape the observation that there is a tendency for spatial separation of deposits which developed contemporaneously.

It is also useful to reflect on the selection of Rhum Point as a preferred area for these discard events within the immediate area. As noted, this area appears to have a number of advantages over other nearby areas. Local erosion at Rhum Point has seen the formation of a more gently sloping escarpment which therefore probably provides greater ease of access from the top of the escarpment down to the shoreline. Further, as noted above, local resource opportunities are broader, with a short distance to substantial area of dry notophyll vine forest as well as both mangrove and mudflat areas. While no surface water is apparent in the local area, it is available from slow running springs at the base of the escarpments and can be readily found by walking along the narrow beach at low tide.

It is interesting to contrast the Rhum Point area with less substantial shell matrix deposits to the south west which lack many of these advantages but which still clearly provided reasonable sources of shellfish. This is reflected in their composition, which lack any non-molluscan faunal materials and evidence an even more restricted range of shellfish species compared with the Rhum Point sites. It may also reflect a lack of available shellfish resources in this area during earlier (pre-~500 BP) or the destruction of older sites through erosion of the escarpment face.

The archaeology of the *Bweening* coastline does not reflect sporadic use of locally available coastal resources. It seems that particular places evidence relatively large amounts of discard activity for substantial periods of time, and in this regard, Rhum Point is the obvious example. Resources are a key factor here however this is something of a simple point, for shell matrix sites are by their very nature a record of resource use. Of greater interest is to articulate the broader production strategy associated with these discard events. Excavations at *Bweening* strongly support the claim that these features are related to the collection, preparation, consumption and discard of shellfish, principally, *A. granosa*, and to a lesser extent *M. hiantina* and *S. cucullata*, rather than general exploitation of the local environment. Taphonomic factors alone do not explain the lack of non-molluscan faunal materials in these sites and it is argued here that it in fact reflects a narrow and specific production strategy. This argument is developed in more detail in subsequent chapters and also explored in relation to excavations carried out at *Prunung*.

Chapter 8: *Prunung*

Prunung, also known as Red Beach, is an extensive beach ridge plain on the north Mission River that occurs at the point where the estuary widens as it enters Albatross Bay (Figure 8-1). A small complex of shell matrix sites, predominantly shell mounds, occurs on the sandy substrates here along with several more isolated sites away from the central mound group. Some of these sites have been subject to previous work (Bailey *et al.* 1994) as briefly summarised in Chapter 4. This chapter presents the results of the author's own excavations of a series of shell matrix deposits at *Prunung* and incorporates key results from earlier work in the immediate area. The chapter begins with a brief introduction to the environment and archaeology of the *Prunung* area and outlines the reason for carrying out investigations here as part of this project.

8.1 Background

The sandy beach ridge plain at *Prunung* has formed adjacent to an extensive bauxite plateau (Figure 8-1) and consists of a series of low but distinct shore-parallel ridges. Sediments in these ridges vary from fine dark sand with high proportions of organic material and bauxite pisoliths inland, to cleaner yellow and white sands towards contemporary shorelines with larger proportions of whole shell and shell hash. The beach ridge plain is vegetated by dune woodland that is relatively open near the coast and increases in density further to the west. A seasonal swamp occurs on the beach ridge plain and vegetation here varies between *Melaleuca* spp. forest in seasonally inundated areas, to occasional stands of dry notophyll vine forest in more elevated localities. Much of the south west facing shoreline is undergoing significant erosion which has exposed a long, near-continuous section of the beach ridge substrates. These reveal distinct lenses of *A. granosa* dominated shell deposit and fine shell hash within a matrix of fine sand; these have been interpreted by previous researchers as natural shell deposits (Bailey 1994; Stone 1992).

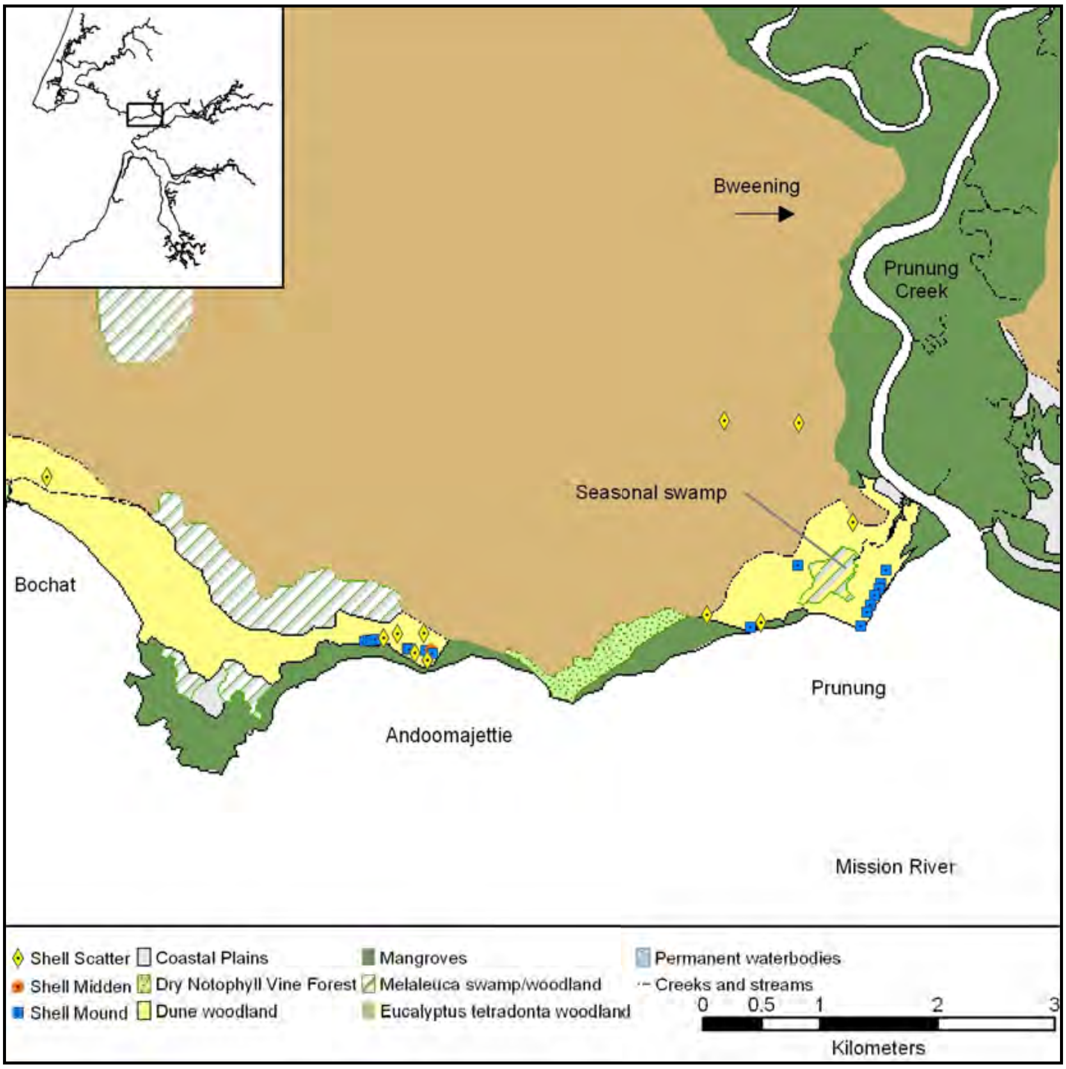

Figure 8-1: The *Prunung* Study Area

As outlined in Chapter 2, Stone (1995) analysed and dated sediment core samples at three locations between the seasonal swamp and the south east facing beach to understand beach ridge formation processes. His dates suggested the ridge sequence formed largely after 3,000 BP (Stone 1995: 87) though importantly, this does not provide a clear understanding of the depositional history of areas of beach ridge plain near *Prunung* Point or inland of the seasonal swamp.

Between the early 1950s and mid-1970s, *Prunung* was used as a landing point for small barges transporting mine equipment from Weipa to areas further north (Evans 1957; Morrison 2003c). Today, and indeed since the late 1970s, *Prunung* has been a popular recreation area and both activities have caused distinct impacts on the local environment including:

- Moderate clearing which has caused the likely destruction and heavy disturbance of some shell matrix sites in the vicinity of *Prunung* Point;
- The deposition of large amounts of bauxite pisoliths and ironstone in some areas in order to create a hard vehicle track over soft sandy substrates;
- Heavy disturbance to soft sandy substrates in some areas as a result of unmanaged four wheel drive traffic; and
- Vegetation thinning as a result of the intensive removal of trees for firewood, past clearing and poor fire management in recent years.

Figure 8-2 shows the location of recorded archaeological sites in the immediate *Prunung* study area. The most substantial deposits occur to the north east of *Prunung* Point where a series of elongated *A. granosa* dominant shell mounds up to 2 m in height occur parallel to the present shoreline. These sites are all are partially covered by small thickets of vine forest. Sites SM:90-94 are largely undisturbed by recent activities such as earthmoving or quarrying however the area between SM:95 and SM:96 appears to have been cleared with substantial amounts of likely anthropogenic deposits removed or spread out onto the surrounding substrates[6]. SM:95 is essentially a remnant of this activity and when grass fires have removed surface vegetation its approximate original basal area can be seen. A combination of quarrying for shell, earthmoving and heavy repeated vehicle traffic has also impacted upon the largest mound, SM96, located at *Prunung* Point itself and from which large amounts of deposit have been removed.

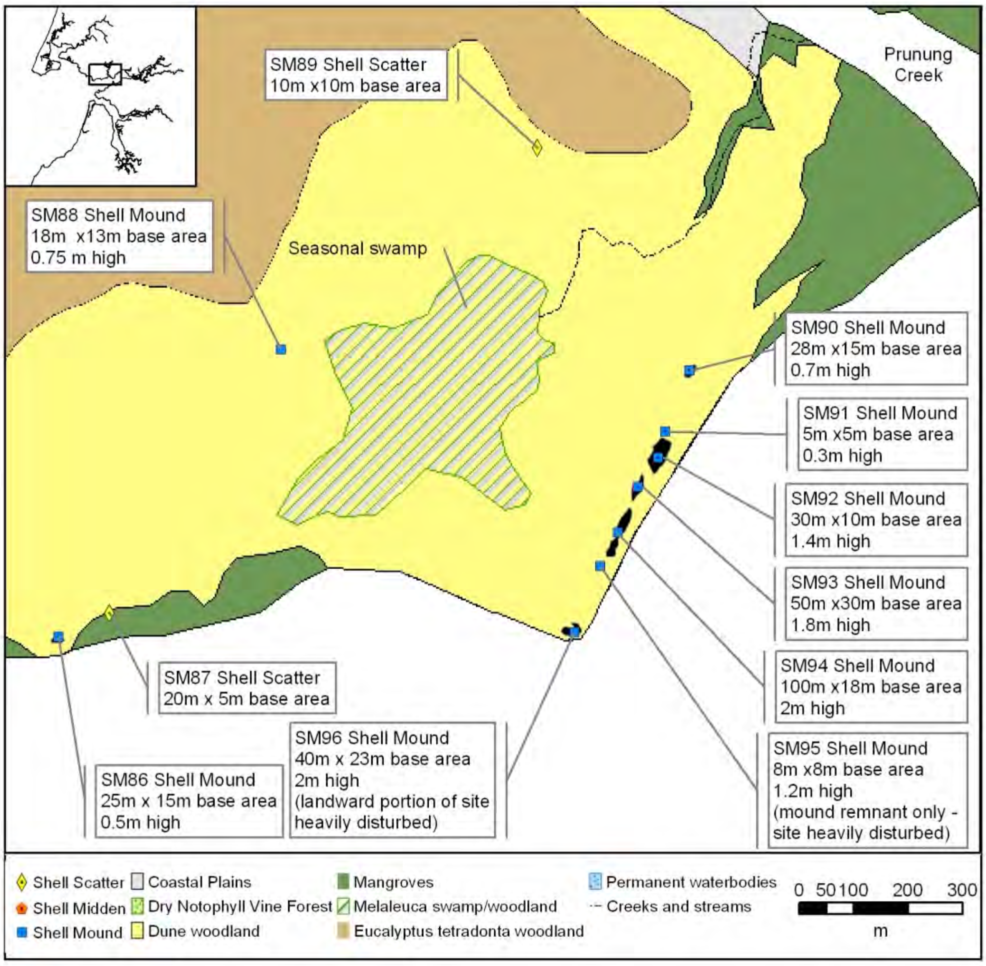

Figure 8-2: Archaeological features in the *Prunung* study area

Identifying anthropogenic surface scatters around *Prunung* Point was considerably difficult, particularly due to past disturbance and the likelihood that some surface

[6] This area was considered by Morrison (2003c) to have been the location of the barge landing.

shell deposits (including those containing *A. granosa*) may have been natural in origin. However elsewhere in the area two shell scatters, SM:87 and SM:89 (see Figure 8-2), were recorded. Both sites occur on firm sandy substrates set within largely undisturbed dune woodland and were predominantly composed of *A. granosa* shellfish. Identification of these deposits was made possible by the fact that they were quite distinct from surrounding substrates which were mostly fine sand containing little natural marine shell.

Two further low shell mounds were recorded some distance from the *Prunung* Point group of sites. Almost 1,000 m due west of *Prunung* Point was SM:86, a 0.5 m high *A. granosa* dominated mound located on a slight natural promontory adjacent to a natural gap in the mangrove forest (see Figure 8-2). The second shell mound, SM:88, was located ~750 m north west of SM:96 at the very rear of the beach ridge plain and on a low distinct ridge that has formed alongside the margin of the bauxite laterite plateau. The site measured 0.75 m in height and its surface composition was predominantly *A. granosa* and had been subject to minor quarrying activity in the past[7]. Significantly, sandy substrates around SM:96 have very low amounts of natural shell and contain far more bauxite pisoliths – presumably derived from the immediately adjacent plateau – than those closer to the contemporary shoreline. Stone's (1995) dates on the nearby beach ridge sequence did not investigate this area however it is likely sediments here were deposited earlier than those seaward of the swamp. This suggests they are likely to be more than 2-3,000 BP in age.

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[7] Most likely used as fill on a boggy section of a nearby dirt track.

Prunung was of interest as an area for archaeological excavations as part of this project for a number of reasons. Firstly, it is a substantially different environment to that of the *Kwamter* or *Bweening* areas where previous work had taken place. Shell matrix sites at *Prunung* all occur on well drained sandy substrates within sparse dune woodland and a seasonal swamp and substantial areas of mangrove forest occur nearby. Investigations here therefore aimed to generate data on shell matrix site composition in a third, unique environmental context within the broader Albatross Bay study area. Secondly, the sites at *Prunung* are mostly more substantial than those at *Bweening* thereby potentially providing an understanding of longer term discard patterns in mound formation or abandonment. A more intensive dating program was employed at *Prunung*, and the results of earlier work by other researchers on SM:96 also contributed to this. Finally, the issue of cultural versus natural formation of shell mound deposits was also considered important. Many of Stone’s (e.g 1995) claims regarding the natural formation of shell mounds in the region were based upon work at *Prunung* and so archaeological investigations of a range of shell matrix sites here allow further reflection upon the issue of cultural versus natural formation of these deposits.

The author carried out excavations at *Prunung* during a 10 day field trip in October 2003 with a supplementary six day field trip during October 2004. Analysis of excavated materials took place during 2004 and early 2005. As has been the case elsewhere, calibrated radiocarbon age spans are cited here however the calibration and correction techniques, along with full details of radiocarbon data, are provided in Appendices 1, 2 and 5.

8.2 SM:96

8.2.1 Description

No excavations or dating were undertaken on SM:96 as part of this project and here only the results of work by previous researchers on this site are presented. Previous work on this site focussed on a long exposed section created through natural erosion along its seaward face. Beaton obtained several dates from this section while more recent work (Bailey 1993a; 1994) generated a more detailed sequence of dates and along with compositional data from column samples on anthropogenic and natural deposits. While column samples provide an important insight into site formation processes and the question of natural or anthropogenic formation, no detailed quantification work on shellfish or other cultural materials within deposits from SM:96 have yet taken place. As such, the following discussion focuses on the stratigraphy and dating on the site.

8.2.2 Stratigraphy

The cross section of the SM:96 site provides important information on the relationship between the shell mound deposit and adjacent substrates, along with the locations of column samples reported by Bailey (Figure 8-3). Bailey *et al.* (1994: 76) described the stratigraphy of SM:96 as consisting of layers of relatively clean *A. granosa* alternated with darker layers or lenses of shell in a dark earthy matrix (1994: 76). They interpreted the former layers as representing periods of rapid shell deposition and the latter as reflecting periods of slow accumulation.

Column sample RB1-11 cut through the SM:96 deposit and into the underlying substrates and results are highlighted below (Figure 8-4). The shell mound deposit is dominated by *A. granosa* with low proportions of materials often associated with natural deposits including pisoliths, fine shell hash or other materials under 1 mm in size. The most marked change in the column is at RB10 and RB11, which are interpreted by Bailey *et al.* (1994) as being natural sandy substrates upon which the shell matrix deposit has accumulated. The RB West column has low proportions of *A. granosa* (< 1 – 35%) and moderate to high proportions of sediment < 1 mm in diameter (see Figure 8-5). Proportions of fine shell hash are similar or lower than those of the RB 1-9 column samples and the numbers of pisoliths are similar or greater.

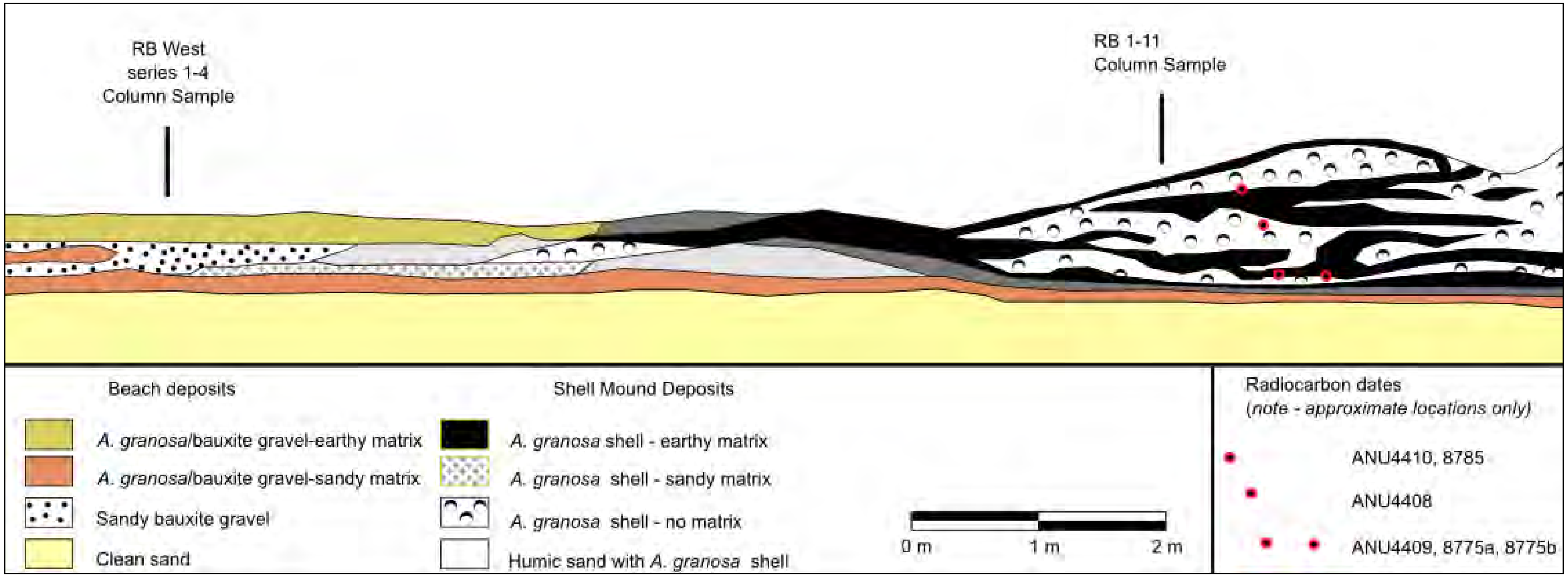

Figure 8-3: Section drawing, SM:96 and surrounding deposits
(after Bailey 1993b)

Bailey *et al.* (1994:76-77) argued that the differences between both deposits are statistically highly significant and strongly support the argument that the SM:96 deposit was sufficiently distinct from surrounding substrates to be an anthropogenic deposit. Their investigations of a bird mound adjacent to *Prunung* Creek also suggested statistically strong differences compared with the shell mound deposit, but high similarities with the beach deposits.

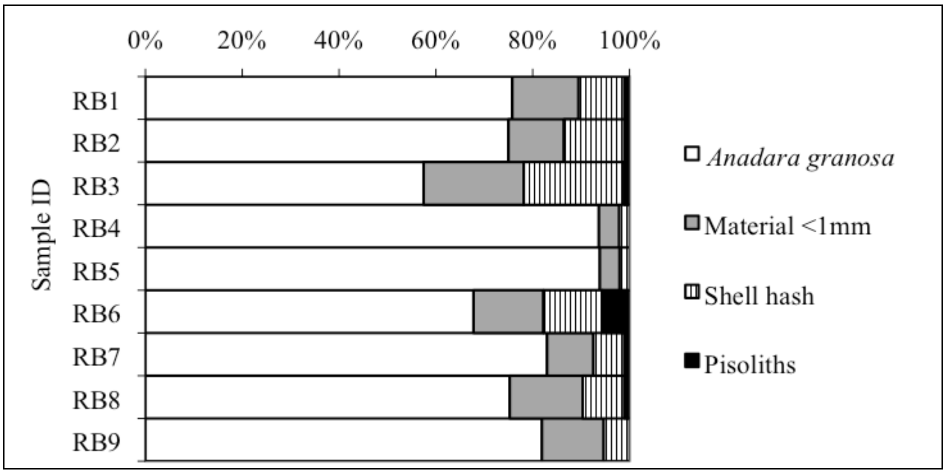

Figure 8-4: RB 1-11 column sample composition, SM96
(after Bailey et al. 1994 Table 2 p 77)

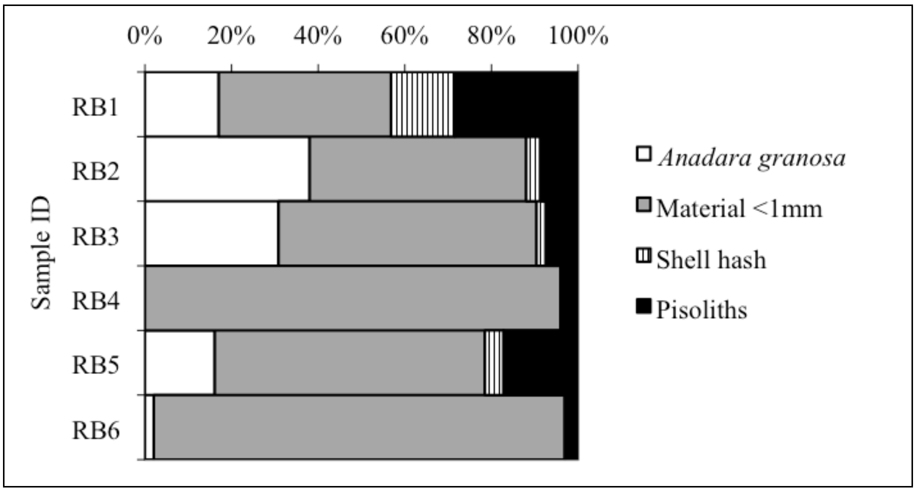

Figure 8-5: RB West column sample composition
(after Bailey et al. 1994 Table 2 p 77)

8.2.3 Dating

A range of radiocarbon determinations are available for SM:96 and summary data for these are provided in Table 8-1. Beaton initially obtained three determinations from the site; those from the base and middle returned calibrated ages of 302(356)401 cal BP (ANU4409) and 323(379)427 cal BP (ANU4408). A third surface sample is outside of the calibration curves, but returned a CRA of 360±100 BP (ANU 4410). The precise context of these determinations are unclear but approximate locations are shown in Figure 8-3.

Bailey *et al.* (1994) obtained additional radiocarbon samples from the mound in order to supplement data obtained by Beaton. Two of these were basal dates: one obtained on a charcoal sample returned an age of 923(930)933 cal BP (ANU-8775b) and a second on *A. granosa* was 323(379)427 cal BP (ANU-8775a), a difference of ~550 cal years. A near-surface sample returned an age of 440(471)503 cal BP (ANU-8785).

Context	**Beaton**		**Bailey *et al.* 1994**	
Upper	(CRA 360±100)	ANU4410 (Ag)	440(471)503	ANU8785 (Ag)
Middle	323(379)427	ANU4408 (Ag)	-	-
Basal	302(356)401	ANU4409 (Ag)	923(930)933	ANU8775b (ch)
	-	-	323(379)427	ANU8775a (Ag)

Table 8-1: Summary of radiocarbon results, SM:96

Ag = *Anadara granosa*. Ch = charcoal. The ANU4410 is cited as a conventional radiocarbon age as it is beyond the calibration curve (see Appendix 2).

It is evident from these dates that irregularities exist in the determinations on SM:96 and these require discussion. The first is a ~550 cal year discrepancy between basal dates on *A. granosa* (ANU8775a) and charcoal (ANU8775b) obtained by Bailey *et al.* and the fact that the date ANU 8775a is ~92 cal years younger than the determination on the upper layers (ANU8785). The second problem is the near contemporaneous dates on *A. granosa* obtained by Beaton from the middle and basal layers of the section (ANU4408 and ANU4409). These inconsistencies suggest that intermixing of older and younger deposits have occurred on this site during or subsequent to its formation: SM:96 has the highest degree of exposure to storm surges, high winds and tidal action than any other site in the immediate area and this is likely to have been the case during its period of formation. As such, it is conceivable that older deposits have been redeposited on the upper mound surface, or more recent deposits were reworked into older ones. Further, as described earlier quarrying activity has had a severe impact on the site and this may have also led to intermixing.

Given these issues, chronological data from SM:96 are used cautiously here. It is likely that basal determinations suggest the site commenced forming sometime between ~350 and ~400 cal BP, if not earlier. Cessation of site accumulation appears to have been fairly recent as the upper CRA of 360±100 (ANU4410), which was too recent for calibration, is likely to have been deposited during, or just prior to, the historic period.

8.3 SM:93a

8.3.1 Description

SM:93 is a low elongated shell mound approximately 50 m long, up to 18 m in width, and is oriented roughly parallel with the adjacent shoreline. The site overlies the gradually sloping face of the most seaward beach ridge and is a maximum of 1.8 m high, with its peak occurring near the centre of the site. At the time of excavation the surface of the site appeared to have only minor surface disturbances caused by shallow animal burrowing and fallen trees. Approximately 30% of the surface of the site was covered by dry notophyll vine forest and up to 20 cm of humic material had accumulated in these areas. The remainder of the mound surface was clean white-grey shell with little surface vegetation beyond occasional grasses or low shrubs.

A single 1 m^2 pit was excavated on a relatively level area on the upper surface of SM:93. Importantly, the location with deepest deposits was not selected for excavation because of potential problems with stabilising the pit walls at depth. Instead, the pit was placed at a location that was estimated to have less than 1.2 m of cultural deposit.

8.3.2 Stratigraphy and composition

The single pit on SM:93 was excavated to a maximum depth of around 120 cm below the site surface (Figure 8-6) revealing a deposit consisting primarily of densely packed shell. Variations in the proportions or colour of soil, degree of shell fragmentation and the presence of ashy sediments defined stratigraphic layers. Layer A consisted of densely packed and highly fragmented shell in a matrix of fine dark soil whilst Layer B consisted of much more loosely packed shell that appeared to be dominated by *A. granosa* and, to a lesser extent, *M. hiantia*. Layer C consisted of a distinct intrustion into Layer B distinguished only by greater proportions of fine sediment with little or no variation in proportions of fragmented shell. Layers D and E are broadly the same in composition as Layer C except that the shell is more fragmented and has distinctly higher proportions of soil. A characteristic of all of the lower deposits was the tendency toward greater proportions of fine sediment, ash and charcoal; for example, between Layers J and E several distinct lenses of fine yellow sand containing bauxite pisoliths occur. Layer K represents a distinct break from all upper deposits; it consisted of sandy loam with frequent bauxite pisoliths and infrequent shell. Layer O was similar except for the complete lack of shell and a lighter colouration.

Table 8-2 highlights summary excavation data for SM:93. Only 6 mm residues have been quantified in detail however 2 mm residues were sampled and results are provided separately below.

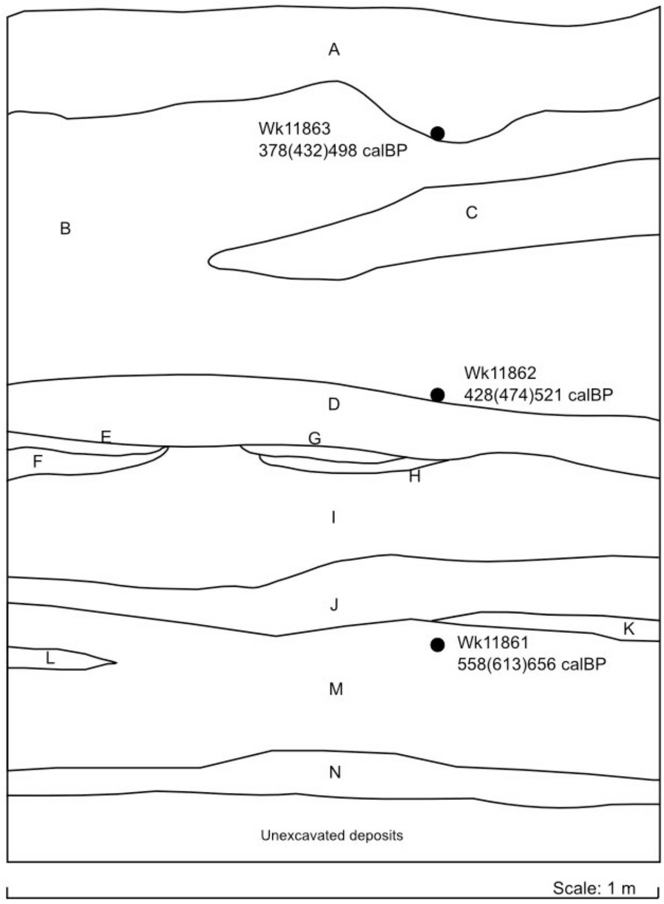

Figure 8-6: East facing section radiocarbon determinations, SM:93a

Layer descriptions

A. Densely packed shell, highly fragmented with dark fine soil matrix. Frequent fine roots.
B. Layer of loosely packed and mostly whole shell dominated by *A. granosa* (Ag) with occasional *M. hiantina* (Mh). Negligible soil matrix, sparse roots.
C. Loosely packed shell (Ag and Mh), mostly whole but with higher proportions of fine dark soil similar than in B.
D. Mostly fragmented shell with large proportions of dark soil matrix.
E. Intrusion of yellow sand containing frequent bauxite pisoliths.
F. Small intrusion of very ashy material containing large amounts of highly fragmented shell and charcoal.
G. Intrusion of yellow sand containing frequent bauxite pisoliths
H. Small intrusion of very ashy material containing large amounts of highly fragmented shell and charcoal
I. Ashy sediment containing frequent fragmented shell and higher proportions of dark soil matrix than adjacent layers.
J. Shell dominant layer of mostly whole shell (Ag and Mh). Little sediment.
K. Intrusion of yellow sand containing frequent bauxite pisoliths
L. Densly packed brittle shell (Ag and *S. cucullata*). Small amounts of fine yellow sandy sediment throughout
M. Yellow to brown sand with frequent bauxite pisoliths. Negligible marine shell. Culturally sterile deposit.
N. White to yellow fine sand with frequent bauxite pisoliths. No marine shell. Culturally sterile deposit.

XU	Mean depth (cm)	Gross (g)	6 mm shell (g)	Non-diagnostic shell (g)	Diagnostic shell (g)	Charcoal (g)	Other stones (g)
1	2.86	41900	26337.30	18009.50	8327.80	-	59
2	8.07	48200	42111.10	25562	16549.10	0.60	56
3	12.86	50700	48712.10	21042.50	27669.60	3	31
4	18.15	35200	27510.60	2794.50	24716.10	2	5
5	23.05	39700	34010.21	3529.50	30480.71	3	3
6	27.73	42700	32893.01	5727.51	27165.50	14.70	9
7	33.00	36400	29954.01	3796.90	26157.11	5.50	122
8	36.25	12400	11732.71	1995.90	9736.81	3	13
9	39.45	36000	31504.70	4673	26831.70	6	7
10	44.86	37000	34880	6597	28283.00	2.50	22
11	50.81	43000	41188.80	5245.00	35943.80	7	20
12	56.40	46900	39258.50	5632	33626.50	12.50	18
13	60.64	35700	21575.80	4940	16635.80	24	419
14	65.55	50700	28283.40	9974	18309.40	28	40
15	70.56	37200	16559.30	7260	9299.30	20	61
16	75.31	46400	23858.10	8157.50	15700.60	32	12
17	79.48	33000	18708.22	4255.02	14453.20	49	86
18	84.54	46000	25489.50	8106	17383.50	37	13
19	89.61	43600	17376	7462	9914	12	17
20	93.80	50400	17544.60	6238	11306.60	35	117
21	99.38	49200	4657.50	1193	3464.50	5	415
22	104.61	41000	2199	1282	917	2	631
23	109.09	41900	702.50	443	259.50	1	407
24	116.06	87900	-	-	-	-	-

Table 8-2: Summary data, SM:93a

8.3.3 Dating

Three samples of *A. granosa* were collected and submitted for radiocarbon determinations from SM:93a. Calibrated ages suggest accumulation of the deposit commenced around 558(613)656 cal BP (Wk11861). Wk11862 was obtained from the base of Layer B, approximately the middle of the section, and returned a determination of 428(474)521 cal BP. The third radiocarbon sample was obtained from the interface between the upper limit of Layer B and the lower portion of Layer A and the resulting determination was 378(432)498 cal BP (Wk11863). Importantly, this does not date the most recent deposits on the site at the section surface.

8.3.4 Shellfish analysis

The most frequently occurring cultural material recovered in the 6 mm sieve residues was marine shellfish (Table 8-2 and Figure 8-7). The proportions of non-diagnostic shellfish are highest in the upper 15 cm of deposit and this correlates with the observation of more highly fragmented shell in the upper layers of the section profile. XUs 4 through 13 evidence the highest proportions of diagnostic shellfish, and this correlates with the layers of densely packed mostly whole shell that were observed in the stratigraphic section. The proportions of non-diagnostic shell steadily increase with depth below XU 12.

Species estimates based on MNI calculations demonstrate that *A. granosa* is by far the most frequently occurring shellfish species throughout the deposit (Table 8-3 and Figure 8-8). *Anadara granosa* consistently represents over 70% of the total shellfish MNI in XUs 1 to 18. The lower XUs 19-23 have overall lower numbers of shellfish and *A. granosa* makes up a smaller proportion of the total MNI for each of these layers. No diagnostic shellfish occurred in the sand-dominated basal layer. *Marcia hiantina* is the second most frequently occurring shellfish species based on MNI estimates and peaks in the proportions of this species as a percentage of the total shellfish MNI occur in XUs 1 and 2 (17-18%), 10-15 (20-25%) and 19-23 (22-44%).

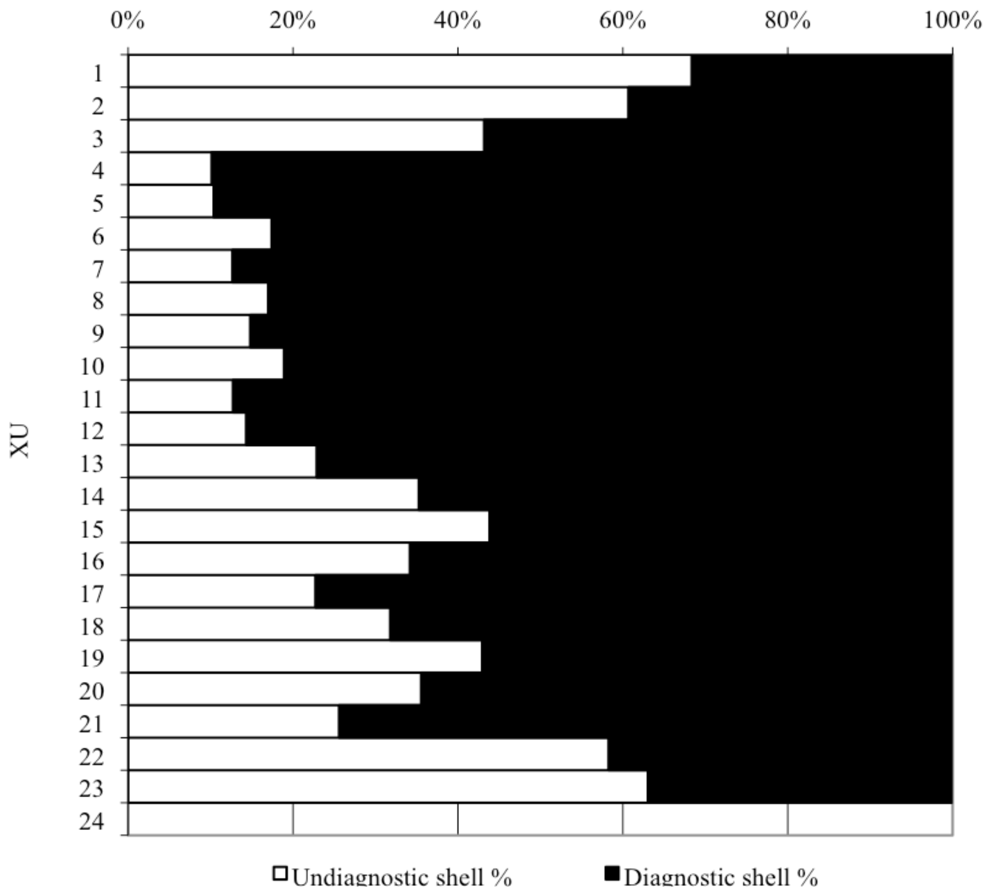

Figure 8-7:Diagnostic versus undiagnostic shellfish remains, SM:93a

The contribution of all other species to the composition of the site is less than 10% for all but two XUs where they represent 14% (XU 20) and 29% (XU 23) of the total shellfish MNI. The peak in XU 23 correlates with a dramatic reduction in overall shellfish MNI and weights. The proportions of other species in the deposit vary but most frequently included *S. cucullata*, *P. erosa*, *N. lineata*, *T. telescopium*, *V. cochlidium*, *Melo* sp., *Balanus* sp, *Cerithium* sp, *Ellobium* sp. and *Terebralia* sp.

XU	Mean Depth	XU Totals		*Anadara granosa*				*Marcia hiantina*				All other species			
	(cm BS)	MNI	Weight (g)	MNI	MNI (%)	Weight	Weight (%)	MNI	MNI (%)	Weight (g)	Weight (%)	MNI	MNI (%)	Weight (g)	Weight (%)
1	2.9	868	8328	680	78	8000	96	155	18	253	3	34	4	75	0.90
2	8.1	1714	16549	1341	78	16000	97	316	18	482	3	58	3	67	0.41
3	12.9	2379	27670	2136	90	27000	98	187	8	578	2	57	2	92	0.33
4	18.2	2021	24716	1832	91	24129	98	147	7	529	2	43	2	58	0.24
5	23.1	2682	30481	2392	89	29704	97	198	7	651	2	93	3	126	0.41
6	27.7	2689	27166	2348	87	26254	97	286	11	822	3	55	2	90	0.33
7	33.0	2439	26157	2131	87	25417	97	256	10	632	2	53	2	108	0.41
8	36.3	980	9737	908	93	9525	98	54	6	138	1	18	2	74	0.76
9	39.5	2386	26832	2139	90	26045	97	186	8	513	2	62	3	274	1.02
10	44.9	2632	28283	2037	77	25952	92	545	21	2053	7	50	2	278	0.98
11	50.8	3148	35944	2367	75	32909	92	712	23	2607	7	69	2	428	1.19
12	56.4	2778	33627	2015	73	30148	90	697	25	2708	8	66	2	771	2.29
13	60.6	1574	16636	1207	77	15330	92	328	21	1032	6	40	3	274	1.65
14	65.6	2049	18309	1518	74	16662	91	474	23	1330	7	58	3	317	1.73
15	70.6	1134	9299	858	76	8416	91	230	20	749	8	46	4	134	1.44
16	75.3	1543	15701	1363	88	15145	96	114	7	246	2	67	4	310	1.97
17	79.5	1583	14453	1510	95	14257	99	44	3	107	1	29	2	89	0.62
18	84.5	2528	17384	2074	82	15857	91	403	16	1281	7	51	2	246	1.41
19	89.6	1727	9914	972	56	7736	78	685	40	1778	18	70	4	400	4.03
20	93.8	1633	11307	825	51	8699	77	573	35	1601	14	235	14	1007	8.90
21	99.4	564	3465	413	73	3184	92	129	23	212	6	22	4	69	1.98
22	104.6	174	917	90	52	695	76	77	44	162	18	7	4	60	6.54
23	109.1	38	260	17	44	110	42	10	27	26	10	11	29	124	47.59
24	116.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8-3: SM:93a shellfish composition

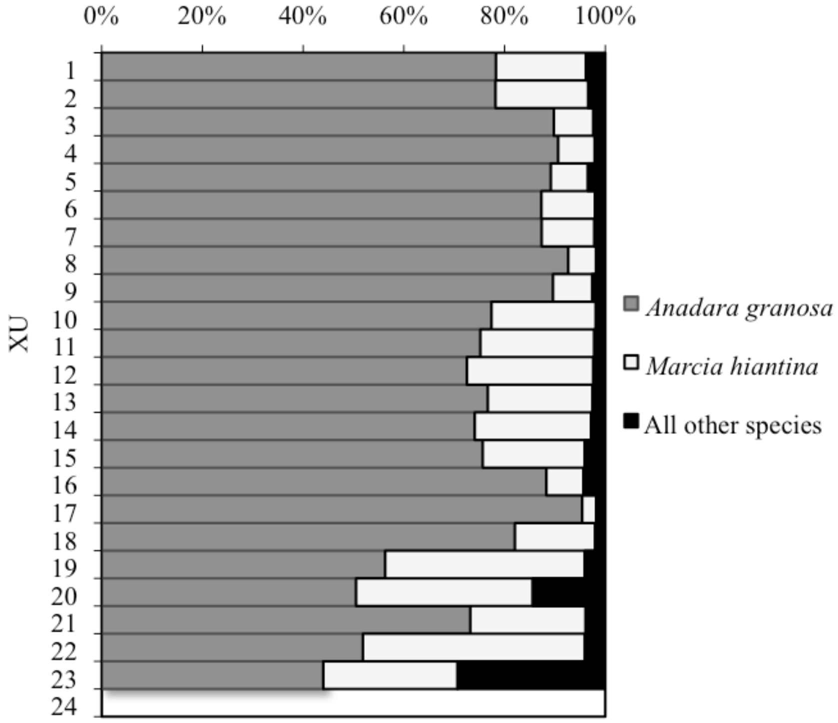

Figure 8-8: MNI of primary diagnostic shellfish

8.3.5 Other faunal materials

A restricted range of other faunal remains were recovered in the 6 mm sieve residues as shown in Table 8-4 below. These included fragments of mammal bone, as well as occasional crab claw fragments and a single fish otolith. The proportions of bone and crab shell per kilogram of deposit are shown in Figure 8-9.

Two cranial skeletal elements were recovered in the excavation including a small fragment of a mandible and a small piece of tooth. Identification was not attempted on these because of their small size and incomplete state, although the mandible fragment is likely to be that of a bandicoot (*Isodoon* sp.). A total of 63 post-cranial bone fragments were recovered. These were all very small and generally less than 10 mm in length. Bone materials recovered in the excavation weighed less than 34 g in total for all pits combined.

The crab claw fragments were very small, with often only the claw tip being identified. These are likely to be *S. serrata*, a very common species in the region. Total crab fragments weighed around 5 g in total for the entire excavation. The single fish otolith was 12 mm in diameter and identification is not likely to be possible due to its fragile and damaged condition.

There is no clear relationship between the proportions of combined otoliths, bone and crab shell recovered and the depth below surface. As can be seen in Figure 8-9 combined proportions of these materials peak in XUs 6, 11 and 13 however these high values are offset by very low proportions in adjacent XUs.

XU	XU weight (kg)	Bone (No.)	Bone weight (g)	Crab weight (g)	Otoliths (No.)	Combined bone/ crab (g/kg)
1	41.9	-	-	-	-	-
2	48.2	4	3.4	-	-	0.0705394
3	50.7	4	1.5	-	-	0.0295858
4	35.2	2	10	-	-	0.0284091
5	39.7	3	1.5	-	-	0.0377834
6	42.7	5	6.0	1.00	-	0.1639344
7	36.4	3	1.0	0.03	-	0.0282967
8	12.4	-	-	-	-	-
9	36.0	-	-	-	-	-
10	37.0	-	-	0.5	-	0.0135135
11	43.0	4	5.0	-	-	0.1162791
12	46.9	1	0.1	0.5	-	0.0127932
13	35.7	17	6.0	-	-	0.1680672
14	50.7	12	2.0	1.00	1	0.0591716
15	37.2	2	1.5	-	-	0.0403226
16	46.4	2	0.1	-	-	0.0021552
17	33.0	-	-	-	-	-
18	46.0	1	0.5	-	-	0.0108696
19	43.6	6	3.0	-	-	0.0688073
20	50.4	-	-	3.00	-	0.0595238
21	49.2	4	1.5	-	-	0.0304878
22	41.0	-	-	-	-	-
23	41.9	-	-	-	-	-
24	87.9	-	-	-	-	-
TOTAL	**1033.1**	**70**	**34.1**	**6.03**	**1**	

Table 8-4: Invertebrate faunal remains, 6mm residue, SM:93a

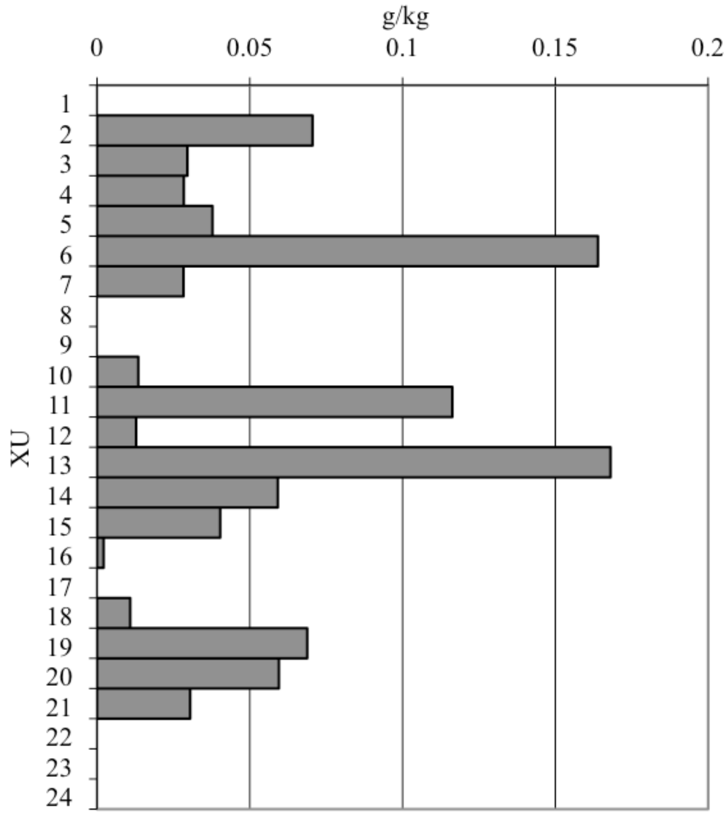

Figure 8-9: Combined weights of crab and bone (g/kg), 6mm residue, SM:93a

8.3.6 Shell and stone artefacts

A small number of shell and stone artefacts were recovered in SM:93a. These included three small quartz fragments, the largest measuring a maximum of 21 mm in length and 12 mm in width. All were highly angular with few clear diagnostic attributes and are classified here as debitage.

In addition, two distinctive shell artefacts were recovered, one each from XU 9 and 10. Both items are flat (< 3 mm) pieces of an unknown species of shell 30 mm by 27 mm and 32 by 26 mm in size . Both were clearly broken at one end and ground to form a smooth, rounded edge at the other. Although this margin was clearly ground, no other major evidence of use such as striations, edge damage or polishing were apparent. Both were also concave in shape.

All *P. erosa* fragments with an intact margin were investigated for evidence of use or modification using a binocular microscope. Twelve specimens were noted to have at least one of four types of evidence of use (rounding, polishing, striations and retouch/edge damage) (Table 8-5). Of the 21 instances where some type of evidence of use was noted, 14 were low confidence and six were of moderate confidence. A single example had striations considered highly likely to be of cultural origin.

	Elements present				**Modification type**				**Modification location**			
	DM	*VM*	*AM*	*PM*	*Rounding*	*Polishing*	*Striations*	*Edge damage/ Retouch*	*DM*	*VM*	*AM*	*PM*
XU7		X			0.5		0.5			X		
XU7		X						0		X		
XU8		X	X	X		0.5	0.5	0.5		X		
XU9		X			0	0	0	0.5		X		
XU9		X					0			X		
XU9		X			0.5	0.5				X		
XU10	X	X	X	X		0	0			X	X	X
XU11		X				0				X		
XU12	X	X	X	X	0		0			X		
XU12		X					1	0.5				
XU13		X				0	0			X		
XU16	X	X	X	X	0	0	0			X		

Table 8-5: Summary of results of analysis of *Polymesoda erosa* modification and use
Notes. DM – Dorsal Margin, VM – Ventral Margin, AM – Anterior Margin, PM – Posterior Margin. Modification type classification: 0 – none or low confidence modification, 0.5 – moderate confidence of modification, 1 high confidence of modification.

8.4 SM:92

8.4.1 Description

SM:92 is an elongated shell mound that is part of the primary group of sites at *Prunung* Point. The site is 30 m long, 10 m wide, and up to 1.4 m in height and is situated immediately to the north east of SM:93. Excavations at this site aimed disturbance to the site itself. To this end, a small 30 by 30 cm pit was excavated to a depth of 75 cm below surface.

8.4.2 Stratigraphy and composition

The site had a 5-10 cm upper layer of fragmented shell with a matrix of fine sediment and dense roots, beneath which a ~50 cm layer of mostly whole *A. granosa* shell with little sediment occurred. The underlying basal layer contained more sediment and ashy deposit, but shellfish was nevertheless the dominant constituent. The substrate on which the deposit occurred consisted of fine yellow to orange coloured sand with essentially no shell hash or other shell.

8.4.3 Dating

A single sample of *A. granosa* valves were retrieved from the basal cultural layer of SM:92 for radiocarbon dating. The resulting determination returned an age span of 430(473)516 cal BP (Wk14507).

8.4.4 Shellfish analysis

Anadara granosa appeared to be the most frequently occurring shellfish species in the deposit. Other species including *M. hiantina* and *S. cucullata* were also noted to occur in small proportions.

8.5 SM:91

8.5.1 Description

SM:91 is a small shell mound situated immediately to the north of SM:92 with a maximum height of 30 cm and up to 5 m in diameter. The site occurs on a sandy substrate containing bauxite pisoliths and significant proportions of naturally occurring shell, including *A. granosa* valves of a range of sizes. This is likely due to the exposed location in which SM:91 occurs for unlike other sites at *Prunung*, no vegetation buffer occurs between it and the active beach which is approximately 30 m away. Sampling strategy B was used on SM:91 (see Section 5.3.4) and therefore shellfish proportions are based on detailed analysis of a sub-sample of the 6 mm sieve residues.

8.5.2 Stratigraphy and composition

A single 0.5 x 0.5 m pit was excavated on the highest part of the SM:91 mound surface. Approximately 35 cm of shell-dominated deposit was excavated before reaching sand dominated layers containing little to no shell. The stratigraphy consisted of a 3-5 cm upper layer (A) comprising whole and fragmented shell with moderate proportions of dark humic soil. Significantly, sand and bauxite pisoliths occurred in moderate proportions within this upper layer. A second layer (B) up to 18 cm in depth consisted of densely packed *A. granosa* valves 3-5 mm in length with occasional other species. Small numbers of bauxite pisoliths occurred here along with small proportions of light sand. The basal layer (C) consisted of yellow to orange coloured sand with frequent bauxite nodules and low proportions of shell. This latter layer was interpreted as culturally sterile due to the low proportions and shell and their more fragmented nature.

XU	Mean depth (cm)	Gross weight (g)	6 mm residue (g)	2 mm residue (g)	Soil (g)	Charcoal (g)	Stones/ Rocks (g)
1	4.2	11500	4811	3000	3689	1	260
2	3.35	13000	4932	2500	5568	1	365
3	3.6	13000	4637	2500	5863	3	230
4	4.25	15000	4673	2500	7827	5	205
5	2.8	12500	3001	3000	6499	2	295
6	4.5	14250	3384	2500	8366	2	395
7	3.4	13000	3062	2000	7938	1	370
8	4.75	16500	4026	4000	8474	0	475

Table 8-6: Bulk data, SM:91

8.5.3 Dating

A sample of *A. granosa* valves were retrieved from the interface between Layers B and C, approximating the lowest level of anthropogenic shell deposit. The resulting determination of 469±43 BP (Wk13788) was too young for calibration.

8.5.4 Shellfish analysis

100% of the *A. granosa* and a sub-sample (25-50%) of the remaining deposits were quantified for SM:91. Sample information on which MNI data are based are shown in Table 8-7 and Figure 8-10 along with summary MNI and weight data.

Anadara granosa is the most frequently occurring shellfish species across all XUs at SM:91 representing 38-61% by MNI. *Saccostrea cucullata* and *Cerithium* sp. are the most frequently occurring sub-species, with the former representing 10-18% of the MNI in the upper 4 XUs, and the latter species most frequent at 17-42% in the lower XUs. *Cerithium* sp. are a small gastropod generally < 15 mm in length and which commonly inhabit intertidal mudflats. Their presence in reasonable numbers is of significance and considered here to reflect the influence of storm surges washing over this very low, exposed site. They are also commonly located in naturally formed beach ridge deposits at *Prunung*, and the high proportions of Cerithidae in XUs 6, 7 and 8 is considered to reflect intermixing of anthropogenic shell with the underlying natural substrate.

XU		XU 1	XU 2	XU 3	XU 4	XU 5	XU 6	XU 7	XU 8
Sample Information	Sample weight	773	939	698	670	516	650	514	669
	Sample % of total	27.93	29.19	25.24	25.95	27.80	27.45	25.02	25.59
	Combined shellfish MNI - Sample	68.39	87.47	51.68	61.26	46.94	63.29	48.77	84.84
	Combined diagnostic shellfish weight - Sample	702.53	666.59	574.57	666.57	379.33	361.89	290.25	390.37
***Anadara granosa*[1]**	MNI	150	133.5	123.5	145.5	100.5	88.5	97	142
	Weight	2043	1715	1872	2089	1145	1016	1008	1412
	Adjusted MNI	41.89	38.97	31.18	37.76	27.94	24.29	24.27	36.34
	Adjusted MNI %	61.25	44.55	60.33	61.64	59.52	38.38	49.77	42.83
	Adjusted Weight	570.53	500.59	472.57	542.07	318.33	278.89	252.25	361.37
	Adjusted Weight %	81.21	75.10	82.25	81.32	83.92	77.06	86.91	92.57
Saccostrea cucullata	MNI	12.5	12	9.5	9.5	5	1.5	0	1.5
	MNI %	18.28	13.72	18.38	15.51	10.65	2.37	0.00	1.77
	Weight	100	125	70	85	47	5	0	2
	Weight %	14.23	18.75	12.18	12.75	12.39	1.38	0.00	0.51
Cerithiidae	MNI	8	31	5	6	8	18	13	36
	MNI %	11.70	35.44	9.68	9.80	17.04	28.44	26.65	42.43
	Weight	2	6	1	2	2	3	3	7
	Weight %	0.28	0.90	0.17	0.30	0.53	0.83	1.03	1.79
All other species	MNI	6	5.5	6	8	6	19.5	11.5	11
	MNI %	8.77	6.29	11.61	13.06	12.78	30.81	23.58	12.97
	Weight	30	35	31	37.5	12	75	35	20
	Weight %	4.27	5.25	5.40	5.63	3.16	20.72	12.06	5.12

Table 8-7: Sample size information and shellfish quantification data, SM91

Notes..1: All *A. granosa* valves for each XU quantified. MNI and Weight values are the unmodified figures. Adjusted MNI and weight (rows 7-10) are adjusted to reflect the overall sample size subject to systematic quantification in the lab (percentage values in row 2). All other shellfish weights and MNI data based on counts of the sample investigated in the lab (i.e. rows 1 and 2).

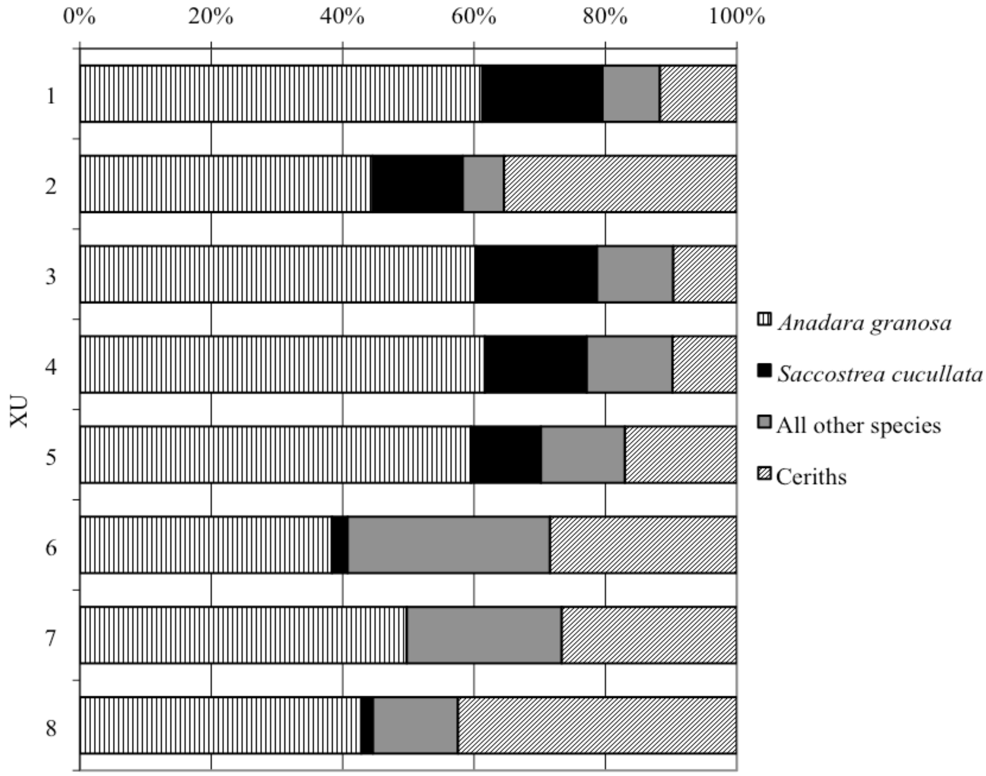

Figure 8-10: MNI data, SM91

8.5.5 Non-molluscan faunal materials

Only very small numbers of non-molluscan faunal material were recovered in the 6 mm residues from SM:91 (Table 8-8). A total of 2 g of crab fragments and 3 g of bone were recovered in XUs 2-4, all of which were very small and non-diagnostic. No otoliths were recovered.

XU	Crab Fragments (g)	Other Bone (g)
1	-	-
2	-	0.5
3	1	1.5
4	1	1
5	-	-
6	-	-
7	-	-
8	-	-
Total	2	3

Table 8-8: Non-molluscan faunal materials, SM:91

8.5.6 Artefacts

Two artefacts were recovered in SM:91 and summary data for these is provided in Table 8-9. The first was a small broken silcrete flake recovered near the surface in XU 1. The second was a small fragment of green glass measuring 13 mm in length. This unusual item was noted to have a series of eraillure scars running across its surface and for this reason is considered to be a small flake probably produced during modification of a larger piece of glass (see Figure 8-11). It is significant that this item was recovered in XU 5 or around 16-18 cm below the surface and near the base of the anthropogenic deposits because this indicates it was likely deposited in association with shellfish remains discarded on the site.

XU	Raw Material	Type	Cortex (%)	Length (mm)	Width (mm)	Thickness (mm)
1	Silcrete	Broken flake	1-50	35	19	10
5	Green Glass	Flake	na	13	9	2.6

Table 8-9: Artefacts, SM:91

Figure 8-11: Glass fragment, SM:91 XU5

8.6 SM:90

8.6.1 Description

SM:90 is a slightly elongated shell mound 28 m long, 15 m wide and up to 70 cm in height. It is located at the north eastern end of the primary complex of shell mounds at *Prunung* Point. Work on this site aimed to simply obtain a sample suitable for radiocarbon dating with minimal disturbance to the site. A 20 x 20 cm pit was excavated on its upper flank to a depth of 55 cm.

8.6.2 Stratigraphy and composition

Stratigraphy of SM:90 consisted of a 15 cm upper layer of highly fragmented shell in a matrix of dark organic soil. Below this, a 30 cm layer of whole and fragmented shell occurred; this contained little soil or sediment and consisted of large proportions of *A. granosa* valves that had a relatively 'clean' appearance compared with the preceding layer. The basal layer was less than 10 cm in depth and consisted of whole and fragmented shell, ashy sediment and frequent fine sand with occasional bauxite pisoliths. The underlying substrate here consisted of fine beach sand with moderate proportions of bauxite pisoliths.

8.6.3 Dating

A single sample of *A. granosa* valves were removed from the basal cultural layer of SM:90. These were submitted for radiocarbon determinations and the resulting calibrated age span was 489(535)593 cal BP (Wk14506).

8.6.4 Shellfish analysis

Brief field inspections indicated that the composition of SM:90 was predominantly *A. granosa*. Moderate proportions of *M. hiantina* were also recovered, along with occasional *P. erosa*, *N. lineata* and *V. cochlidium*. No detailed quantification work was carried out on these samples.

8.6.5 Discussion

Preliminary investigation of SM:90 suggests this is a cultural deposit dominated by large proportions of *A. granosa* valves. The anthropogenic deposit is distinct in relation to the underlying substrate, which consists of large proportions of fine beach sand, bauxite pisoliths and infrequent fragmented shell.

8.7 SM:86

8.7.1 Description

SM:86 is a low mound up to 50 cm in height with maximum basal dimensions of 15 by 25 m located approximately 1 km directly west of SM:96 (Figure 8-2). Surface estimates suggested a deposit predominantly comprised of *A. granosa* overlaying sandy sediments containing large numbers of bauxite pisoliths and infrequent shell. The area in which SM:86 occurs is unique because of the occurrence of a slight promontory comprised of hard bauxite pisoliths and ironstone conglomerate pavement. This pavement slopes gently down from the flat, sandy dune substrates – which are approximately 1.5 m above water level – down to the mudflats exposed at low tides. Unlike the shorelines adjacent to the promontory, the occurrence of the conglomerate pavement has restricted mangrove growth along the water's edge and therefore provides a natural access point through the mangroves to the mudflats (see Figure 8-2). SM:86 is set about 5 m inland of the point at which the dune substrates give way to the conglomerate pavement and is therefore located on flat sandy substrates. Vegetation on and around the site is sparse and open, although a moderate sized bloodwood (*Eucalyptus nesophilia*) is growing on the site. Work on SM:86 consisted of excavating a single 50 x 50 cm square test pit through the cultural deposits and into the substrate[8] .

8.7.2 Stratigraphy

Summary data for SM:86 are provided in Table 8-10. The stratigraphy of SM:86 consisted of two distinct layers with the upper layer (A) consisting of loosely packed shell interspersed with dark sandy matrix. This was up to 35 cm in depth and numerous small roots and rootlets occurred throughout. A single large root 6-10 cm in diameter was removed from the northern portion of the square in this layer. Whole and fragmented *A. granosa* valves were the primary shellfish species observed in the section. The second layer (B) was up to 20 cm in depth and consisted of compact yellowish sand devoid of substantial proportions of shellfish. Occasional fine rootlets also occurred. A distinct intrusion of primarily *A. granosa* shell occurred in the southern portion of the square (C) and this was up to 5 cm in depth and 14 cm long.

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[8] Excavated 6 mm samples for XUs 5 and 6 were unavailable for analysis: these, along with some less crucial soil and sediment samples from other areas, were lost while being transported by a freight company from Weipa to Townsville. These data are therefore omitted here.

XU	1	2	3	4	5	6	7	8	9	10	11
Mean depth (cm)	6	2.65	6.3	5.7	3.6	2.6	2.7	3.2	3.4	4.4	7.5
Gross weight (g)	10000	11500	10500	8500	9500	9000	10000	9500	13300	15000	16000
6 mm residue (g)	4840	5783	4590	3970			4457	4177	3036	1183	1038
2 mm residue (g)	2500	3500	3500	3500	3000	3500	700	200	400	500	3600
Soil (g)	2660	2217	2410	1030	6500	5500	4843	5123	9864	13317	11362
Stones/ Rocks (g)	8	10	5	18			2	2	14	20	65
Charcoal (g)	4	8	5	12			5	5	3	3	2

Table 8-10: Bulk data, SM86

Note: darkened cells represent samples lost during transport[8].

8.7.3 Dating

A single sample of *A. granosa* valves were obtained from the basal layer of SM86. This returned a calibrated age span of 279(340)399 cal BP (Wk13787).

8.7.4 Shellfish analysis

Results of quantification of 6 mm samples from SM:86 are outlined in Table 8-11 and Figure 8-12. Sampling strategy B was used on XUs 1-3 (see Section 5.3.4) however in remaining XUs all of the excavated samples were sorted and quantified in detail. Sample sizes on which MNI and weight data are based are shown in Table 8-11.

MNI data for the XUs with most substantial deposits of shell (1-10) indicate that *A. granosa* compromises between 44 and 98% of overall MNI. *Marcia hiantina* is the next most frequently occurring species, ranging from 5 to 52% of each XU's total MNI. Significantly, the proportions of *M. hiantina* broadly increase over time, and are present in greater proportions than *A. granosa* only in XU 1. Other species frequently represented included *S. cucullata*, *N. lineata* and *V. cochlidium*. Several barnacle fragments were also recovered.

		XU 1	XU 2	XU 3	XU 4	XU 7	XU 8	XU 9	XU 10	XU 11
Sample Information	Sample weight	795.0	489.0	243.0	521.0	565.0	269.0	387.0	400.0	-
	Sample % of total	26.6	28.0	25.2	100.0	100.0	100.0	100.0	100.0	100.0
	Total MNI - Sample	90.4	121.2	84.8	256.0	420.5	497.5	378.0	103.5	5.5
	Total Weight - Sample	579.0	1207.8	977.5	3539.8	4034.0	3950.0	2699.0	853.5	15.0
Anadara granosa	MNI (Actual)	152.0	292.0	239.0	226.0	395.5	488.0	361.5	85.0	-
	Weight (Actual)	1848.0	4035.0	3627.0	3449.0	3892.0	3908.0	2649.0	783.0	-
	Adjusted MNI	40.4	81.7	60.3	226.0	395.5	488.0	361.5	85.0	-
	Adjusted MNI %	44.7	67.4	71.1	88.3	94.1	98.1	95.6	82.1	-
	Adjusted Weight	491.0	1128.8	915.2	3449.0	3892.0	3908.0	2649.0	783.0	-
	Adjusted Weight %	84.8	93.5	93.6	97.4	96.5	98.9	98.1	91.7	-
Marcia hiantina	MNI	47.0	27.5	17.5	23.5	20.5	8.0	11.5	17.5	5.5
	MNI %	52.0	22.7	20.6	9.2	4.9	1.6	3.0	16.9	100.0
	Weight	80.0	60.0	55.0	80.0	70.0	20.0	20.0	70.0	15.0
	Weight %	13.8	5.0	5.6	2.3	1.7	0.5	0.7	8.2	100.0
All other species	MNI	3.0	12.0	7.0	6.5	4.5	1.5	5.0	1.0	-
	MNI %	3.3	9.9	8.3	2.5	1.1	0.3	1.3	1.0	-
	Weight	8.0	19.0	7.3	10.8	72.0	22.0	30.0	0.5	-
	Weight %	1.4	1.6	0.7	0.3	1.8	0.6	1.1	0.1	-

Table 8-11: Shellfish MNI data summary, SM:86

Note: six millimetre residues for excavation XUs 5 and 6 are not available for analysis [8]

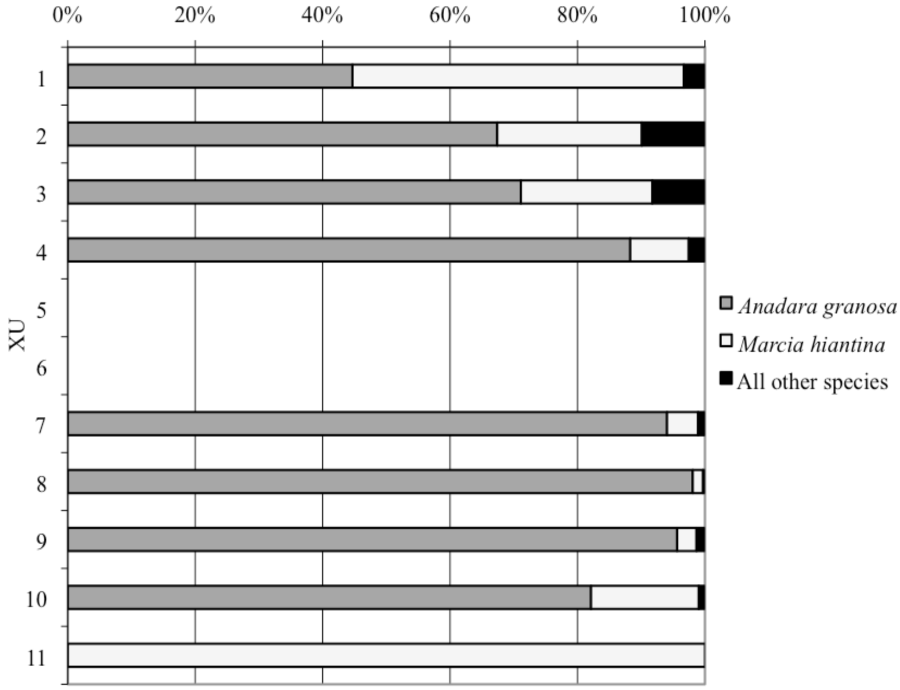

Figure 8-12: Shellfish MNI data, SM:86
Note: Six millimetre residues for XUs 5 and 6 are not available for analysis [8]

8.8 SM:88

8.8.1 Description

SM:88 is a small shell mound deposit whose surface composition is dominated by mostly whole *A. granosa* valves. The mound is up to 75 cm in height with maximum diameter of 18 m. The site is located approximately 450 m north of the contemporary shoreline, 800 m north west of the main group of shell mounds at *Prunung* Point, and 650 m north east of the site SM:86 discussed in the previous section (see Figure 8-2). SM:88 occurs on a narrow sand ridge that lies between the margin of the bauxite plateau and the inland limits of the seasonal swamp. As a result, much of the surrounding area becomes inundated during the wet season. A large depression has been constructed several metres to the north of SM:88 in recent times, probably for use as a well. A 3 by 4 m area of deposit has been removed through quarrying however the remaining deposit is undisturbed.

SM:88 was discovered during the final stages of field work undertaken towards this thesis and so time available to carry out an excavation was limited. Because of the site's location in relation to other features at *Prunung* it was considered a high priority for excavation. A 50 x 50 cm pit was excavated on an undisturbed area of the site to approximately 70 cm below surface. Analysis of SM:88 focussed less upon shellfish quantification with more detailed attention to non-molluscan faunal components.

8.8.2 Stratigraphy and composition

The stratigraphy of SM:88 consisted of three broad layers. A 15 cm deep upper layer (A) was comprised of large proportions of mostly fragmented and whole *A. granosa* shell interspersed with dark humic materials and a dense layer of rootlets. Beneath this a further layer dominated by *A. granosa* shell occurred (B); this contained larger proportions of whole shell and high proportions of soil of a darker colour than in Layer A and was 45-50 cm deep. Layer B overlay a layer of fine sandy sediments containing large proportions of bauxite pisoliths (C). Shell was infrequent, and these deposits are considered here to be the natural mound substrate. This layer was excavated to a depth of around 15 cm and shell proportions decreased with depth. Bulk sample data for SM:88 are shown in Table 8-12.

Samples of sediments were taken in the area around SM:88 using a hand auger to a depth of around 50 cm. These were retrieved from the ridge on which SM:88 occurred and also from the lower ground away from the ridge. Preliminary analysis of this indicated compact, sand-dominated substrates with high proportions of bauxite pisoliths and occasional small (<30 mm) ironstone pieces. Whole shell and shell hash were infrequently encountered in these samples and clearly indicate that substrates across this sand ridge are distinctly different from those encountered in the shell dominated shell mound deposit.

	XU 1	XU 2	XU 3	XU 4	XU 5	XU 6	XU 7
Mean depth (cm)	7.27	11.78	11.95	10.22	9.23	9.52	7.28
Gross weight (g)	21700	24400	24500	24900	26000	27500	16000
6 mm residue (g)	9455	8601	8168	8555	9727	7012	3452
2 mm residue (g)	3000	3700	3500	3500	3400	2500	6500
Soil (g)	9245	12099	12832	12845	12873	17988	6048
Stones and rocks (g)	495	205	130	130	400	405	655

Table 8-12: Summary data, SM:88

8.8.3 Dating

Two samples of *A. granosa* were selected for radiocarbon determinations. These were obtained from the interface between Layers A and B (21 cm bs) and the interface between Layers B and C (65 cm BS), the base of the lower cultural layer. The basal determination returned a calibrated age span of 309(372)424 cal BP (Wk14509). During the physical pre-treatment stages the laboratory observed that the upper radiocarbon dating sample had undergone calcite recrystalisation. Aragonite was selected for dating and, due to the reduction in sample size, AMS measurement was required. The resulting determination was 139(206)279 cal BP (Wk14508). This represents a near-surface (~21 cm BS) age span and gives an approximate date at which site accumulation ceased.

8.8.4 Shellfish analysis

Sampling strategy B was used to calculate shellfish data for SM:88 (see Section 5.3.4). MNI data are therefore based on sub-samples of the 6 mm residues and these represented between 12% and 51% by weight of the 6 mm residues after diagnostic *A. granosa* had been removed (Table 8-13 and Figure 8-13).

Significantly, *M. hiantina* is the dominant shellfish species across all XUs, though in many cases it occurs in only marginally greater proportions. *Marcia hiantina* comprises 43-61% of XU MNI while *A. granosa* variously comprises 27-48% of the MNI for each XU. Subspecies comprise up to 14% by MNI in some XUs, and this is primarily due to the presence of *V. cochlidium* and *S. cucullata* in significant numbers in some XUs.

		XU 1	XU 2	XU 3	XU 4	XU 5	XU 6	XU7
Sample Information	Sample weight	938	3260	2875	1439	1700	1852	818
	Sample % of total	12.8	49.4	50.8	25.6	25.9	34.2	25.9
	Estimated total MNI	67	286	306	177	207	210	26
	Estimated total Weight	407	1461	1669	1019	1117	1072	140
Anadara granosa	MNI (Actual)	224	197	247	329	357	170	35
	Weight (Actual)	2120	1998	2503	2939	3153	1604	288
	Adjusted MNI	28.7	97.4	125.3	84.3	92.3	58.2	8.9
	Adj MNI %	42.7	34.0	41.0	47.7	44.5	27.8	34.4
	Adjusted Weight	271.1	986.4	1270.3	753.1	815.3	549.3	74.5
	Adj Weight %	66.6	67.5	76.1	73.9	73.0	51.2	53.0
Marcia hiantina	MNI - sample	29	174	157	85	101	125	14
	MNI - %	43.2	60.8	51.2	47.8	48.7	59.6	54.0
	Weight - sample	60	380	310	218	240	365	33
	Weight - %	14.7	26.0	18.6	21.4	21.5	34.0	23.5
All other species	MNI - sample	10	15	24	8	14	27	3
	MNI - %	14.1	5.2	7.8	4.5	6.8	12.6	11.6
	Weight - sample	76	95	89	48	62	158	33
	Weight - %	18.6	6.5	5.3	4.7	5.5	14.7	23.5

Table 8-13: Shellfish MNI and weight summary data, SM:88

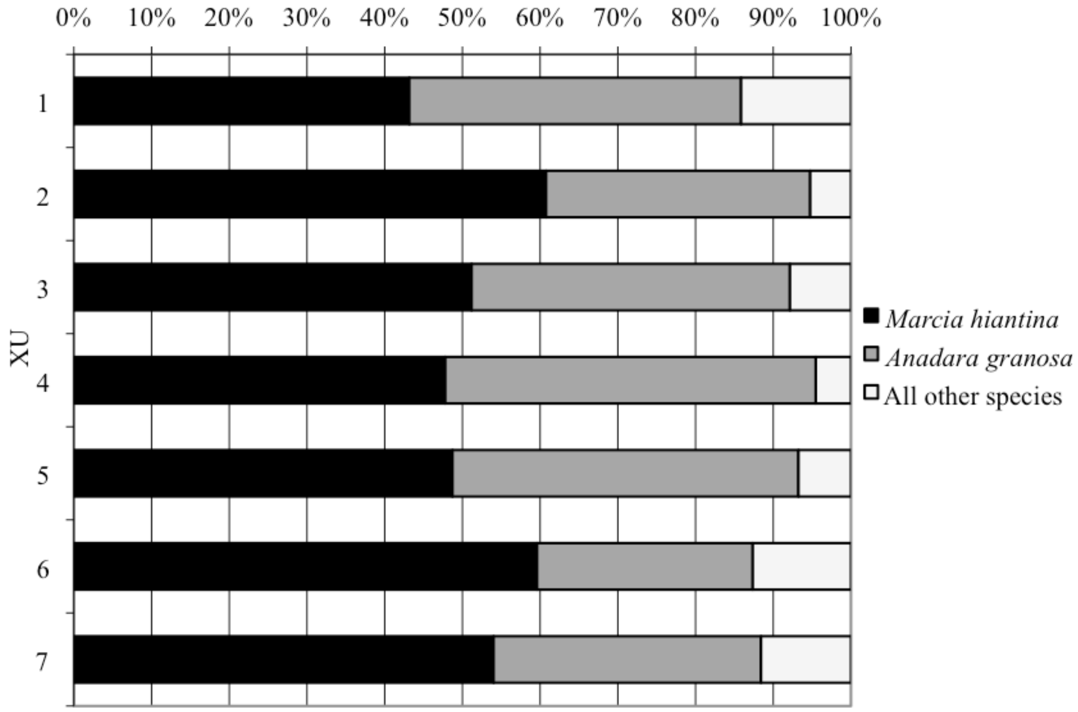

Figure 8-13: Shellfish MNI as proportion of total XU MNI, SM:88

8.8.5 Non-molluscan faunal materials

Small numbers of crab, bone and otoliths were recovered in the excavation of SM:88 (Table 8-14). As noted above, all of the 6 mm samples were sorted in order to maximise chances of recovering these materials. While only one otolith was identified in XU 4, both crab fragments (typically small fragments of claw) and non-diagnostic bone were found consistently through XUs 2-5. No more than 5 g of bone and 5 g of crab were found in any one layer, and overall weights were 21 g for crab and 14 g for bone.

	1	2	3	4	5	6	7	Total
Otoliths (No.)	-	-	-	1	-	-	-	1
Crab Fragments (g)	-	5	5	5	5	1	-	21
Other Bone (g)	-	5	2	3	4	-	-	14

Table 8-14:Proportions of non-molluscan faunal materials, SM:88

8.8.6 Artefacts

Three stone artefacts were recovered from SM:88 (Table 8-15). A broken silcrete flake was recovered near the surface of XU 1, a broken quartz flake recovered in XU 2 and a small angular of quartz recovered in XU 4. No identifiable shell or bone artefacts were recovered.

XU	Raw Material	Type	Cortex (%)	Length (mm)	Width (mm)	Thickness (mm)
1	Silcrete	Broken flake	50-99	36	32	13
3	Milky Quartz	Broken flake	0	13	13	8
4	Quartz	Angular fragment	0	12	8	5

Table 8-15: Stone artefacts, SM:88

8.9 2 mm residue sampling

As with *Bweening*, investigations of 2 mm residues at *Prunung* selectively targeted XUs with the highest proportions of non-molluscan faunal remains in the 6 mm residues. A larger number of sites were sampled in this manner at *Prunung* compared with *Bweening* because a greater number of sites here were found to have non-molluscan faunal remains in 6 mm residues. A single XU from sites SM88, SM91 and SM93 was investigated and a summary of results are provided in Table 8-16.

SM:88 yielded the greatest proportions of non-molluscan fauna when 6 mm residues were investigated however results of 2 mm analysis from XU 2 did not generate any significant new insights. Less that 0.8 g of highly fragmented bone and crab shell were found combined along with two very small fragments of quartz debitage along with a small number of diagnostic *M. hiantina* (n=30) which had a weight of only 6 g in total. 35 complete land snails, 8 very small ceriths and 1 small (< 5 mm) intact trochus were also recovered.

Site / XU	2 mm residue	Charcoal/ vegetation	Bone		Stone artefacts		Crab		Ceriths		Land snail		*M. hiantina*		Trochus	
	g	*g*	*No.*	*g*	*No.*	*g*	*No.*	*g*	*MNI*	*g*	*MNI*	*g*	*MNI*	*g*	*MNI*	*g*
SM88 XU 2	2547	4	12	0.45	2	0.02	9	0.03	8	< 1	35	0.6	30	6	1	< 1
SM91 XU 2	2662	18	82	3.2	4	0.7	-	-	375	23	7	< 0.5	16	2.8	-	-
SM93 XU 6	3752 (50% or 1904g sorted)	94	10	0.7	-	-	1	< 0.5	37	2.8	10	< 1	27	11	1	< 1

Table 8-16: Summary of results of 2 mm residue analysis, *Prunung*

Much larger numbers of bone were recovered from SM:91 (n=82 fragments) however these were typically very small and weighed a total of just 3.2 g. A large number of ceriths were recovered with 375 diagnostic specimens identified in the deposit. Four pieces of quartz debitage and a small number of *M. hiantina* (MNI of 16) and landsnail (MNI of 7) were also recovered.

The third sample investigated was XU 6 of SM:93 which yielded little; less than 0.7 g of fragmented, non-diagnostic bone. One of the bone fragments is possibly artefactual and may be the sharpened tip of a point measuring 12 mm long and 4 mm in diameter. However due to its very small size and fragile, fragmented nature it is considered here to be too ambiguous to be classified as definitely artefactual.

Results of this limited investigation suggest that, as with *Bweening*, investigation of 2 mm residues does not add any significant new information to our understanding of non-molluscan component of shell mound composition. It is however of some note that such a large number of ceriths were recovered in SM91. The analysis of the 6 mm residues from this layer recovered only 31 individuals and so the addition of a further 375 individuals through analysis of 2 mm residues clearly has implications for our understanding of shellfish composition of this XU and the entire site. Implications of this are explored in more detail below.

8.10 Discussion

Excavation, analysis and radiocarbon dating of six shell mound sites of varying sizes at *Prunung*, in combination with previous work carried out by Beaton and Bailey *et al*. (1994) has generated a substantial amount of new data relevant to the prehistory of the Albatross Bay region. In this concluding discussion key elements of this data are highlighted with particular attention given to shell mound composition and the chronological interrelationships between these sites.

8.10.1 Spatial and temporal patterns

The results presented above provide important new data on spatial and temporal patterns in shell mound deposition at *Prunung*, however this data is not without some limitations. Of most concern is that several of the sites at *Prunung* (namely SM:96 and SM:93) are large, complex features whose depositional histories are unlikely to be fully understood through the limited dating programs carried out to date. As discussed earlier, SM:96 illustrates this problem well and a number of inconsistencies appear in the dates obtained by Beaton (cited in Stone 1995) and Bailey *et al*. (1994). While recent human disturbance and natural processes may account for anomalies on this exposed and heavily impacted site, it still highlights the likely complex depositional history associated with the formation of larger mounds: simply put, a linear (or upward) progressive accumulation should not be assumed but instead needs to be demonstrated for larger shell mound sites. The radiocarbon determinations obtained for SM:93 and SM:92 do not indicate any obvious anomalies in accumulation, however given their large basal dimensions (50 by 30 m and 30 by 10 m, respectively) it is unlikely these dates encapsulate the potential complexity of discard activities in these areas. A more thorough assessment of accumulation rates across the mound is required and this would necessarily involve a more extensive radiocarbon dating program. The smaller sites of SM:91, SM:90, SM:88 and SM:86 pose less difficulties in terms of interpreting radiocarbon dates. Deposition on these four features has been more constrained being focussed upon a smaller area, suggesting vertical accumulation. They therefore present fewer difficulties for understanding chronological patterns in mound accumulation compared with larger, more complex features.

However, despite these issues it is still possible to develop a broad but necessarily preliminary framework of spatial and temporal patterns of shell mound formation at *Prunung*. Available basal calibrated age spans for sites dated in the area are provided in Figure 8-14. These suggest initial deposition at the area in the vicinity of the south-east facing shoreline from at least 650-550 cal BP, evidenced by the dates from SM93, SM:90 and SM:92. As argued earlier, the existing basal ages of 302(356)401 (ANU 4409) and 323(379)427 (ANU8775a) for SM:96 are unlikely to reflect actual age of commencement and therefore provide a minimum age estimate for commencement of discard here. Importantly, the existing determinations for the sites adjacent to the shoreline (SM:93, SM:96, SM:90, SM:92) reflect contemporaneous formation of these sites through concentrated discard activity across a 500 m area for at least the past ~550-600 calendar years. Undated sites in the area including the heavily disturbed SM:95, along with SM:94 – which at 2 m high and 100 by 18 m in basal dimensions is the most substantial deposit at *Prunung* Ðw ere also probably deposited within this timeframe. It is therefore clear that development of these sites has not been in succession: discard in a new area does not seem to have started following abandonment of an earlier site.

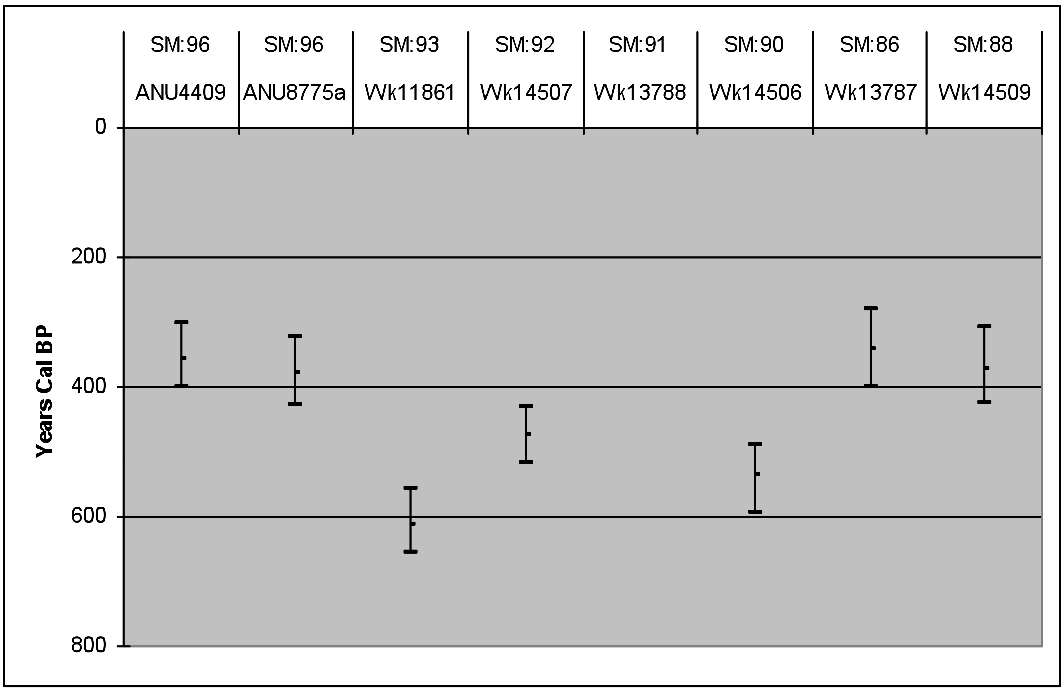

Figure 8-14: Summary of shell mound basal age spans, *Prunung*

From 300-400 cal BP two new discrete deposits are established: SM:86 and SM:88, both located in unique contexts away from the primary complex of sites. SM:86 is located adjacent to a stone pavement which provides a natural access point through dense mangrove forest to open mudflats. SM:88 is located 500 m inland from the nearest shoreline but in an area which is immediately adjacent to both seasonal swamps and messmate woodlands. This is a relatively unique environmental context compared with other deposits in the *Prunung* area.

Importantly, radiocarbon data for *Prunung* provide clear evidence of continued use of the area up until the 18th century. SM:88 has a near surface age of

139(206)279 cal BP (Wk14508), or 1671(1744)1811 AD obtained from ~21 cm below the present surface. This implies that the actual date of cessation of deposition here was even more recent and likely as late as the early 1800s. SM:96 has a more recent age than SM:88 beyond the calibration curve at 360±100 BP (ANU 4410) - this strongly implies use during the post-contact period after 1800 AD. Most unambiguous evidence for continued use of shell mounds into the historic period comes from the most recently formed site at SM:91 which was deposited on the northern margins of SM:92 and which has an uncalibrated basal age of 469±43 BP (Wk 13788). Furthermore, the discovery of a small glass flake in the near basal deposits of this site also strongly supports the proposition that site formation commenced during or shortly before the late 1800s and that it continued to be used on some basis into the post-contact period.

8.10.2 Site stratigraphy and composition

Stone argued that the *A. granosa* dominated mounds that occur parallel to the shoreline at *Prunung* unique were natural phenomena and that "…there is no evidence to suggest that any of this shell was collected by Aborigines for food" (Stone 1995: 94). It is argued here that Stone's interpretation of shell mound deposits at *Prunung* was based on spurious data. He based his claims on column samples obtained across the beach ridge sequence in three transects. However, only one of these transects (A-B, Stone 1995: 87 Fig. 6a) included a distinct shell mound deposit; the remaining two (C-D and E-F) were a further 300 and 800 m to the north east (towards *Prunung* Creek) where no deposits that are considered by archaeologists to be anthropogenic occur. Reference to Stone's published results (Stone 1995: 87 Figure 6) indicates that only one column was obtained from a potential anthropogenic deposit. In this case, his column sample appears to have been taken from this feature's landward lower flank where intermixing with natural substrates is likely to be greatest. Details of comparison of the composition of this column sample in relation to surrounding substrates are not provided by Stone. Importantly, such detailed comparative work was carried out by Bailey *et al.* (Bailey 1993a, 1994) and this clearly points to the anthropogenic origin of these deposits.

New data from a wider range of sites at *Prunung* presented here also refute Stone's claim that shell mounds at *Prunung* are natural deposits scraped into mounds by the scrub fowl, *Megapodius reinwardt*. A clear attribute of the SM:93, SM:91, SM:86 and SM:88 sites was their compositional and stratigraphic distinctiveness compared with their underlying substrates. In all cases shell mound substrates were sand dominated with negligible amounts of whole large shell and large proportions of bauxite pisoliths. Shell hash, small whole shells and sparse *A. granosa* were occasionally noted, particularly in the substrates on which SM:93 and SM:91 were found. However, shell mound deposits were composed of a restricted range of species of known economic importance. These deposits contained overall low proportions of bauxite pisoliths and lacked the sand dominant matrix evident in the substrates. Indeed, as suggested above, Stone himself could not demonstrate compositional or stratigraphic similarities between shell mound deposits and natural substrates and his program of column sampling on substrates in the vicinity of *Prunung* Point were highly selective and only involved limited sampling of the landward margin of a single shell mound deposit.

The site SM:88 also provides further strong support for the claim that shell mound deposits at *Prunung* are of anthropogenic origin. This site occurs in an area that is above or beyond the influence of any substantial marine deposition processes within the past few thousand years as it is located over 400 m from the modern shoreline inland of a substantial seasonal swamp. The site occurs on an inland sand ridge which is likely to be at least 2,000 BP in age – though more likely to be closer to < 3,000 BP – based upon Stone's (1995) estimate of the age of beach ridges that are within 200 m of the present shoreline. There is little question that this is a deposit composed of shellfish collected and transported by humans because the ~372 cal BP aged shell mound deposit clearly post dates the < 2,000 cal BP formation of the underlying substrates. If this shell mound was in fact a bird mound composed of naturally occurring shells from the surrounding subtrate, then it would necessarily follow that the shell mound itself would be of similar age to its substrates, or around <2,000 cal BP in age. Furthermore, the possibility that SM:88 is the result of a scrub fowl scraping non-mounded anthropogenic shell deposits into a mound is also not considered to be applicable. At best only very sparse shell is found within the surrounding substrates and there are no remnants of non-mounded anthropogenic shell deposits in the area that scrub hens could have scraped into a mound.

In short, there is little question that humans were responsible for transporting and depositing the shell in the deposits at *Prunung* that are classified here as anthropogenic shell mounds. Their close similarities with anthropogenic mounds at *Bweening*, the contrast in their composition compared with ground substrates and their overall stratigraphy and appearance suggests only one accumulation agent: people. However, this does not imply a lack of any influence of natural processes on these sites for it is clear that some have at times been influenced by coastal deposition process. For example, several fine lenses or layers of sand occurred in

SM:93 and both this site and SM:91 had larger proportions of small ceriths than SM:86 or SM:88, which are less exposed to coastal processes. Furthermore, both sites evidence increasing proportions of these species with depth and this indicates they were deposited when the shell mounds were lower in height and therefore more prone to storm surges.

The occurrence of small proportions of ceriths in other deposits away from the influence of marine processes – both at *Prunung* and *Bweening* – also hints at the addition of what could be best described as ‘by catch’ to the mounds. Ceriths, for example, are relatively small and found in very large numbers on mudflats and could be easily intermixed with mud attached to target shellfish species and incidentally transported to the site. Shellfish composition is discussed in more detail below. At SM91, it is significant that only through investigation of 2 mm residues that an accurate understanding of the numbers of ceriths in the deposit was obtained; analysis of 6 mm residues alone clearly has a potential to miss large numbers of these. For this reason the actual numbers of individuals in this site are underrepresented, though the magnitude of this recovery bias in other sites appears much less significant. This may be for a number of reasons including a tendency for smaller sized ceriths at SM:91 than at other sites.

Although broadly similar, there are minor stratigraphic variations between the sites excavated and analysed at *Prunung*. The most variable stratigraphic attribute is the proportion of soil and humic material observed in section: some sites, notably SM:96 and SM:93, evidence clear alternating layers of whole clean shell with layers of more fragmented shell and higher proportions of soil and humic materials. SM:88 however had high proportions of soil or humic material throughout but lacked the distinct alternating layers. Conversely, SM:86 and SM:91 had no such layers and only evidenced whole, relatively clean shell. It is clear that in the case of *Prunung*, shell mound size has an obvious relationship to the presence of the distinctive layering, with larger and more complex features more likely to demonstrate this layering, an observation also made at *Bweening*.

However, while greater mound size seems to lend itself to the preservation of soil rich versus soil poor layers, it is the presence or absence of vegetation in the surrounding environment that is viewed here as the source of this variation. The two smallest sites (SM:91 and SM:86) which lacked this layering occurred in relatively open contexts and neither had any substantial surface vegetation other than grasses and sparse trees in close proximity. They also lacked substantial amounts of humic material on their surfaces. SM:88, SM:96 and SM:93 however all occurred in areas either within or in close proximity to stands of dry notophyll vine forest and subsequently have substantial proportions of humic material over their surfaces, though importantly this was not consistent across these sites. It was also noted that humic materials tended to collect in depressions and in areas sheltered from wind by trees, grasses and low shrubs.

8.10.3 Shellfish analysis

Data on the internal variations in shellfish MNI at each site have been discussed previously and thus here the focus is on MNI data for each site as a whole. As outlined, shellfish estimates at most sites (SM:88, SM:86, SM:91) were calculated from a sub-sample of 6 mm sieve residues and this is an important consideration in discussions of relative species abundance. MNI data, including relevant details on sample sizes are shown in Table 8-17 and Figure 8-15 below.

Location	**SM:86**		**SM:91**		**SM:88**		**SM:93**	
	MNI	%	MNI	%	MNI	%	MNI	%
A. granosa	1738	88.76	262.64	46.39	2135.79	73.15	33172.86	80.50
M. hiantina	179	9.12	125	22.08	684	23.43	6801	16.50
S. cucullata	7	0.33	52	9.10	36	1.23	449	1.09
P. erosa	-	-	2	0.35	1	0.03	7	0.02
V. cochlidium	9	0.46	-	-	36	1.23	135	0.33
N. lineata	4	0.20	-	-	4	0.14	154	0.37
T. telescopium	1	0.05	-	-	6	0.21	33	0.08
Barnacle	10	0.51	-	-	2	0.07	203	0.49
Cerithiidae	5	0.26	125	22.08	4	0.14	84	0.20
Land Snails	5	0.26	-	-	8	0.27	52	0.13
Ellobium sp.	-	-	-	-	-	-	8	0.02
Melo sp.	-	-	-	-	3	0.10	-	-
Other sub-species	-	-	-	-	-	-	111	0.27
Overall MNI[2]	**1958**		**566.14**		**2919.79**		**41209**	
Overall Sample %[3]	**46.8**		**26.84**		**31.91**		**100**	

Table 8-17: Relative shellfish MNI, *Prunung*

Notes. 1: Some of these figures are based upon analysis of sub-samples of 6 mm sieve residues and not full analysis of 6 mm sieve residues. See discussions throughout this chapter for details.

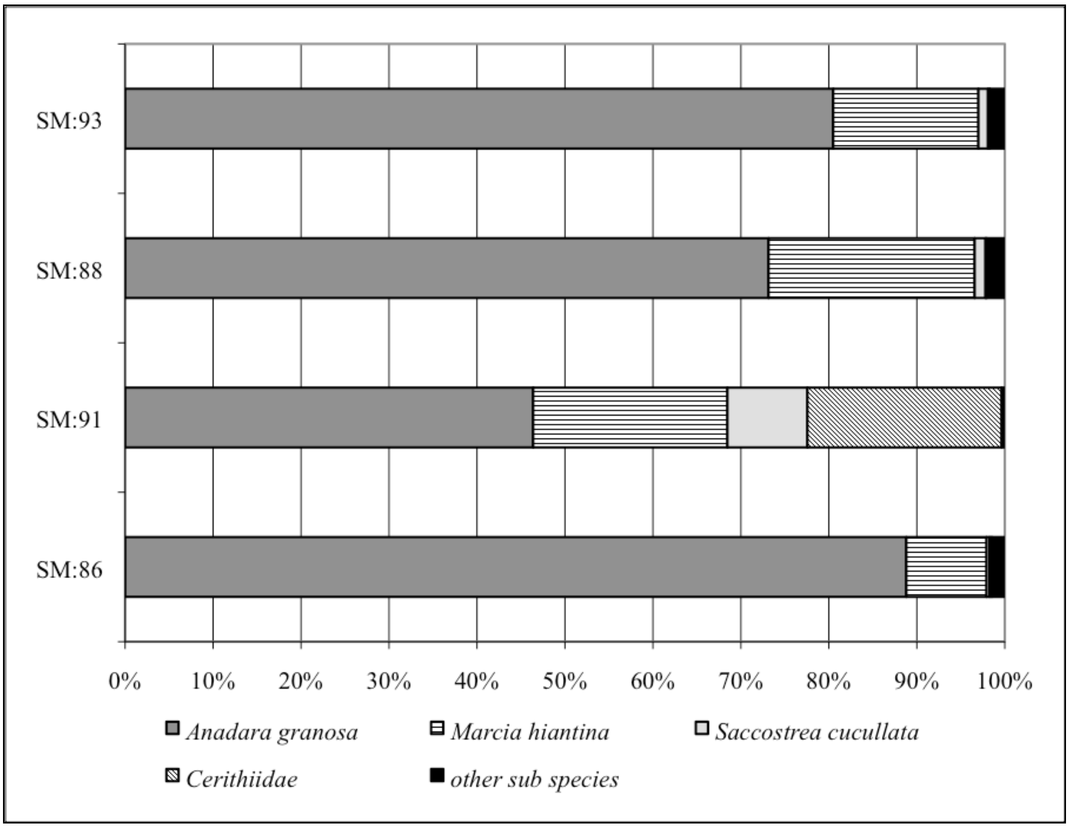

Figure 8-15: Shellfish MNI data, *Prunung*

Anadara granosa is the most frequently occurring species across all sites ranging between 46% and 89% of total site MNI, with the lowest proportions of the species being found in the smallest site, SM:91. *Marcia hiantina* is a significant species in three of four sites at 9-23% of total MNI. In many sites it represents the dominant shellfish species at different times, and it is almost always present in all XUs of all sites. Both *A. granosa* and *M. hiantina* are species that inhabit inter-tidal mudflats and this is significant given that collectively these species represent 68-97% of total site MNI. Again, the lowest proportions of both species are found in SM:91 where collectively they represent 68% of total site MNI. Here, this low figure is influenced by the occurrence of much larger proportions of ceriths than in other sites (22%) and as outlined these are thought to be derived from both intermixing with mound substrates and the influence of storm surges depositing material from off site. If the ceriths are overlooked for this site as a non-economic species then in all cases *M. hiantina* and *A. granosa* together represent 90-98% of total MNI for all excavated sites at *Prunung*.

The presence of seemingly large amounts of ceriths in deposits of SM:91 are seen here to reflect the influence of storm surges or wave activity on the site. Their presence in larger numbers in 2 mm residues is important and highlights the well known problem of the under-representation of small shellfish when only larger sieve residues are investigated (Claassen 1998). Ceriths were also present in small numbers in SM:93, SM:86 and SM:88. Their presence in SM:93 – located adjacent to the shoreline – may reflect similar process as suggested for SM:91: that is, the likely occurrence of storm surges in the past. Ceriths are not considered here to be an economic species, and therefore their under-representation in 6 mm sieve residues on which shellfish analyses are based is not seen as particularly problematic. The small numbers of ceriths in sites located away from the influence of marine process (e.g. at SM:88 or the *Bweening* sites) compared with larger numbers at exposed sites strongly suggests that small numbers of ceriths that occur in many sites originate as a result of incidental collection (i.e. 'by-catch') or perhaps reflect intentional collection by people for as yet unknown purposes.

Conversely, shellfish species common to mangrove forests and rocky shorelines such as *P. erosa*, *V. cochlidium*, *T. telescopium*, *N.* sp., and *S. cucullata* are typically represented in very low numbers. The highest proportion of any of these species is a total of ~9% *S. cucullata* in SM:91.

In addition to the presence of ceriths, a limited range of other small and unusual shellfish species were recovered, with the greatest proportion of these occurring in SM:93. Those most commonly encountered – albeit in very small amounts – included soft shelled land snails, small trochus, Judas ear shells (*Ellobium* sp.) and barnacles. A range of plausible explanations can be found for the incorporation of these and other uncommon species in shell mound deposits. Barnacles, for example, were occasionally observed attached to *A. granosa* shells recovered during excavations and have also been observed on living *A. granosa* and *M. hiantina* shell collected on mudflats (personal observation). Other less commonly occurring species may have been accidentally collected, introduced by other animals (such as birds) or of course used by people for unknown purposes.

8.10.4 Artefacts

Low proportions of artefacts were recovered in shell mound sites at *Prunung* (Table 8-18). None occurred in SM:86, two occurred in SM:91, three in SM:88 and five in SM:93. Artefacts included modified shell, a single glass fragment and a number of small flakes. The greatest number of artefacts was recovered in the site with the largest amount of excavated deposit.

Stone artefacts were the most frequently found artefact type, though very small in absolute numbers. Frequencies of raw material included one on quartz, two on silcrete and four on quartz. The average size of stone artefacts was 20 x 14 mm. These consisted primarily of broken flakes and one small angular fragment.

The modified shells are on an unknown species, but are likely to be a piece removed from a larger shell such as *Melo* sp. Both items were broken and had significant amounts of edge-grinding and wear either through modification or use on their distal ends. The curved ground edge is heavily and consistently rounded and smoothed and therefore not considered to have been used for cutting or scraping tasks. Its use or purpose is unknown.

The recovery of the glass fragment in SM:91 represented an unusual find. While there is a likelihood that the item may have moved downwards through the deposits, its presence in basal layers is not considered to be anomalous given the recent age of the site. The presence of a distinct eraillure scar and lack of cortex/glass surface suggests that this item is a small flake probably the by-product of modification or use of a larger piece of glass. In combination with the young age of this site, it clearly supports the assertion that shell mound formation continued following European contact in the region.

Artefact densities were calculated for all four sites excavated in order to better compare results and as Table 8-19 shows, the highest proportions of artefacts were recovered on SM:91 which has approximately 1.8 artefacts per 100 kg of deposit. When stone artefacts alone are compared, SM:88 has the highest density, also at around 1.8 artefacts per 100 kg. Realistically however, these represent very low numbers of quite small artefacts and for this reason it is not considered that there are any significant variations in artefact numbers across the sites at *Prunung*.

Site	Material	Type	Cortex (%)	Length (mm)	Width (mm)	Thickness (mm)
SM:88	Silcrete	Broken flake	51-99	36	32	13
	Milky Quartz	Broken flake	0	13	13	8
	Quartz	Angular fragment	0	12	8	5
SM:93	Quartz	Broken flake	0	10.9	8.2	3.1
	Quartz	Broken flake	0	14.5	8.4	3.8
	Shell	Modified	NA	30	26	2.2
	Shell	Modified	NA	31	25	2.5
	Quartz	Broken flake	1-50	20	10	5
SM:91	Silcrete	Broken flake	1-50	35	19	10
	Glass - Green	Fragment	na	13	9	2.6

Table 8-18: Summary artefact data, *Prunung*

XU	Weight of 6 mm deposit investigated	No. of Artefacts	Stone Only	All artefacts per 100 kg	Stone artefacts per 100 kg
SM:93	1033.1	5	3	0.4840	0.2904
SM:91	108.75	2	1	1.8391	0.9195
SM:86	122.8	-	-	-	-
SM:88	165	2	3	1.2121	1.8182

Table 8-19: Artefact density data, *Prunung*

8.10.5 Non-molluscan faunal materials

Investigation of 6 mm sieve residues indicated low proportions of non-molluscan faunal materials in all sites excavated and analysed (Table 8-20). While SM:93a had the overall largest weight of non-molluscan fauna, the density per kg was similar to that of SM:91. Overall, the highest density of these materials was in SM:88 at ~21 g of bone, otoliths and crab shell per 100 kg of deposit. The principal reason for this is the presence of 21 g of crab claw fragments, typically the dense claw tip, and these are heavier than the small fragments of bone that rarely weighed more than 1-2 g per fragment.

There are significant issues in using weight as a measure to estimate the relative abundance of bone, as different skeletal elements and different non-molluscan faunal materials will be over- or under-represented. However, this was unavoidable given that essentially no diagnostic elements were identified apart from a single fragment of mandible in SM93 along with a few fish otoliths. Realistically, the overall numbers of non-molluscan materials are very low and for these reasons the observed minor variations in proportions of bone between sites are treated with caution, and only very clear patterns are discussed below.

The first of these is that SM:88 does evidence higher numbers of non-molluscan faunal materials than other sites. Crab claw fragments are similar to those of *S. serrata* (mud crab) based on visual comparison with a modern example. The bones recovered were small fragments typically less than 10 mm in length and the broadest level of identification possible is that they were mammal or reptile bones rather than bird bones. There are overall greater proportions of non-molluscan faunal material in SM:88 (21g per 100 kg) compared with other sites (< 5 g per 100 kg) and this is considered to partially reflect the location of the site adjacent to seasonal swamps and messmate woodland.

Site no.	Bone (g)	Crab (g)	Otoliths (g)	Deposit weight (kg)	Combined (g per 100 kg)	Bone only (g per 100 kg)
SM93	34.8	6.03	2.00	1033.1	4.1458	3.3685
SM91	3.00	2.00	-	108.75	4.5977	2.7586
SM86	-	-	-	122.8	-	-
SM88	14.00	21	1.00	165	21.8182	8.4848

Table 8-20: Weights and density of non-molluscan faunal materials, *Prunung*

Importantly, investigations of selected 2 mm residues strongly support the argument that shell matrix sites at *Prunung* evidence little in the way of non-molluscan faunal remains. Those materials that were found were extremely fragmented and all non-diagnostic with no cranial skeletal elements or any complete skeletal elements recovered. This is not to say that diagnostic elements of non-molluscan fauna are not and will never be found in shell mound sites at *Prunung*. The key point here is that the numbers of these materials are demonstrably low in those XUs where proportions of 6 mm non-molluscan faunal remains are greatest. This, along with the results from *Bweening*, rules out the possibility that sampling bias is the reason for a lack of these materials in shell matrix sites. Other potential issues, including the possibility of taphonomic bias, are explored in more detail in Chapter 9.

8.10.6 Summary

In summary, the bulk of shellfish deposition at *Prunung* has been focussed upon the immediate shoreline area and this has been the case since at least ~600 cal BP and seems to have continued until at least ~150 to ~200 cal BP and likely into the early 19th century. It is clear that development of all of these shell mounds – including the outliers SM:86 and SM:88 – took place largely contemporaneously and this has significant implications for understanding the production strategies surrounding shell mound formation and use. SM:86 and SM:88 are highly likely to have developed partly due to their unique micro-environmental contexts. The composition of SM:86 suggests it was primarily concerned with exploitation of mudflat shellfish species and this is supported by its location adjacent to a natural access point to these environments as well as the lack of non-molluscan faunal materials and stone artefacts.

A similar explanation could also be applied to the complex of sites adjacent to the shoreline near *Prunung* Point which are positioned in close proximity to a gentle sloping beach and the deep channel which flows out into Albatross Bay from

Prunung Creek. Extensive areas of mudflats occur nearby, however many of these are only accessible with a short water crossing. Here too, the most significant feature of shellfish composition is a strong preference towards mudflat species and negligible use of other resources. Other resources are minimal across all sites: SM88 had the greatest proportion of non-molluscan fauna present and evidences a marginally wider resource base than other mounds located close to the shoreline. In any case, shellfish is the primary resource used on this site and other resources appear to have been used in a supplementary or incidental fashion at best. As with *Bweening*, this points to the likelihood that shell mounds are associated with a highly specialised form of production focusing upon mudflat shellfish resources.

Chapter 9: An archaeological model of mudflat shellfish production

This study has generated significant new data about shell matrix sites in the Albatross Bay region. Controlled excavated samples are now available from 12 shell matrix sites not previously investigated at *Prunung* and *Bweening* and detailed data now exists for 477 individual shell matrix sites. Furthermore, results of radiocarbon dating presented herein have generated a picture of shorter-term temporal patterns in the development of groups of sites at *Prunung* and *Bweening*. This complements earlier work on longer-term patterns in mound formation at *Lueng*, *Uningan* and *Idholga* as well as previous work at *Prunung* and *Kwamter*. The following discussion draws upon this range of data to develop an explicitly archaeological model of the production strategies associated with shell matrix site formation, particularly shell mounds.

9.1 Shellfish composition

A small number of sparse surface scatters composed of shellfish species other than *A. granosa* or *M. hiantina* have been recorded within the region. None have yet to be recorded within close proximity to the suite of shell matrix sites argued here to be associated with production strategies associated with mudflat shellfish exploitation. The sites in question consist of low density background scatters usually of *P. erosa* and *T. telescopium*, and most commonly have been found on dunes and beach ridges. These sites are excluded from the following discussion and it is contended here on the basis of their quite different composition that they are likely to be associated with production strategies and settlement patterns different to those associated with focussed mudflat exploitation. Investigating these sites nevertheless represents an important priority for future work in the region.

A long-standing observation about the shell mounds of the region has been the extent to which their composition is dominated by *A. granosa*, however results presented here allow us to refine this broad assessment. Summary data for all sites excavated in the region (Table 9-1) indicates a heavy and consistent focus on a combination of two key species: *A. granosa* and *M. hiantina*. A third species, *S. cucullata* is also well represented in several sites, notably SM:137 and SM:140, however even in these cases one or both of the aforementioned species are still represented in substantial proportions. Other species of shellfish are present in small numbers and excavated sites typically included a number of common economic species such as *Terebralia* sp., *T. telescopium*, *P. erosa* and *Nerita* sp. Collectively, across all sites except the *Kwamter* mound (SM:393) - where detailed data is not available - these sub-species comprise less than 5% of shellfish composition.

Site	*A. granosa*	*M. hiantina*	*S. cucullata*	*P. erosa*	Other
SM:86, PR	88.76	9.12	0.33	-	1.74
SM:91, PR	59.54	28.34	11.67	0.45	-#
SM:88, PR	73.15	23	1.23	0.03	2.16
SM:93, PR	80.50	16.50	1.09	0.02	1.89
SM:137sh BW	39.60	0.12	55.39	0.12	4.78
SM:136a BW	63.69	27.73	5.99	0.05	2.54
SM:140 BW	29.19	39.08	30.01	-	1.72
SM:126 BW	88.87	3.47	5.57	0.18	1.92
SM:123 BW ^	84.91	-	13.84	0.00	1.26
SM:116 BW ^	97.76	0.22	0.89	0.22	0.89
SM:115 BW	95.52	1.30	2.01	0.06	1.10
SM:114 BW	93.96	1.61	3.02	-	1.41
SM:393 KW	96*	-	-	-	-
SM:217 MJ	85.2	13.8	-	-	0.9

Table 9-1: Overall shellfish MNI (by percentage) for excavated shell matrix sites, Albatross Bay

Notes: PR – *Prunung*; BW – *Bweening*; KW – *Kwamter*; MJ – *Mandjunggar*
- Cerith sp. Are excluded from totals for SM:91 as these are argued to be naturally derived.
* Weight estimate only. ^ Shell scatter or midden; all other sites are mounded.

The dominance of *A. granosa* and *M. hiantina* is significant because both have characteristics of r-selected shellfish and are prone to forming large biomasses within preferable environments. Both species also tend to occur in similar habitats: soft, intertidal mudflats. *Anadara granosa* has been subject to a number of biological studies which have noted that changes in sediment levels, temperature, salinity, substrate characteristics and storm or flooding events can all have detrimental effects on their abundance, growth rates and overall availability (Broom 1982a, 1982b, 1983; Narasimham 1988; see also Bailey 1999; Morrison 2003). These factors can cause significant damage to shellfish populations on a short or long-term basis at both specific locales or across large areas. However, where conditions are optimal very large biomass' form within the middle to lower intertidal zone of mudflats (not sandflats as is often asserted). Contemporary oral accounts from Indigenous people at Weipa also suggest that very large populations of *A. granosa* at times formed on intertidal mudflat and were collected in large proportions using rakes, wire dredges, by hand and also by diving from bark canoes or wooden boats (Morrison 2003b).

There is good evidence that *M. hiantina* exhibits similar characteristics as *A. granosa.* Unfortunately, *M. hiantina* remains a poorly investigated species (Toral-Barza and Gomez 1985) and as such scientific literature on this species is minimal. Anecdotal evidence in the form of accounts from Indigenous people at Weipa, field observations by the author and others, most notably Meehan (1982), points to strong similarities with *A. granosa*. Today, when available, *M. hiantina* are collected from intertidal mudflats at low tide and indeed are more commonly collected than *A. granosa*. The *M. hiantina* shellfish beds are often said to move around from year to year, and while in some years are difficult to locate, when they are found small groups of women collect very large amounts of the species[9]. Like *A. granosa*, *M. hiantina* is rarely found in significant numbers within the firmer muddy substrates often found on intertidal mudflats and prefers the often very soft substrates within the mid- to lower intertidal range and as a result, can be very difficult to access and collect.

There is strong evidence from scientific literature and the lifelong observations of Indigenous people at Weipa that both species are subject to inter-annual variations in the location and size of shell beds. A characteristic of r-selected species is that their high fecundity enables them to form high biomasses when conditions are optimal; however, they are equally susceptible to population losses when salinity levels, temperatures, turbidity or sediment levels vary. In addition to this, Meehan (1982:163) described massive population losses due to irregular environmental events such as large storms or cyclones. In summary then, the effective exploitation of either species would necessarily require some degree of flexibility in associated production strategies.

9.2 Non-molluscan fauna

Non-molluscan fauna are poorly represented across all shell matrix sites excavated in the Albatross Bay region to date. Despite the fact that 6 mm sieve fractions have been the primary analytical unit used, it is argued here that low proportions of these materials are not likely to be the result of sampling bias. It is widely recognised that non-molluscan faunal recovery in archaeological sites is heavily dependent upon

[9] During the fieldwork undertaken as part of this thesis, the author was regularly invited to participate in various foraging activities, most of which were oriented around the collection of shellfish (most notably, *M. hiantina*, *S. cucullata*, *T. telescopium*, *P. erosa* and *N. lineata*), crabs and fish.

sieve fraction size and that residues from 1 to 3 mm sieve fractions can yield important data (eg. Barker 1975; Casteel 1972, 1976; Dye 1994; Gordon 1993, 1994; James 1997; Lyman 1994; Payne 1975; Ross and Duffy 2000; Shaffer 1992; Shaffer and Sanchez 1994; Stein 1992b; Thomas 1969; Ulm 2002c; Waselkov 1987). However, it has been acknowledged by some that thorough assessment of these fine fraction materials is extremely time consuming and not consistently useful. For example, Vale and Gargett (2002) suggested that analysis of 3 mm sieve residues did not increase the diversity of fish taxa recovered in an assemblage of > 60,000 fish bone specimens (but see Gobalet 2005; Zohar and Belmaker 2005).

Results from intensive archaeological investigations are now available for a range of shell mound sites across northern Australia (e.g. Bailey 1975a; Beaton 1985; Bourke 2000; Faulkner 2006; Mitchell 1994; Robins *et al.* 1998; Veitch 1999a). In all cases except that of Princess Charlotte Bay where sieve fractions or analysis methods are unspecified (see Beaton 1985), sampling of mound sites has involved analysis of fine sieve fractions. Faulkner (2006) indicated that his sampling strategy included collection of 3 mm samples however results are not presented. Indeed, few studies have reported in detail the abundance or diversity of faunal materials recovered in coarse fractions (> 4 mm) compared with those recovered in finer fractions (< 4 mm). Bourke indicated that upwards of 80% (by weight) of the bone recovered during excavations of Darwin Harbour shell mound sites came from 3.2 mm fractions, although she noted that “much of it was burnt, very fragmented and difficult to identify to specific taxa” (2000: 66). Veitch (1996) suggested little difference in faunal representation between large and fine sieve fractions and recovered virtually no non-molluscan faunal remains across three individual shell mound deposits, all of which seem to have included analysis of small sieve fractions.

Available non-molluscan faunal data from shell mounds where < 4 mm sieve residues were investigated are summarised in Table 9-2. The first and most notable point that can be made from this is that while faunal recovery rates vary across sites and regions, they are nevertheless all very low. Total faunal materials recovered in column samples range from 0 to 620 g across the 11 separate shell mounds from which valid data are available; however, more useful is the standardised measure of combined total weight of bone, otoliths and crab fragments per cubic metre[10] as shown in Table 9-3. This indicates that between 0 and 239 g of combined non-molluscan faunal remains were recovered per cubic metre, with a mean of 89.5 g/m^3 and a median of 24 g/m^3.

An important consideration is what the general weight figures outlined in Table 9-3 represent in terms of the numbers of individuals present. A maximum figure of 239 g/m^3 of deposits may seem high, but 1 m^3 of shell dominant deposit reflects a very large number of shellfish. Table 9-4 highlights the number of faunal elements that could be identified to family or species level recovered in the four sites with the best rates of faunal recovery. This reveals that these relatively high recovery rates (in terms of bone weight) equate to very low number of diagnostic skeletal elements. For example, at MA7 and HI83, which have the highest recovery rates, faunal remains consist of only a few diagnostic mammal and fish skeletal elements. Bailey (1975)

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[10] The more conventional measure of g/kg is not possible because of differences in the way data has been reported by other researchers.

placed similar recovery rates at *Kwamter* into perspective by estimating meat weights based on his combined bone assemblage: he concluded that these remains represent a mean of 3.8 kg of meat per m^3 of deposit, compared with a figure of 125 kg/m^3 of shellfish meat. This equated to an estimated 6% of non-molluscan food versus 94% for molluscan meat (Bailey 1975: VII 29). This serves to illustrate a critical point: even in those sites where the recovery rate of non-molluscan fauna are highest, these remains represent a very small number of individuals consumed during hundreds of years of consistent accumulation of shellfish.

The possibility that taphonomic loss is associated with such low proportions of non-molluscan faunal data also needs to be considered. High levels of bone fragmentation is often observed to be a problem with non-molluscan faunal assemblages from shell matrix sites and shell mounds in particular. For example, at *Kwamter*, Bailey noted that generally speaking the bone recovered was so “exiguous and fragmentary” (Bailey 1975a: VII 29) that the majority of fragments could not be assigned as being either fish or mammal. Similarly, Bourke (2000) frequently noted the high degree to which bone was fragmented in shell mound sites near Darwin. High fragmentation is also a characteristic of the bone assemblages from sites excavated as part of this project.

Site Name	Region	Sample size (m)	Pit depth (m)	Total Deposit (kg)	Sieve sizes (mm)	Shellfish method	Primary mollusc taxa	Bone		Otoliths		Crab
Wundadjing-angnari	Mitchell Plateau	1 x 1	1.7	-	Large/ small	MNI	Ag	-	1	0	0	0
Goala	Mitchell Plateau	1 x 1	1.26	-	Large/ small	MNI	Mh	0	0	0	0	0
Idayu	Mitchell Plateau	1 x 3	0.8	-	Large/ small	MNI	Ag, Mh.	0	0	0-	0	x
Mari-Maramay	Croker Island	0.5 x 0.5 (x 2 pits)	-	-	6/3	MNI	Gt (67.5%) Cp(24.3%)	-	10	0	2	-
MA7	Middle Arm	0.5 x 0.5	0.5	100	6.4/3.2	MNI	Ag (46.2%) Mh (18.8)	16.2	-	0.5	3	13.2
MA1	Middle Arm	0.5 x 0.5	0.44	135	6.4/3.2	MNI	Ag (66.8%)	0.3	-	1.4	4	0
MA10	Middle Arm	0.5 x 0.5	0.25	91	6.4/3.2	MNI	Ag (87%)	1.5	-	0	0	0
HI83	Hope Inlet	1 x 0.5	1	588	6.4/3.2	MNI	Ag (97.9%)	101	-	1.9	7	5.4
HI81	Hope Inlet	1 x 0.5	1.6	933	6.4/3.2	MNI	Ag (99.2)	50.1	-	5.5	28	9.5
HI80	Hope Inlet	1 x 0.5	-	986	6.4/3.2	MNI	Ag (79.1%)	122	-	27	57	22.1
HI66	Hope Inlet	1 x 1	0.6	424.5	6.4/3.2	MNI	Ag (79.2%)	17.3	-	3	0.7	0.3
Bayley Point	Southern Gulf of Carpentaria	0.5 x 0.5	0.77	204	2/4	Weight	Ag (98%)	35.7	29	-	-	-
Kwamter Mound	Albatross Bay	1 x 1	3	-	8/2	Weight	Ag (>95%)	626	390	-	-	-

Table 9-2: Summary of non-molluscan faunal recovery from selected north Australian shell mound sites

Note: Column 8 abbreviations include Ag – *Anadara granosa*; Mh – *Marcia hiantina*; Gt – *Gafrarium tumidum*; Cp – *Callista planatella*

Site	Volume (m^3)	Combined bone (g/m^3)
Wundadjingangnari	1.7	0
Goala	1.26	0
Idayu	2.4	0
Mari-Maramay	-	-
MA7	0.125	239.2
MA1	0.11	15.4545
MA10	0.0625	24
HI83	0.5	217.2
HI81	0.8	81.375
HI80	-	-
HI66	1.6	12.875
Bayley Point	0.1925	185.455
South Mound	2	0
Kwamter Mound	3	208.667

Table 9-3: Summary of non-molluscan bone proportions from selected north Australian shell mound sites
Note: data from Table 9-2

To date the only substantial contribution to considering the taphonomic processes associated with bone preservation in shell mounds or any shell matrix sites in northern Australia has been made by Bourke (2000:112). She has suggested that systematic reduction processes influence the preservation of bone in shell mounds at Darwin Harbour via similar processes to those outlined by Linse (1992) for the British Camp midden in North America. Here Linse suggested that the solubility of hydroxyapatite, the primary inorganic constituent of bone, increases in proportion to increasing alkalinity above a pH of ca 7.8. Further, Linse (1992: 342) concluded that bone has "extreme susceptibility…to decomposition in highly alkaline (> 11 pH) conditions" and that "negative effects on the potential for bone preservation are likely to be produced by extremes in alkalinity as well as extremes in acidity". However, the conditions at the British Camp site – a deposit comprised of high proportions of soil matrix - were radically different to the shell dominated deposits described by Bourke for Darwin Harbour. Documented shell mound pH values in northern Australia are typically ca 8 (neutral) (e.g. Veitch 1996), thus suggesting that pH levels are near neutral in shell mound sites, not extreme. Bourke also suggested that these processes have resulted in the vertical distribution and preservation of bone along a normal curve, however this proposition is only marginally supported by her bone distribution data and is not at all supported by that at *Kwamter* (Figure 9-1). In short, her assertion that these processes may be at work on these assemblages is considered here to be unfounded.

Site	Fish	Mammals	Other
MA7	3 otoliths, fork tailed catfish (*Arius* sp.)	2 teeth of Antilopine kangaroo (*Macropus antilopine*)	Snake bone fragments, including vertebrae
	Jaw and vertebrae of fish, numbers not stated	2 small macropod teeth	
		2 possum teeth	
HI83	6 forktailed catfish otolith	2 macropod incisors	Identified birds, numbers not stated.
	1 Black jewfish otolith	3 macropod teeth	
	Unknown number of wrasse	2 possum teeth	
		1 rodent incisor	
Bayley Point	13 fork tailed catfish fragments (*Arius* sp.)	1 fragment of possum (*Trichosurus* sp.) or flying fox (*Pteropus* sp.)	1 fragment of dragon lizard (Agamidae)
	2 fragments whiting (*Sillago analis*)	5 fragments of flying fox (*Pteropus*)	1 fragment of snake (Elapidae)
	1 fragment blue salmon (*Eleutheronema tetradactylum*)		
	3 fragments of shark or ray (Elasmobranch)		
	1 fragment of crab (Brachyura)		
Kwamter	125 vertebrae, spines and occasional jaw fragments of fish including bream (*Mylio* sp)	264 pieces mammal bone including agile wallaby (*Macropus agilis*), short-nosed bandicoot (*Isoodon macrourus*)	
	21 crab claw fragments (including *Scylla serrata*)		

Table 9-4: Summary of identified faunal elements from selected north Australian shell mounds sites

In summary, the low proportions of non-molluscan fauna in shell matrix sites excavated around Albatross Bay are consistent with results from deposits elsewhere across northern Australia. The strategic investigation of selected 2 mm sieve fractions from the XUs of sites with relatively high proportions of non-molluscan fauna at *Prunung* and *Bweening* did identify non-molluscan faunal remains. However, as with other examples discussed here these amount to small proportions of highly fragmented materials and did not significantly alter the frequencies of non-molluscan fauna recovered in those spits: if anything, they simply served to identify smaller non-diagnostic fragments of materials found in the coarse sieve residues.

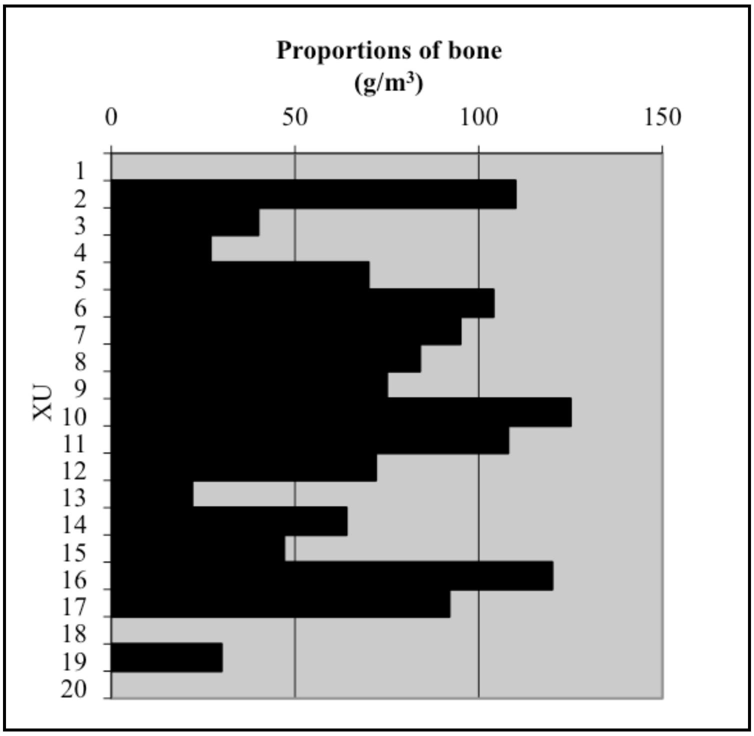

Figure 9-1: Weight of bone recovered at *Kwamter*
(data from Bailey 1975)

A number of possible explanations may account for this phenomenon. First and foremost is that these materials were prepared, consumed and discarded away from shell matrix sites and thus not preserved within the latter. While possible, this explanation is not preferred here because such a discard pattern would presumably result in other archaeological phenomena within close proximity to shell mound deposits such as the occurrence of hearths, background scatters of marine shell, or artefacts. A second possible explanation is that very large proportions of non-molluscan fauna are completely destroyed by unknown taphonomic processes leaving little to no indication that they had been deposited at all. In this regard, the porosity and coarse nature of shell matrix sites along with seasonally alternating wetting and drying may have a unique but undocumented impact on bone preservation leading to chemical leaching and ultimately physical destruction. Further, scavenging dingos may have effectively removed non-molluscan fauna after discard. However, at this stage both scenarios are considered unlikely for two reasons: firstly, small fragile bone fragments that would be most likely to be destroyed by taphonomic processes are regularly found, secondly; skeletal elements that are typically quite durable (such as otoliths and teeth) are rarely found.

The interpretation preferred here then is that available evidence indicates that the low proportions of non-molluscan fauna in excavated shell matrix sites at Albatross Bay is a cultural phenomena. There is no question that non-molluscan fauna were discarded on these sites, and that taphonomic processes contribute to a high degree of fragmentation of them. However, there are no grounded alternative explanations that adequately account for the very low proportions of these materials in these sites. Thus, it is suggested here that the production strategy associated with the formation of these sites was heavily oriented around exploitation of a restricted range of shellfish found on intertidal mudflats. Non-molluscan fauna appear to have been supplementary or incidental resource within this specialised production strategy. The proportions of non-molluscan fauna do appear to vary from site to site and it is highly likely that proximity to secondary resources was a factor influencing the location of shellfish discard events; however, access to and collection of a restricted range of mudflat shellfish species appear to be a primary factor in the activities associated with the formation of these sites.

9.3 Artefacts

Stone, shell or bone artefacts are poorly represented in the sites excavated across the Albatross Bay region. *Kwamter* had notably higher numbers of stone artefacts along with a number of stingray barbs, bone points and macropod jaws with incisors attached, all of which Bailey interpreted as tools based on ethnographic data. Our understanding of stone artefact technologies in the region are relatively detailed and even the largest artefact scatters recorded to date rarely have more than several hundred individual artefacts (Shiner and Morrison 2009). The low numbers of stone artefacts in excavated shell matrix sites is thus consistent with what is currently known about the regional archaeological record.

9.4 Shell mound stratigraphy

Stratigraphic layering is minimal within lower density shell midden and shell scatter deposits due to their small size, however many shell mound sites excavated in the region have quite distinctive layering. This is best described as consisting of layers of relatively clean shell with little to no sediment, alternated by sediment rich shell layers. The most common explanation of this stratigraphic pattern is that it relates to episodes of intensive shell deposition to create the ‘shell rich’ layers, followed by periods where discard ceased thus allowing sediment rich shell layers to form (Bailey *et al.* 1994; Beaton 1985). Here this process is further considered.

During field surveys undertaken as part of this project it was frequently noted that where moderate to dense vegetation occurred on or immediately adjacent to shell mounds, a thick layer of humic material tended to occur on the mound surface. This humic layer was most substantial in slight depressions on the surfaces of mounds or where the vegetation itself trapped humic material, preventing it from being blown away. Substantially less or no humic material was found in areas where vegetation was absent or sparse, or where the mound surface was too steep to allow it to accumulate. Physical, chemical and biological decay processes within the surface humus eventually break these materials down into sediment that is fine enough to move downwards into the loosely compacted upper layers of shell deposit. In section, it is evident that this process effectively forms an A-horizon that extends as much as 30 cm into the mound surface. This layer is likely to be more biologically active than adjacent areas with higher levels of bioturbation, greater numbers of roots and overall likely to result in a high degree of shell fragmentation and decomposition.

It is likely that the formation of these A-horizons within the surfaces of shell mounds is thus heavily dependent upon the nature and extent of surface vegetation, as well as the topography of the mound surface itself. In short, where humic material can not build up on a mound surface, this distinctive A-horizon is likely to be absent or insubstantial at best. This taphonomic variability – in combination with spatial and temporal variations in discard foci on mound surfaces - would result in the burial of some A-horizons where sediment accumulation had been previously occurring, as well as create new locations suitable for accumulation to occur. Human activity on mounds - for example, selective burning to remove grass cover, encouraging or protecting selected young trees or removal of others – would also have an impact on humic material build up. Hence, in a longer-term view variability in the build up of surface humus and variations in human activity would result in the formation of shell dominant layers with varying proportions of sediment.

As described in Chapters 7 and 8 such distinctive stratigraphic patterns are frequently absent from shell mounds < 0.5 m in height. These sites generally have more homogenous, sediment rich deposits – often with frequent ash – and with less internal differentiation. It is likely that this is because their low height means that they are exposed to higher proportions of humic material derived from the surrounding environment and that this deposition is ongoing or more frequent than is the case with higher mounds. For example, low mounds are more likely to have wind-born materials such as leaf litter from the surrounding environment deposited on them, are more easily colonised by grasses and light vegetation, and are also likely to be subjected to more frequent fires. In short, due to their low heights they are more prone to exposure to taphonomic processes occurring in the surrounding environment. Many larger mounds have homogenous basal layers with similar characteristics suggesting that as mound height increases, taphonomic processes unique to the mound itself – rather than that of the surrounding environment – have a stronger influence on its stratigraphy.

The sediment rich layers within larger mounds are considered here to be buried surfaces where active discard had sufficiently slowed or ceased to allow the formation of an active A-horizon where humic material has accumulated on the mound surface. Importantly, the observation that the extent of humic materials varies substantially on mound surfaces today suggests that these A-horizons may have only formed on portions of a mound surface. Discard may have continued elsewhere on the mound and also is likely to have contributed to the burial of A-horizons.

9.5 Discard patterns

Considering the nature of discard activities associated with formation of individual shell matrix sites is fundamental to resolving questions regarding production strategies associated with their formation. The following discussion draws upon archaeological data in order to reconstruct the nature of the individual discard events that cumulatively led to the formation of individual deposits, particularly larger shell mound deposits. It is proposed that the basic unit of shell mound formation was quite small in spatial extent and that discard was focussed upon a relatively discrete area. This argument is based on two key sets of data.

Important insights into processes of shell mound formation are available via consideration of small *A. granosa* dominant surface scatters. Seven groups of such sites were recorded at *Bweening*, each < 2 m in diameter and occurring as part of small groups of < 10 individual scatters (Figure 9-2) and most located a relatively short distance from more substantial shell mound deposits. One such shell scatter – SM:123 – was excavated and although low amounts of cultural material were recovered, composition data was similar to that of larger shell mound deposits. Observations of other similar discrete surface scatters also indicate a dominance of *A. granosa*. Beyond *Bweening*, few other examples of scatters such as these have been recorded, however this is considered to reflect two factors: taphonomic processes leading to the rapid destruction or burial of these deposits owing to their low density, and secondly; their poor visibility during field surveys.

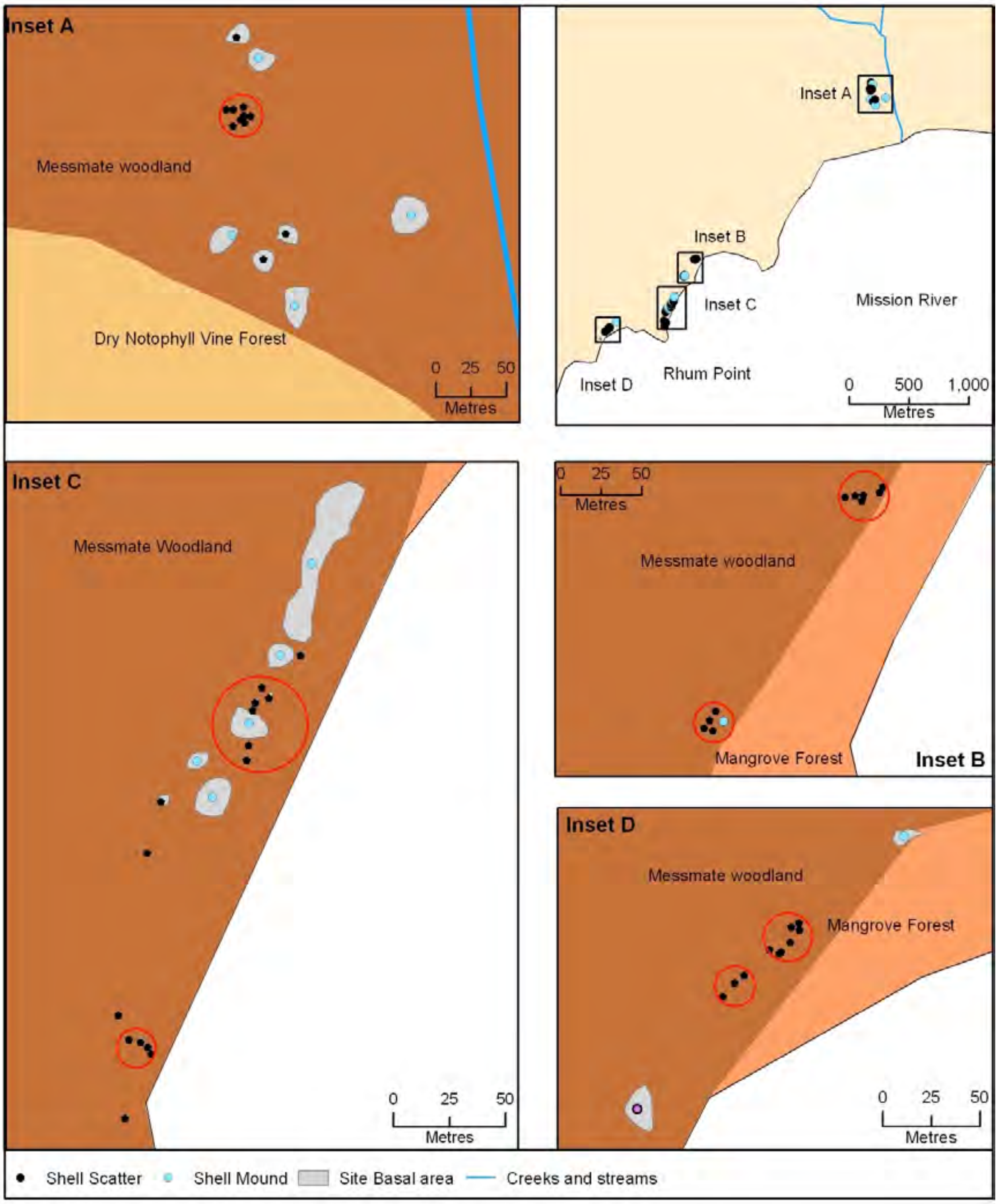

Figure 9-2: Shell scatters and incipient mounds, *Bweening*

It is proposed here that these concentrations of discrete shell scatters represent the very early stages of formation of small non-mounded middens and, eventually, small shell mound deposits: in short, they are incipient shell mounds. Not only are they compositionally similar as described above, but groups of these scatters have similar spatial distribution and orientation to adjacent mounds as shown in Insets A, C and D in Figure 9-2. These groups of scatters also tend to have similar basal dimensions to neighbouring mound deposits. In short, these scatters are considered here to reflect the smallest unit of archaeologically discernable discard activity that cumulatively lead to the formation of more substantive shell matrix deposits. This strongly suggests that the discard events associated with formation of larger deposits are likely to have been 1-2 m in diameter, but that multiple discard events took place within the same general area resulting in small numbers of these discrete scatters within relatively close proximity of each other.

Data on shell mound size also supports the argument that the discard events associated with shell mound formation were small in size. As outlined in Chapter 6, 477 shell matrix sites have been recorded in the region and data on basal areas are available for 440 of these. A total of 57 % of these sites have basal areas less 100 m^2 in area and with basal diameter of ~10 m. A further 25% have basal areas between 100.01 and 400 m^2 and likely to have basal diameters between 10 and 22 m. In short, almost 90% of shell matrix sites in the region for which basal data are available (the majority of which are shell mounds) have basal areas < 400 m^2. This strongly suggests that at the very least the basic unit of shell mound formation is focussed on an area less than 400 m^2 but more likely around 100 m^2. This is also consistent with the area that groups of discrete *A. granosa* shell scatters occupy.

In sum, the archaeological data discussed here suggests that shell mound formation is the result of multiple discard events each only a few metres in diameter. There is sufficiently strong evidence to suggest that such numerous individual discard events were focussed on small areas probably less than a few hundred metres in area.

9.6 Accumulation rates

Estimating the accumulation rates of individual mounds based on radiocarbon determinations provides an important insight into understanding patterns of mound formation and use. The method used here follows Stein and Deo (2003) who calculated accumulation rates for portions of deposit on mounds bracketed by upper and lower radiocarbon determinations. Calculating accumulation rates in this way can assist with understanding gross variations in intensity of discard across dating sequences on specific sites (where available) and also between different sites.

Since a minimum of two determinations are required on each site, accumulation rates can be calculated for only a relatively small subset of dated sites across the region. A number of available sequences have also been excluded here because of previously discussed complications with dating: these include determinations obtained by Stone (1995) on SM:393 (the *Kwamter* mound) as well as those obtained by Bailey *et al*. (Bailey *et al.* 1994) on SM:96 at *Prunung*. Instances where basal dates are considered to be potentially misleading have also been omitted, particularly cases where basal dates were obtained from the flanks of particularly large mounds where high degrees of intermixing are likely. However, despite these invalid cases, accumulation rates have been able to be calculated for 14 sequences across 13 sites: summary data on these are outlined in Table 9-5.

The lowest accumulation rates occur on SM:90 and SM:171 which are 2.9-5.9 cm/100 yrs; however, the next highest rates from five separate sites range between 20.08 and 25.6 cm/100 yrs. This is in fact much closer to the mean accumulation rate of 35.4 cm/100 yrs. Upper rates are as high as 59.2-61.4 cm/100 yrs for four sequences on three sites (SM:393 has two sequences).

For most sequences only two determinations are available (usually an upper and lower) and this is inadequate for exploring changes in accumulation rates over time. Three sites have sequences of three determinations and in these cases it is clear that lower portions of shell mounds have accumulated much more gradually than upper deposits. This is most dramatic on SM:217 at *Mandjunggar* where it has been argued that the lower rate of ~11 cm/100 years is due to deposition taking place across a broad basal area (Morrison 2005). As mound height grew, the surface area for on-site deposition decreased and accumulation rates increased to 58 cm/100 yrs. This pattern is also evident on SM:93 at *Prunung* and SM:393 at *Kwamter* where accumulation rates in the lower portion of deposit are 24.4 and 50.1 cm/100 yrs, respectively compared with rates of 95.2 and 85 cm/100 yrs, respectively on the upper deposits. Further insight into potential temporal variations in accumulation can be found by comparing overall accumulation rates on sites of different size. The seven smallest mounds in the sample range between 0.2 and 0.8 m in height and apart from one anomaly (SM:126) all have accumulation rates less than 26.5 cm/100 yrs. Conversely, the seven highest mounds are between 0.8 and 3 m in height and apart from a single anomaly (SM:171) have overall accumulation rates of between 37.2 and 61.4 cm/100 yrs.

Site (Height)	Samples Compared	Lab Code	Depth (cm BS)	Intercept mid-point (cal BP)*	Total Accum. (cm)	Duration of Accum.	Accum. Rate (cm/100yr)
SM393 (3 m)	U/L	I-1738*	“Base”	692	300	506	59.289
		I-1737*	“Surface”	186			
	U/L				260	423	61.466
	U/M	SUA-147*	35	591	115	134	85.821
	M/L	SUA-148*	150	725	145	289	50.173
		SUA-149*	295	1014	5		
SM90	U/L	Wk13788	25	469	15	511	2.935
(0.7 m)		Wk14506	40	980			
SM88	U/L	Wk14508^	21	206	44	166	26.506
(0.75 m)		Wk14509	65	372			
SM93	U/L	Wk11863	23	432	74	181	40.884
(1.8 m)	U/M	Wk11862	63	474	40	42	95.238
	M/L	Wk11861	97	613	34	139	24.460
SM126	U/L	Wk12157	2	475	17	28	60.714
(0.2 m)		Wk12156	19	503			
SM217	U/L	Wk16362	3.5	306	73.5	366	20.082
(0.8 m)	U/M	Wk16363	43.5	374	40	68	58.824
	M/L	Wk16364	77	672	33.5	298	11.242
SM96	U/L	ANU4410	“Surface”	360	195	400	48.750
(2 m)		ANU4409	“Base”	760			
SM193	U/L	ANU4413	“Surface”	705	50	209	23.923
(0.5 m)		ANU4415	“Base”	914			
SM186	U/L	ANU4417	“Surface”	85	60	279	21.505
(0.6 m)		ANU4418	“Base”	364			
SM166	M/L	ANU4424	“Middle”	209	150	247	60.729
(3 m)		ANU4423	“Base”	456			
SM171	M/L	ANU4426	“Middle”	320	75	1264	5.934
(1.5 m)		ANU4425	“Base”	1584			
SM161	U/L	ANU4428	“Surface”	1306	80	312	25.641
(0.8 m)		ANU4427	“Base”	1618			
SM159	U/L	ANU4431	“Surface”	1083	80	215	37.209
(0.8 m)		ANU4430	“Base”	1298			

Table 9-5: Accumulation rates for shell mound sites

Notes: Shaded rows are based on CRAs and not intercept mid-points as some samples were too recent for calibration. In column 3, U: Upper date; M:Middle date and; L: Lower date. ^ represents an AMS determination. * represents a determination on charcoal: all other determinations are on *A. granosa*. Details on radiocarbon determinations available in Appendix 1, 2 and 5.

In summary, current evidence indicates a tendency for smaller mounds to have slower accumulation rates and higher mounds to have more rapid accumulation rates. This is likely to be because accumulation rates are slower during the early stages of mound formation because there is a larger area for deposition. As mounds increase in height, vertical accumulation rates also increase as the area for discard is reduced. There are also anomalies that highlight the important point that not all shell mound deposits are likely to have had similar intensities of discard activity, particularly given the large number of sites that occur within the region.

9.7 Shell matrix groups

One of the key questions identified in Chapter 1 related to whether larger concentrations of shell matrix sites are contemporaneous or developed in succession. This question is crucial to considering the nature of discard activity and therefore production strategies associated with their formation.

Mound groups at three locations within the region have sufficient radiocarbon dates across large groups of sites to consider gross temporal patterns in the development of shell matrix groups within the past ~2,300 cal years. At all three locations, mounds are distributed between the edge of the bauxite laterite plateau and across fringing open coastal plains to the landward margins of mangrove forests (Figure 9-3, Figure 9-4 and Figure 9-5). At *Uningan* (Figure 9-3), the earliest deposits commenced forming on the landward margin of the coastal plain at ~900-1,000 cal BP with abandonment by ~700-750 cal BP. More recent deposits occur at the seaward margin of the coastal plain and appear to have accumulated within the past ~500 cal BP, with surface dates indicating use until as late as ~160 cal BP or even more recently if the CRA of 180±50 (ANU 4416) is reliable. At *Lueng*, (Figure 9-4), four basal dates on mounds on bauxite laterite substrates inland of the coastal plain suggest site formation began ca 1,618-1,298 cal BP. A single basal date of 424(456)494 cal BP was obtained on a large mound at the seaward margin of the ~300 m wide coastal plain. Finally, at ***Imbuorr*** on the eastern Hey River determinations on mounds on the inland margin of the coastal plain returned ages of ~1433-2335 cal BP (ANU 8774) while those at the seaward margin of the coastal plain were ~1,072-379 cal BP (Bailey *et al.* 1994). In summary, at all three locations, dates on mounds are progressively younger across the coastal plain indicating that mounds within these large groups developed in succession as coastal plains developed. However, identifying more subtle trends – such as whether some mounds developed contemporaneously – are difficult to assess with such gross data.

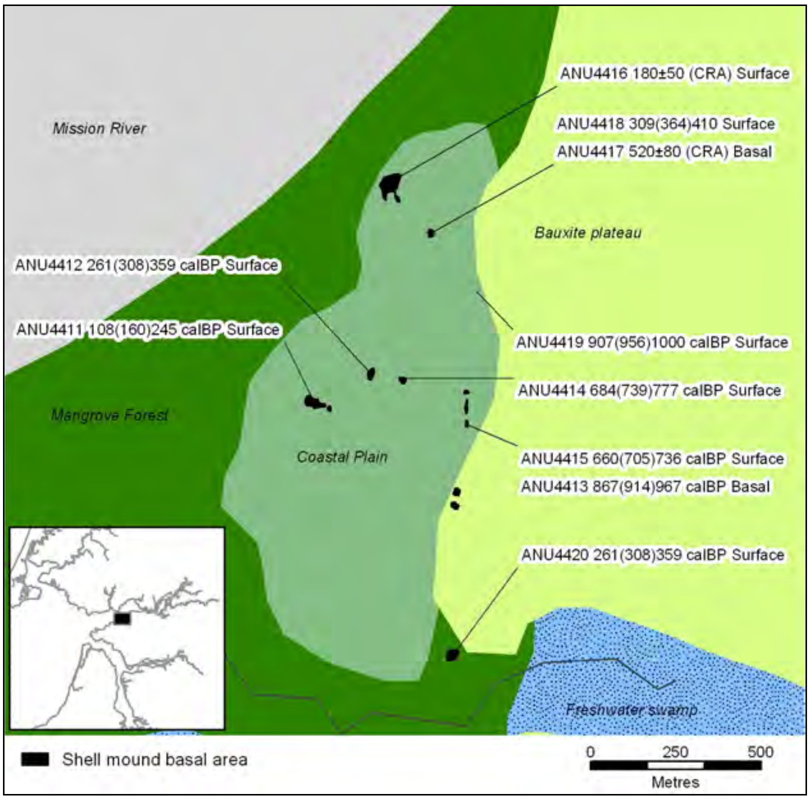

Figure 9-3: Radiocarbon data from *Uningan*, south Mission River

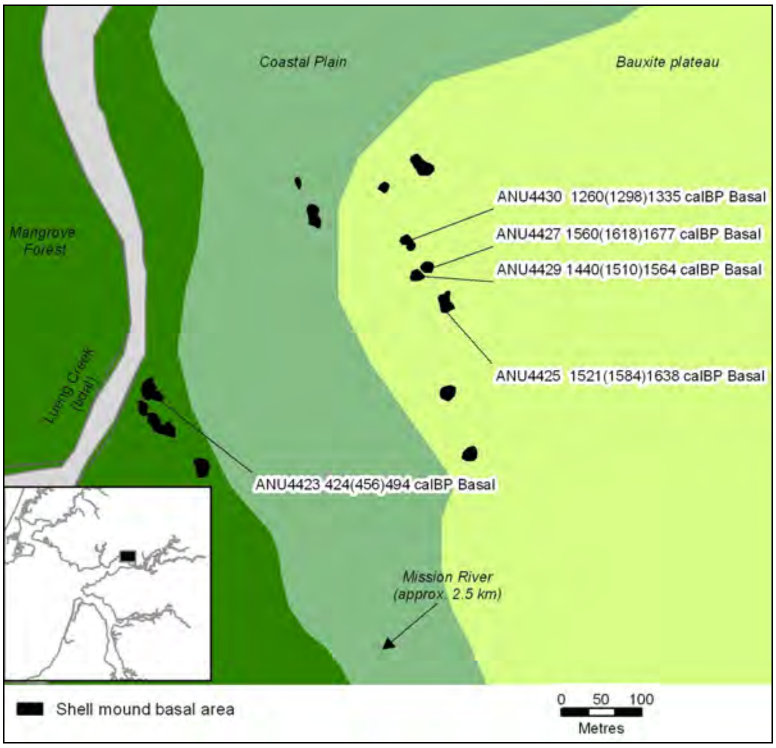

Figure 9-4:Radiocarbon data from *Lueng*, north Mission River

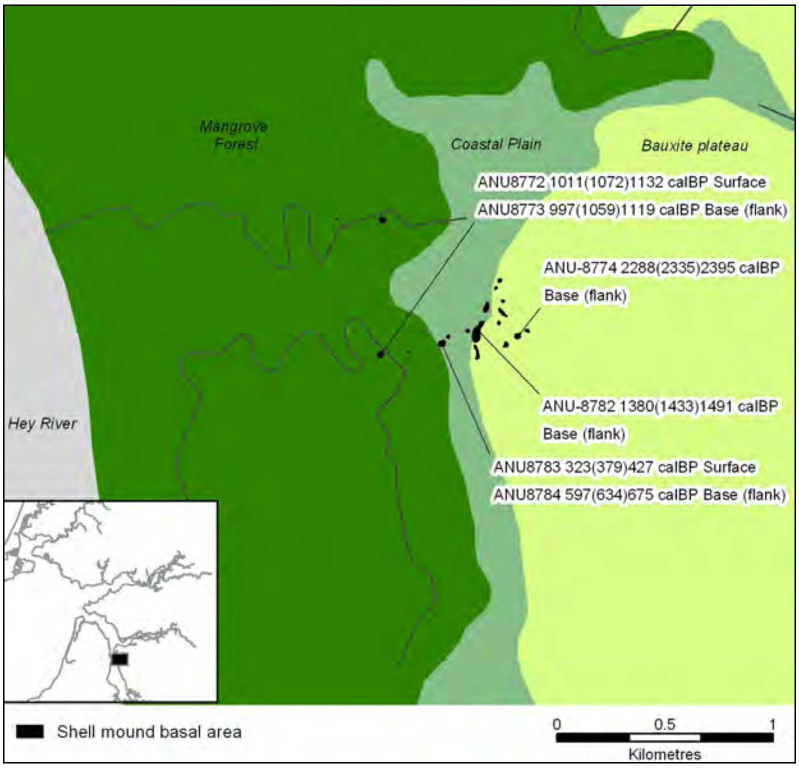

Figure 9-5: Radiocarbon data from *Imbuorr*, east Hey River

Work on more temporally confined sites at *Prunung* and *Bweening* add significantly to our understanding of temporal patterns in the formation of shell mound groups. At *Prunung*, determinations for the group of sites adjacent to the shoreline (SM:93, SM:96, SM:90, SM:92) indicate contemporaneous formation of mounds across a 500 m area for at least the past ~550-600 calendar years. Other isolated deposits some distance from the main group of sites also commence within this period. At *Bweening*, initial discard on shell matrix sites commenced around ~1,000-900 cal BP and appears to have become more intensive after around ~510 cal BP as a range of new deposits are formed both at Rhum Point and Rhum Point West. While there are indications of subtle shifts in discard focus over time, for the most part these sites are also archaeologically contemporaneous.

In summary, results of investigations at *Prunung* and *Bweening* point to archaeologically contemporaneous accumulation of shell matrix deposits at both locations during the past 500-600 yrs cal BP. Discard activity is focussed across multiple discrete deposits at both locales until at least 200 cal BP and possibly more recently. Within this period, new discrete deposits emerged at both locations however there is little indication that discard ceased on existing sites. However, there are subtle indications of longer-term changes in discard activity: at both areas, new discard foci emerge in locations that are some distance from existing groups of sites.

A range of short term behavioural scenarios may explain the formation of multiple archaeologically contemporaneous deposits within small specific localities. On the one hand, simultaneous discard events may have been occurring across a range of foci: in short, discard activities may have involved use of a number of mounds at any time. Alternatively, discard activity may have focussed on a single site, but that this focus regularly shifted between different shell matrix sites within the immediate area. Both scenarios would have the same archaeological signature over time – multiple, archaeologically contemporaneous deposits within specific areas. There is sufficient supporting evidence to suggest that both processes were at work thus intimating that these discard activities were dynamic and varied in scale.

At *Prunung*, discard was focussed in an elongated pattern oriented toward the shoreline at multiple locations across an area approximately 500 m long. At Rhum Point, the area over which shell matrix sites occur is even smaller with the bulk of sites occurring across an area only a few hundred metres long. At both locations, there are no obvious advantages that would come as a result of shifting discard from one site to others in the adjacent area. All sites are located within the same environmental context, offer the same advantages in terms of access to shorelines, aspect, view, prevailing wind and even vegetation cover. For this reason, it is considered unlikely that formation of these groups was the result of a shifting, singular focus of discard across different mound sites. Rather, it is likely that these deposits are the result of discard occurring on multiple sites simultaneously, thus in effect pointing toward a higher level of discard intensity.

However, shell mounds are not always found in groups and as outlined above there are numerous examples where relatively isolated sites occur. At *Prunung* and *Bweening* such outliers developed during the same period in which discard was continuing at the main mound group. Such examples point to discard events oriented toward a single foci, rather than across multiple foci as evidenced elsewhere. The implication of this is that they are associated with discard behaviour of a less intensive nature compared to that occurring at larger contemporaneous mound groups.

The available evidence thus suggests that the discard activities associated with shell mound formation varied in scale or intensity in different contexts. In some locations, the archaeology supports a model of simultaneous discard on multiple sites within specific focal areas. In other locations, discard was of a lower intensity and focussed upon a single site. It is feasible that there were temporal variations in the intensity or scale of discard: for example, it is possible that in some cases discard at larger mound groups may have been less intensive and focussed on a single site, while at other times in the same area, discard activity may have been more intensive and focused on a number of sites. This model is the most parsimonious explanation of the variability evident in the archaeological record and also is consistent with the likely episodic and fluctuating abundance of shellfish populations within any given area.

The very character of the physical landscape is also likely to have strongly influenced discard patterns. In some areas a more dispersed pattern of discard is evident, such as at *Prunung* where contemporary sites are distributed across a relatively large (500 m) area. However, in others discard has been focussed on fewer, larger sites concentrated within a small area. The strong tendency for more numerous small sites to occur on bauxite plateaus compared with fewer, larger sites on low-lying coastal plains is a good example of this.

The case studies at *Lueng*, *Uningan* and *Imbuorr* suggest that over longer periods of time the focus of discard changed, in these examples this is likely to be in response to their increasing distance from shorelines as a result of infilling and shoreline progradation. Small groups of mounds initially formed on the margin of the bauxite plateau but as the shoreline shifted multiple new mounds were created at locations closer to mudflat access points. However, other factors may have also led to such long-term shifts in discard focus, such as for example, changes in vegetation communities, or major shifts in the location of mudflats. The dating is relatively coarse in these examples so at this point it is unclear whether some of the sites further inland may have continued to be occasionally used after the focal area shifted. In any case, the Albatross Bay area provides a good opportunity for understanding longer-term processes such as these due to the large number of different examples available for investigation.

9.8 Broader patterns of landscape use

Although this chapter has focused exclusively on shell matrix sites, it is important to briefly consider the role of other types of sites in regional settlement patterns. As noted, few other classes of archaeological site are found in the region. Low concentrations of stone artefacts are typically found near to permanent or seasonal water courses with 81.1 % of stone artefacts on the Weipa Peninsula recorded to date being within 250 m of such areas. Concentrations of artefacts are typically found at nodal points along major waterways such as adjacent to larger permanent waterholes suggesting greater levels of activity in these areas. Few large stone artefact scatters have been found immediately adjacent to coastal areas or on coastal landforms, though isolated occurrences of small scatters are present in some areas (Shiner and Morrison 2009).

Although low in numbers, the presence of artefact scatters along waterways clearly indicates that coastal areas were not the sole focus of settlement in pre-contact times. The environments where many of these scatters occur have moderate to high resource potential at different times throughout the year. For example, small creeks often continue to flow for many months after the wet season ends, largely as a result of the discharge of water from underground aquifers while larger waterholes often hold water well after the end of the wet season. Both of these types of areas likely provided important and seasonally variable resource opportunities: freshwater fish and tortoises, vegetable foods derived from riverine ecosystems as well as birds, mammals and reptiles are all likely to have been important resources influencing settlement patterns in these areas.

While much more systematic investigation of artefact deposits along waterways is required in order to develop a robust model of associated settlement patterns or associated production strategies, some preliminary comments can be made. The most parsimonious explanation for these deposits is that local groups employed settlement patterns that incorporated these areas into a broader scheduling strategy. Over time, preferred areas – such as those with distinct resource benefits – attracted repeat visits while less preferable areas saw infrequent or episodic visitation and consequently low artefact discard rates. These watercourses are also likely to have been pivotal to use of the largely homogenous open woodlands on the adjacent bauxite plateaus. These creeks usually extend 2-3 km or more inland from the coast and thus may have enabled greater mobility through broader open woodland environments with relatively lower levels of productivity. Although bauxite plateaus provide some resources, particularly in terms of game, it is proposed here that effective exploitation of these environments would have required settlement patterns that were largely oriented around forays from the networks of waterways that incised them. In short, these networks of creeks, lagoons and other waterbodies likely provided resource-rich corridors enabling people to effectively access and exploit much larger areas than otherwise possible.

Earth mounds represent another important source of information on broader patterns of landscape use around Albatross Bay. These features occur on creeks at or near the transitional zone between freshwater and saltwater, often near open wetlands or swamps. They are associated with low densities of stone artefacts, shell scatters – most commonly comprised of *P. erosa* – and what appear to be low proportions of burnt termite mound. The environments in which these sites occur can be highly productive; for example, many earth mounds are located near areas that today attract seasonal migrations of birds such as magpie geese or where a very broad range of resources can be found. Estuarine portions of these creeks contain a variety of resources including shellfish, fish, crabs, rays and so on; while freshwater areas provided access to terrestrial game, birds and vegetable foods. In short, current limited evidence indicates that earth mounds are located in areas with a broad resource base, thus pointing to the possibly that they were also associated with more broad based production strategies than are argued to be associated with shell mounds.

The role of earth mounds in these contexts is unclear however they may result from several different types of activity. One possibility is that they represent occupation platforms: earth mounds recorded to date almost always occur on fine alluvial substrates that become muddy or waterlogged after heavy rain and where flooding is likely to occur at the height of the wet season. However, in most cases raised, flood free and well-drained bauxite plateaus can be found within a few hundred metres of major concentrations of earth mound sites so this explanation is far from flawless. Another possibility is that they are associated with food preparation activities: at Aurukun, Sutton (1994) notes that earth mounds were constructed and used as earth ovens, a scenario that may partially explain earth mound deposits near Albatross Bay. In any case, further systematic archaeological investigations are required in order to develop grounded models of earth mound function or use, as well as to clearly resolve the question as to whether they are of anthropogenic origin.

Overall, although the discussion here has focussed upon shell matrix sites – and particularly shell mounds – it is by no means suggested that settlement patterns in the region were exclusively or even predominantly oriented landscapes where these highly visible deposits are found. The archaeological evidence unequivocally demonstrates that Indigenous people in the region used a wide variety of environments away from coastal areas. Stone artefact scatters indicate settlement patterns focussed on water bodies well away from the coast. Earth mounds are suggestive of other important nodes in or near coastal landscapes that also attracted repeat use. Finally, the lack of sites or presence of very low density and variable shell scatters in coastal areas may not even necessarily indicate low intensity usage of these areas: more likely is that there is no straightforward relationship between the presence or size or archaeological deposits and levels of past occupation intensity. This is an important point, and significantly, has been previously been made by Bailey in terms of his arguments about the over-representation of shell in the region (Bailey 1983, 1994, 1999).

9.9 Summary

It is argued here that the archaeological evidence from Albatross Bay most strongly supports a scenario whereby shell mounds were associated with a relatively specialised yet flexible production system oriented around the episodic availability of these resources. These production events are unlikely to have been of long-duration, but rather, short yet intensive and probably employed anywhere from a few days to several weeks at a time. Although knowledge of broader patterns of landscape use are limited, it is likely that these specialised production strategies were one component of a broader economy that included a diverse range of other environmental niches and associated resource opportunities. It may have been the case that other resources or environmental niches were exploited in similar ways as mudflat shellfish resources, however much more research is required in order to adequately resolve this question.

Significantly, the archaeological data presented here is argued to indicate that the scale of these production events varied between two extremes. At times, small scale activities probably representing the activities of one or two family groups engaged in mudflat shellfish collection for a few days, focussing discard on one or two mounds. These may have been isolated mounds, or alternatively, selected mounds within larger groups. At other times, presumably at periods when the mudflat shellfish resource base was more substantial, numerous such groups engaged in these intensive activities. Discard during these larger scale events was more dispersed across multiple mound sites, largely depending on the numbers of individuals involved. During these events, regardless of scale, other resources – non-mudflat shellfish as well as fish, crabs, mammals and reptiles – were used however these are argued to have been a secondary focus during short-term events timed to coincide with the availability of mudflat shellfish. Thus, mounds are unlikely to represent productive activities at any particular scale; but rather, epitomise flexible, episodic and strategic use of a dynamic resource base.

Chapter 10: Discussion

This chapter sets out to address two key issues. First, while the archaeological model proposed above provides a significant insight into the production strategies associated with mound formation, the potential relevance of the ethnohistoric model outlined in Chapter 3 has yet to be explored. This model is drawn upon here in order to build upon the archaeological scenario outlined in Chapter 9 and to develop a more comprehensive model of the production strategies surrounding shell mound formation and use at Albatross Bay. The second purpose of this chapter is to explore the broader implications of this model in terms of explanations for the late Holocene appearance of shell mound sites, particularly in Cape York. Of particular importance is considering the ways in which shorter-term modelling of the production systems associated with shell mound formation at the local level can contribute to expanding our understanding of longer-term trends at a broader, regional level. The model proposed here is also considered in relation to recent explanations of late Holocene change in Cape York and also the mid- to late Holocene appearance of shell mounds across northern Australia.

10.1 Insights from ethnohistory

Before exploring the ethnohistoric data, it is important to briefly comment on recent criticisms of the use of ethnohistoric data to interpret shell mound sites from northern Australia. In a recent paper Hiscock and Faulkner (2006:213) argued that:

> The formation of shell mounds found in numerous parts of northern coastal Australia reflect an intricate relationship between Aboriginal foraging and the environment, and that neither the prehistoric economy nor its environmental setting survived until the historic period.

They go on to develop the argument that ethnohistoric data are entirely irrelevant to the interpretation of shell mound phenomena across northern Australia (Faulkner 2006; Hiscock 2008; Hiscock and Faulkner 2006). They suggest there is an 800-600 hiatus in radiocarbon years between the end of shell mound formation and *A. granosa* foraging across northern Australia, and the ethnohistoric present. They go so far as to identify Albatross Bay region as one area where this argument applies and this clearly has substantial implications for the interpretation of shell mound deposits here.

In short, this argument is based on an inaccurate reading of the published archaeological data and is also at odds with the data presented herein; as such, it is not relevant at Albatross Bay. In reviewing published sources Hiscock and Faulkner suggest (2006:213) that at Albatross Bay:

> almost all [mounds] were being formed only between 2,700 and 700 years ago. Slightly younger radiocarbon dates have been reported from surface samples at two mounds…but the best interpretation of those samples remains unclear and they may or may not indicate a recent phase of *Anadara* harvesting.

The key criticism of this argument proposed here relates to their use of radiocarbon determinations. Firstly, a review of previous published dates from Albatross Bay (Appendix 2) indicates that no less than 20 uncalibrated determinations from a range of mounds are < 800 BP, and eight are < 600 BP, thus falling within their so called ‘hiatus’. While in some cases individual dates may be problematic, it is nevertheless difficult to overlook the entire range of dates that are available for the region. Further, radiocarbon data obtained as part of this project (Appendix 5) reveals another seven sites with determinations < 800 BP. In short, their claim that mounds were not formed after 800 – 600 BP at Albatross Bay is incorrect.

A second concern relates to their comparison of uncalibrated determinations with calendar ages: they cite conventional radiocarbon ages yet fail to acknowledge the ~ 450 year discrepancy between these and calibrated determinations. This is a notable omission when comparing CRAs with calendar years: if calibrated, their 800-600 year date for the termination of *A. granosa* foraging would more likely be ~ 350-150 cal BP. Indeed, a post-400 cal BP timing for the termination of *A. granosa* foraging and mound building is entirely consistent with the arrival of Maccassans along the Arnhem Land coast and associated well documented socio-economic changes (Clarke 2000; Mitchell 1994, 1996) and the later arrival of Europeans. It is proposed here that this is a far less problematic reading of the archaeological data. The fact that Hiscock and Faulkner have failed to consider the issue of calibration strongly calls into question the conclusions they draw from the data.

While there are other criticisms that could be levelled against Hiscock and Faulkner's model, their problematic use of dating evidence sufficiently undermines its overall applicability at Albatross Bay. There is little question that calibrated determinations unequivocally demonstrate that shell mounds sites were continuing to be used until shortly before the arrival of invader-settlers in the region in the late 1800s. The discovery of historic flaked glass within one site at *Prunung* (SM:91) provides further support for this, and such materials have been located in shell mound sites elsewhere in northern Australia (Clune 2002). In addition, oral history research at Weipa indicates that *A. granosa* usage did not abruptly end after the arrival of Europeans; indeed, to the contrary it was an important resource collected in relatively intensive ways until at least the 1960s (Morrison 2003b) and the frequent occurrence of *A. granosa* surface scatters on historic sites in the region strongly supports this (Morrison 2003d). As such, the claim of widespread disappearance of suitable habitats for *A. granosa* across northern Australia within the past 800 years is questionable, and is not applicable at Albatross Bay.

Thus, there is no archaeological evidence for a hiatus in mound formation or *A. granosa* usage at Albatross Bay; indeed, the species is still locally available today. As such, the argument that “recent cultural, social and symbolic statements of these places cannot inform us of the process or ideology of the formation of Anadara mounds” (Hiscock and Faulkner 2006:220) that is based on the hiatus is also unfounded. There is no question of significant social and economic changes on western Cape York between the late 1800s and the present. As such, uncritical references to selective fragments of contemporary oral history testimony, historical sources or earlier ethnological and ethnographic accounts from Albatross Bay are potentially problematic. It is for this reason that Chapter 3 drew on extensive and rigorous anthropological data from the Wik region to the south of Albatross Bay to highlight key elements of Indigenous production systems during the late 1800s and early 1900s. In the following discussion this substantive data is drawn upon in a critical manner in order to refine and build upon the specialised production model proposed earlier. It is to this task that I now turn.

10.1.1 Scheduling

Seasonality studies on shellfish species recovered in shell matrix deposits (e.g. Claassen 1998; Coutts 1970; Deith 1983, 1985; Koike 1979; Milner 1999, 2001) may one day generate important data on scheduling and the varying role of mudflat shellfish resources throughout the year, though at this stage no such studies have been undertaken in northern Australia. However, references to other sources of data do provide some indirect insights into seasonality and these are reviewed here.

Ethnographic data from the Wik region indicates use of shellfish resources year round, but with a greater degree of importance during the height of the wet season. Sutton (1978: 46) provided a seasonal calendar of resource use (see Figure 3-1) which identifies December to April as a period during which shellfish and other estuarine resources were of moderate to high importance, arguing that restrictions on mobility imposed by extensive flooding at this time limited resource opportunities. Groups occupying coastal estates established permanent camps on sheltered coastal dunes during the height of the wet season and at this time shellfish and other estuarine resources were important because they could be more easily accessed. However, while these resources were of importance they were not used exclusively during this period, with Sutton noting that shellfish were used throughout the year. Importantly, the ethnographic data does not indicate what specific species were used or whether there may have been seasonal variations in target species. For the most part, the geographic areas that Sutton and von Sturmer both referred to are comprised of shorelines that are predominantly sandy with smaller sheltered estuaries and mudflats than occur further to the north at Albatross Bay. Thus, it is likely that ethnographic data relates to use of a different range of species than found in the archaeological record to the north.

Nevertheless, it is likely that shellfish - as a generic resource category - were used year-round in much the same way that other estuarine resources were. However, it is argued here that other factors may have structured the timing and intensity of specialised mudflat production: most notably, tides. Today at Albatross Bay mudflat shellfish species are collected in the most significant proportions during periods when tidal ranges are at their lowest during the mid-dry season (July-August). This is not to say that contemporary shell fishing strategies are the same as those used in pre-contact times, but rather, to highlight the possibility that seasonal variations in tidal ranges and access to intertidal mudflats may have influenced the timing and intensity of mudflat shellfish collection.

During the height of the wet season (January to March) the mean height of tides dramatically increase, flooding coastal plains and expanding intertidal creeks. Both high and low tides are greater than during the dry months and as a result intertidal mudflats and sandbanks are only marginally exposed, typically for short periods. Conversely, during the drier months low tides are consistently lower thus exposing much larger areas of intertidal mudflat for longer periods of time. High tides are also generally lower than during the wet season. In coastal Arnhem Land, Meehan (1982:69) noted a strong relationship between the drier months and large increases in the total weight of shellfish that could be collected, noting that shellfish weights dramatically peaked in October and November due to greater exposure of mudflats at this time. Meehan also noted the relationships between moon phases and shellfish collecting, suggesting that 67% of shellfish were collected during the new and full phases of the moon; this corresponds to spring tides when tidal ranges are at their greatest, with very high and low tides compared with the rest of the month.

In summary, this suggests that greatest access to intertidal mudflat shellfish would have coincided with spring tides during the dry season. This is not to suggest that mudflat shellfish were not used at all outside of these restricted periods of time, but rather, that access to largest abundances and sustained intensive exploitation most likely coincided with such periods. Lower intensity exploitation may have been quite feasible at other times, indeed such a pattern of varying intensity of production fits with the archaeological model outlined in the previous chapter. Further, for large periods of the year it is likely that shellfish were unimportant as people focussed on other types of resources in other sorts of environmental niches.

Thus, it is likely mudflat shellfish production activities were scheduled partly around tidal phases. In particular, larger and more intensive periods of production are argued to have been timed to coincide with periods when access to mudflats was greater. Smaller scale events are likely to have been less constrained by such factors, though nevertheless periods where tidal ranges were on the whole much lower are likely to have been preferred.

10.1.2 Mound function

There has evidently been a strong tendency or preference toward the discard of shell to form mounds within the Albatross Bay region. Developing a suitable explanation for this has been a central concern of previous researchers (Bailey 1977, 1999; Wright 1971) and equally, is argued here to be fundamental to understanding the production strategies associated with their formation and use. As such, the following discussion sets out to address this important question and in doing so draws upon both archaeological and ethnographic data.

The long-standing argument has been that mounds served as occupation platforms, an idea which has largely developed from Roth's (Roth 1900b, 1901) observation of the remains of huts and fires on mounds at Albatross Bay. In developing the self-selecting model, Bailey drew on work by Peterson (Peterson 1973), who had observed people living on earth mounds in the Northern Territory. There are few viable alternative scenarios to the idea that shell mounds were occupation platforms. One possibility that has not been explored in detail is that they were used as processing stations attracting a narrow range of discard activities. Shellfish processing stations have been documented in the Torres Strait (Bird and Bliege Bird 1997; Bird, Richardson, Veth and Barham 2002) where large shellfish were cooked before the flesh was removed for transport to other sites for consumption. This is considered an unlikely scenario for mound formation at Albatross Bay because the species in question are small and easily transported whereas those examples in the Torres Strait were processed because of the high weight of the shell compared with that of the extracted meat. While removal of the meat from the shell would moderately reduce the weight of a load of shellfish, this would also have the undesirable effect that the meat would likely spoil much faster in the hot tropical weather than if left in the shell. Thus, there is little clear incentive for processing in this way.

The idea that shell mounds were used as habitation or occupation platforms remains the most likely reason for their formation. As outlined in Chapter 1, Bailey viewed mounds as dry base camps used for a few months of the year for exploitation of locally available resources, particularly those concentrated around flooded coastal plains. While current archaeological evidence presented here suggests a more focussed production strategy than proposed by Bailey there are nevertheless elements of Bailey's self-selecting argument that remain compelling. The proposal that mounds of shell had characteristics that encouraged both repeated usage and ongoing concentrated discard is thus further explored here. Importantly, a notable point of difference from Bailey's model is that a range of factors are proposed to have influenced repeated use of mound deposits.

Bailey's principal argument for the formation of mounds was that they provided a dry, elevated living area above the height of wet season flooding (Bailey 1975a, 1977, 1999) and this remains a likely partial explanation for mounds in some contexts. It has been proposed above that production strategies surrounding shell mound formation are most likely to have taken place at different times throughout the year at varying levels of intensity; as such it is conceivable that flooding and the associated growth of dense vegetation on coastal plains during the wet season encouraged re-use of existing mounds. The tendency noted here and elsewhere (Bailey 1994) for mounds on coastal plains to be fewer in number but on the whole much larger than those on other substrates strongly supports this point. However, equally this does not provide sufficient explanation of mounds in other contexts, such those on elevated dune ridges or on laterite substrates (Bailey 1999; Morrison 2003b). Bailey (Bailey 1999:109) has also proposed that mounds afforded protection from mosquitoes and other insects due to their elevated position or location in more open areas. To some degree this claim is backed by ethnographic data on campsite selection from the Aurukun region (Chapter 3) and is considered here as an additional factor encouraging repeated use of existing mounds.

Cribb (1986, 1988, 1996b; Cribb *et al.* 1988) has proposed that human activities on shell mound sites near Aurukun contributed to the formation of vegetation communities with high proportions of economically useful species. These included edible fruits, firewood, wood for tools and medicinal products. It is not possible to apply Cribb's domiculture model to shell mounds at Albatross Bay in a strict sense because quantitative data on shell mound vegetation is lacking. However, Cribb's broader observation that vegetation communities on shell mounds were of potential economic importance is nevertheless considered a contributing factor to the repeated use of mounds.

In addition to resource opportunities, vegetation on mounds is likely to have been of importance by providing reliable shade from the hot tropical sun. Ethnographic evidence outlined in Chapter 3 highlights the importance of shade trees to people selecting both short-term activity areas and longer-term camping areas. This may also explain one reason for more numerous, smaller mounds on bauxite substrates compared with those on coastal plains. Coastal plains generally lack any shade-bearing vegetation and thus an existing mound with even small trees on its surface may have been more attractive compared with the surrounding substrate, whether it was flooded or not. Over longer periods of time these areas would have attracted more frequent use and subsequently grown larger thus supporting more substantial vegetation communities. Conversely, mounds in woodland are often partially shaded thus providing numerous options for short-medium duration occupation. This may have provided a greater degree of flexibility for people making decisions about preferred camp sites, in the long term contributing to formation of numerous smaller mounds.

Ethnographic data indicates that along with the presence of shade, preferred activity areas – particularly those used for camping – were those that provided a dry, clear and dust free living area (see Chapter 3). These sources suggest that sandy or shell-rich substrates (such as beach ridges) were often preferred over areas where dust could develop with short-term use by a few people. Mounds – even low incipient mounds ~10 cm in height – are argued here to have such attributes: they are well drained due to the porosity of the shell matrix, do not accumulate dust, sand or dirt, and are loosely compacted so even where dense grass occurs, this can be easily cleared away.

Further to this, it is significant that landscapes around Albatross Bay are on the whole very level with few natural rises; within such a context mounds may have provided opportunities for greater access to subtle breezes. Even a slight increase in exposure to light breezes may have been attractive, particularly during the hotter months when humidity peaks and access to any breeze is desirable. Logically, the taller the mound the greater the exposure to breezes and this in combination with the presence of shade trees may have provided an attractive occupation platform while engaged in mudflat shellfish collection, as well as providing a further reason to intentionally concentrate discard in order to actively encourage the upward growth of mounds. Despite their composition, shell mound surfaces are fairly flat and comfortable locations to sit. Even today during visits to Country Traditional Owners will often immediately choose a shell mound of any height to sit upon rather than on the adjacent ground surface.

Roth’s observation of the construction of huts on mound surfaces is also significant. While he provided little detail on the types of structures he observed on these sites, some ethnographically documented shelters involved digging posts into the substrate as a frame (e.g. Sutton 1994; Thomson 1939). Along with the other advantages a mound offers, the ability to be able to easily dig holes or to level or shape the ground surface to accommodate a structure may also have been of importance. If this is the case, then this may also provide some explanation for apparent dating anomalies in some sites.

Finally, access to large amounts of clean shell dominant substrates as a resource are suggested here as a further reason for the creation and re-use of mounds. In the Wik region, termite mound fragments were used as a heat retainer in earth mounds constructed for cooking, however large fragments of shell conglomerate obtained from beach ridge plains were also used for this purpose (Sutton 1994). As described in Chapter 3, heat retainer materials were placed in shallow depressions over which fires were lit. As the fire cooled, food – sometimes wrapped in bark/leaves – could be placed on the heat retainers before they were covered over with bark and leaves, and then soil or sand. It is proposed here that shell mounds were at times used in a similar way for the rapid cooking of bulk loads of shellfish.

Oral testimony from elderly Traditional Owners at Weipa points to three commonly employed methods of preparing bivalves for consumption. The first is likely a post-contact phenomenon – using a container to boil the shellfish over heat – and as such is largely irrelevant here. A second method, known as a ‘quick fire’ involves arranging a few dozen shellfish in rows, lips embedded in the sand with the hinge pointing up, before covering them over with dry grass and sticks. When lit, the fire quickly burns the fuel and thus cooking the shellfish, which are left to briefly cool, dusted off then eaten. A third practice referred to as a ‘shell oven’ was used to cook larger hauls of bivalves. These are similar to earth ovens: a small depression is dug into sandy substrates and a layer of clean, dead shells are placed in the bottom. A fire is built on this and additional clean, dead shells are placed directly into the fire to heat. Once the flames die down, several buckets of fresh shellfish can be tipped onto the hot heat retainer shells before being covered over by bark or large leaves, steaming the shellfish. Informants indicate that this method is a relatively quick way of cooking large amounts of shellfish. Significantly, Meehan (1982:97, 115) observed the use of a similar type of oven for quickly cooking larger amounts of shellfish in coastal Arnhem Land, and which were locally referred to as *manirra*.

In summary, a mono-causal explanation for the mounding phenomenon is unlikely to provide sufficient explanation for mound building activities. Instead, the scenario preferred here is that a range of features attracted people to re-use existing mounds as occupation platforms. In some cases, and as originally argued by Bailey (1977), they may have provided a dry camp above wet season flooding as well as refuge from insect pests. However, a range of other factors highlighted here suggest that mounds in any context may have been preferable camp sites: some offered shade and potentially resources; even quite low mounds enable greater access to light breezes; shell mound surfaces provide relatively clean and dust free living areas; and finally, mound surfaces may have been more conducive to constructing shelters and huts. However, given that mounds have been argued to be associated with intensive focus on mudflat shellfish resources, access to abundant loosely compacted dead shells may have been important for creating ‘shell ovens’ with which to quickly cook freshly collected shellfish.

10.1.3 Specialised production strategies

There are strong indications that what are termed here as ‘specialised production strategies’ were a core element of the economies of groups across western Cape York Peninsula. As outlined in Chapter 3, many of the resources used by Wik peoples varied annually in quality, abundance or in terms of ease with which they could be obtained. Broader production strategies were in many ways framed or mapped around these seasonal or episodic resource opportunities. Species targeted in this way were often available and used throughout the remainder of the year, however did not occur in the same abundance and thus, production strategies that involved species whose abundance varied were also dynamic, varying in scale and intensity. In many cases, specific named places or locales were often re-used for intensive, resource specific events. The ethnographic data presented in Chapter 3 also suggests that this was a particularly dominant feature of the economies of people living in coastal areas, where resource availability was more variable than in the more homogenous environments away from the coast.

Several examples help illustrate the character of this production strategy. Seasonal nesting events of magpie geese resulted in large resource biomasses concentrated at specific locations where both the birds and their eggs were intensively exploited for short durations. Specific camps were used for a period of a few weeks and substantial efforts focussed on targeting these resources. Fish runs, wallaby drives, large abundances of vegetable foods (such as *Eliocharis dulcis*) were targeted this way and drew on cooperative labour. Fish poisonings at small billabongs and lagoons are a

further example. As described in Chapter 3, these saw efforts focussed upon a restricted range of resources from specific niche environments, including freshwater tortoises and fish, but that were often collected in abundance. Taylor (1984) reported that fish poisoning events successively targeted individual billabongs according to their size and the rate at which they would dry out during the dry season.
Von Sturmer (1978) similarly noted that billabongs were often targeted for a few days by members of a number of different social units until the limited range of resources available at that location were exhausted. This food production strategy appeared to intentionally set out to generate abundances: small lagoons and billabongs could arguably have provided a longer-term supply of food for a smaller number of people. Instead, poisoning and cooperation of different groups was used to increase the amount of resources being produced over a shorter period of time.

It is proposed here that specialised mudflat shellfish production strategies documented in the archaeological record had strong similarities with the ethnographically documented specialised production strategies discussed above. It is likely that small scale, low intensity events took place at different times throughout the year, depending on local resource availability and broader economic schedules. However, when a number of preconditions were met, larger scale intensive exploitation events took place involving larger aggregations of people cooperatively involved in mudflat shellfish collection. Key preconditions proposed here include an abundance of mudflat shellfish resources at a particular locality and suitable access conditions. Local availability of other resources such as vegetable foods or other resources specific to mudflats and surrounding environments (such as crabs, fish or rays) – are also likely to have been factors influencing these events. However, it was the shellfish that were at times available within the specific niche of intertidal mudflats that were the primary factor influencing the timing, duration and scale of these events. Importantly, this strategy was an inherently flexible one, able to be scaled up or down as circumstances allowed or required.

10.1.4 The social dimensions of production

The ability to model social dynamics associated with mudflat shellfish production strategies described above is limited in the absence of direct ethnographic data on these strategies. As such, the aim here is simply to draw on ethnographic and archaeological data to highlight possible generic social dimensions of these events, particularly those that may have had a strong bearing on formation of the archaeological record.

Ethnographically documented specialised production strategies appear to have focused on environmental niches and their success was reliant upon cooperation of larger numbers of people beyond the immediate family group. The example of fish poisoning highlights that where such cooperative activity was involved, individuals from extended familial or social networks took part in short-duration social gatherings. The numbers of individuals and social units involved in fish poisonings varied depending upon the resource base, and indeed, more intensive production involved a larger degree of cooperative labour. Importantly, at other times only several family groups may have been involved and thus the scale of production was much lower.

It is feasible that intensive mudflat shellfish production activities involved more numerous people engaged in cooperative efforts gathering at locations where shellfish were abundant and accessible. As argued above, larger scale events are likely to have been timed to coincide with periods when access to this resource was less constrained by tides and when natural resource availability was at its highest. At these times, members of extended familial or other such social networks were required in order to enable larger amounts of the resource base to be collected. Importantly, it is not proposed that these events were consistent in scale, but rather, that the size of the associated social gathering varied along a cline between the individual family or economic unit at its smallest (< 10 people) and larger social gatherings. It is extremely difficult to propose a maximum size on such gatherings, however ethnographic accounts indicate that gatherings of several hundred people were extremely uncommon, and usually only occurred around major formal ceremonies held every two or three years. As such, for the most part the largest social gatherings argued here to be associated with intensive mudflat shellfish production are tentatively proposed to have involved less than 50 people.

Within the context of these sorts of social gatherings, social and political factors are likely to have influenced spatial patterns in discard activity. For example, social alliances, familial relationships, age-sets and gender-sets are all known to have influenced the structure of larger camps during the early contact period. Again, it is impossible to be specific however the key point here is simply that social dynamics are argued to have influenced activity patterns and consequently discard behaviour and that these dynamics cumulatively manifest in the archaeological record. Indeed, the influence of such dynamics is arguably the most likely explanation for the tendency toward often multiple spatially discrete contemporaneous mound deposits. Importantly, this argument does not carry with it any implication that these social dynamics were the same as those documented ethnographically, or that they remained unchanged over the ~2,300 year period in which shell mound formation occurred. Rather, the general point proposed here is that dynamics similar to these were present in the context of the production strategies surrounding shell mound formation, and that they thus helped structure the archaeological record. Far more detailed archaeological data from a wider range of shell mound deposits would be required to further expand this general argument.

As well as effectively increasing the scale of production, the involvement of larger numbers of people is also likely to have created opportunities for greater degrees of social interaction enabling, for example, the settling of disputes, trade or exchange, and the opportunity to undertake ceremonial or ritual activities. This is not taken to imply that shell mounds are associated with large-scale formal ceremonies; but rather, that at times larger scale social gatherings may have facilitated opportunities for greater degrees of social interaction, and that within this context ritual or ceremonial activities are likely to have been undertaken. The ethnographic evidence from western Cape York discussed in Chapter 3 strongly questions recent suggestions that ceremonial events were always large in scale or highly formalised events (Bourke 2000, 2005; Faulkner 2006; Hiscock and Faulkner 2006); rather, they varied in scale and in many respects were an integral part of daily life. There is little question that around the time of contact larger scale production activities generally involved varying degrees of ritual or ceremonial activity. As such, there is a distinct possibility that such activities were also associated with larger social gatherings that at times are argued to have been part of the social dynamics associated with shell mound formation.

10.2 The specialised production model

Archaeological data on shell matrix site formation at Albatross Bay essentially provide a continuous record of *A. granosa* usage from ~2,300 cal years BP though to the contact period. Our knowledge is now most detailed for the period between ~1,000 cal BP and 200 cal BP and at present, there is no evidence for a widespread hiatus in *A. granosa* consumption or shell mound formation after 800 BP as elsewhere asserted. A more likely scenario is that during the early contact period and by the early 1900s, Indigenous societies had begun to fundamentally change due to the sustained presence of invader-settlers and the establishment of missions in the local area. Throughout this period *A. granosa* and a range of other shellfish resources continued to have been used by Indigenous people, albeit in new or different ways. Numerous important research questions exist on the issue of post-contact cultural change, however these are not explored here (but see Morrison *et al.* In Press.).

Data presented here suggests that shell mounds and other shell matrix sites composed primarily of *A. granosa* (ie. incipient shell mounds) reflect relatively focussed activities oriented around exploitation of intertidal mudflats. Key species within this production system included *A. granosa* and *M. hiantina* and the evidence indicates that other molluscan fauna were typically collected in much smaller proportions. There are several instances of *S. cucullata* being present in significant proportions however these are found within deposits with substantial proportions of the former mudflat species and where the site in question occurred adjacent to natural rocky outcrops. This is more indicative of a tendency for the proportions of other shellfish species to vary within different environmental contexts, a tendency also observed around Darwin Harbour by Bourke (2000).

Non-molluscan resources are uncommon within all excavated shell mound deposits in the region, and it has been argued that these are likely to have been a supplementary or incidentally collected resource. As with non-mudflat shellfish species, there is evidence that proportions of non-molluscan resources varied within different environmental contexts. For example, SM:393 at *Kwamter* had a more frequent and varied range of non-molluscan fauna than at either *Prunung* or *Bweening*. Similarly, there are subtle variations between non-molluscan faunal proportions recovered from sites within different environmental contexts at *Prunung*. Together with the data on molluscan composition, this points to the conclusion that shell mound sites are the result of a production strategy focussed heavily on mudflat shellfish, particularly *A. granosa* and to a lesser extent, *M. hiantina*. Both species have similar characteristics in that they are prone to forming large biomasses when environmental conditions are optimal, but that local populations can be severely depleted by natural events. As such, they are a relatively dynamic resource and shellfish populations are likely to have varied in abundance on a year to year basis, and indeed at times may have been entirely absent in certain areas.

These production strategies saw short-term, episodic focus on a niche environment: intertidal mudflats. Other resources (both molluscan and non-molluscan) were incorporated within this production system on a supplementary or incidental basis during production activities timed to coincide with periods when these niche environments were both productive and accessible. When mudflat shellfish were not available or accessible, discard on mounds ceased. As argued elsewhere (Morrison 2003b) it is a reasonable expectation that had mound use continued in periods where molluscan resources were not used, a range of other resources – including other shellfish (e.g. more accessible mangrove species), mammals, birds and reptiles – are likely to have been incorporated into shell mound deposits. This is not the case and the low proportion of non-molluscan resources is considered here to provide most support for a model of short-term, episodic use of shell mounds at varying levels of intensity. Thus mounds are unlikely to represent increased levels of sedentism (c.f. Faulkner 2006) – even on a seasonal basis – and nor are they likely to be the result of a less focussed production strategy associated with use of a broad range of locally available resources.

Spatial and temporal patterns provide an important insight into the scale of production activities. The occurrence of small groups of closely-spaced and archaeologically contemporaneous mounds points to the possibility that discard sometimes occurred across multiple mounds simultaneously. Yet in other cases, more isolated deposits occur that equally suggest that at times intensity of discard was less intensive and constrained to a single discard foci. In short, the archaeology most strongly supports the argument that discard intensity varied in different locations and at different times. This is consistent with the biological characteristics of these species, which as discussed saw relatively dynamic shellfish populations that at times were very large, but at other times less substantial or absent from local environments.

While an inherently flexible production strategy, it is not suggested that mudflat shellfish were only used in a limited way. If nothing else the ethnographic data from the Wik region (Sutton 1978; von Sturmer 1978) and from coastal Arnhem Land

(Meehan 1982) suggests that shellfish were important on a year-round basis in much the same way that other estuarine resources were. However, the scale of production is argued to have varied throughout the year due to not only to natural changes in the abundance of mudflat shellfish resources, but also, as a result of differing levels of access to intertidal mudflats. Contemporary observations of tidal patterns suggest that the mid- to late dry season may have been when mudflats were most exposed, and exposed for longer durations. Whether past tidal patterns were similar to those today is unclear, however at this stage it is nevertheless proposed that in the past, annual tidal variations enabled greater degrees of access to the mudflats at different times throughout the year: large-scale exploitation of mudflat shellfish resources were scheduled to coincide with these periods.

The activities associated with formation of a single mound seem to have involved multiple, small (< 2 m diameter) discard events concentrated on areas less than 15-30 m in diameter. If the *A. granosa* shell scatters at *Bweening* are any indication of the scale of individual discard events, then it is likely that less than a few hundred shellfish are likely to have been part of any individual discard event. More intensive periods of mound use are likely to have involved more frequent and numerous discard events, whereas lower-intensity use could be reasonably expected to be associated with less numerous discrete discard events. Although the location of buried A-horizons provides a good indication of the location of some past mound surfaces and thus overall phases in mound development, taphonomic processes, the nature of discard events themselves and the loosely compacted shell matrix all contribute to obscure the identification of individual ‘shell dumps’ within stratigraphic sections. This is a point also made by Beaton (1985) in regards to shell mound deposits at Princess Charlotte Bay.

Direct, dated evidence regarding short-term spatial or temporal variation in discard intensity are not available due to the poorly stratified nature of the deposits themselves and the relatively coarse resolution of radiocarbon dating. Available, longer term data suggests these sites on average accumulated at around 35 cm per 100 yrs. There are also good indications that as small dome mound deposits increased in height, the total area for discard became more constrained resulting in increasing rates of vertical accumulation over time. However, accumulation rates are also likely to have varied substantially in different contexts as a direct result of varying intensity of discard though time.

There was evidently a strong cultural preference towards the discard of shell to form mounds over at least a ~2,300 year period at Albatross Bay and in keeping with suggestions of previous researchers, these sites are primarily viewed here as occupation platforms. There are a number of likely reasons for the construction of mounds and their use as occupation platforms. Above all, raised mounds provided numerous advantages over adjacent substrates as campsites: existing vegetation provided shade or resource opportunities, they provided greater exposure to breezes; their surfaces were level and easily cleared, drained quickly after rain and were also above the height of any possible flooding. In addition to this, it is suggested that the shell-rich matrix was itself a resource, used as a heat retainer in shell ovens to rapidly cook new hauls of fresh shellfish. Indeed, such a scenario may also account for intermixing and inverted radiocarbon determinations on some sites.

The argument proposed here then is that the scale of production of mudflat shellfish was dynamic and that the number of people engaged in these activities varied. At times production and discard involved larger numbers of people across numerous closely space mounds, while at other times it involved smaller groups of people producing smaller proportions of shellfish with discard focused on a single mound site. This suggests that previous assertions that shell mounds were consistently associated with 'large' groups of people (Morrison 2003b) is not entirely accurate. Rather, a more complicated and dynamic scenario is envisaged here, whereby the scale of production associated with mudflat exploitation was inherently flexible, at times involving small numbers of people while at other times involving larger groups of people. The episodic and variable nature of this production strategy also suggests that it was but one element of broader regional economies. Unfortunately, very little is presently known about these broader patterns of landscape use, however at the very least it is clear from present data that a diverse range of environments were used within the region, including both other coastal areas and inland creeks and water bodies.

At times, when the scale of production was at its highest, relatively large numbers of people drawn from extended familial and other social networks are argued to have been involved in cooperative exploitation of niche mudflat environments. While it is impossible to give specific numbers it is tentatively suggested here that at most 50 people may have been involved in the largest social gatherings around mudflat shellfish production, and probably generally less than this. These events relied upon on cooperative labour in order to generate larger resource abundances, thus supporting opportunities for greater degrees of social interaction. Ceremony and ritual are likely to have been undertaken within the context of these events, however it is not proposed here that mounds are ‘ceremonial’ edifices or used predominantly for these purposes (c.f. Bourke 2000; Bourke 2005).

During these events social and political factors are argued to have contributed to structuring the archaeological record, shaping discard patterns to the extent that discrete and archaeologically contemporaneous deposits formed. In some cases, such as where the area for discard was relatively limited by geography, these kinds of dynamics were more constrained with discard subsequently focused on fewer locations. Yet in others, such as at *Prunung* or *Bweening*, there were fewer geographic constraints resulting in a more dispersed pattern of discard. Outside of these larger scale events, shell mounds are argued to have been sporadically used by smaller groups - such as family units – during lower-intensity exploitation of mudflat shellfish resources. In short, the scale of these events varied along a cline between these two extremes, but both were fundamentally episodic and inherently flexible by nature.

Shell mound sites are not considered here to be passive economic residue, the stereotypical ‘kitchen midden’. Rather, it is proposed that these edifices in the landscape were actively constructed through intentionally focussed discard activity by multiple generations of people who were conscious of the advantages that came from artificial mounds. It is tempting to consider whether there were other social or symbolic dimensions to the act of mound construction; for example, the large height of many mounds is arguably beyond the requirement of a preferable camp site.

Indeed, in many respects climbing mounds over three or four metres in height could equally be viewed as a disadvantage for an occupation area if a purely functional perspective is taken.

Further, it is an intriguing possibility that social and political dynamics not only influenced spatial patterns in discard during larger-scale social gatherings, but that these also influenced and encouraged the development of larger mounds. For example, ethnographic data presented in Chapter 3 highlighted the way that power dynamics within social networks are known to have played out in the physical landscape in the ways that 'bosses' controlled particular focal sites, particularly those that were associated with nodes in the landscape where there were greater abundances of resources or opportunities for greater degrees of social interaction. Mound sites may have thus represented important nodal points in a broader landscape, at times providing a substantive resource base for short term but large social gatherings and thus opportunities for greater degrees of social interaction. As such, it is a possibility that along with advantages they offered as campsites, shell mound complexes were nodal points in a social and political landscape, and that the ongoing process of mound construction had social or symbolic importance within this context. Whether this is the case or not is unclear, however it is proposed here to be a compelling avenue for further research.

Importantly, the specialised production model proposed here is considered to apply primarily to patterns of shell mound formation over the past ~800 cal years. Radiocarbon chronologies prior to this period are very coarse and there remains an absence of detailed, controlled compositional data from earlier sites. As such, further data is required in order to explore whether the specialised production model proposed here provides sufficient explanation of earlier shell mound deposits. Elsewhere in northern Australia, there are well documented changes in patterns of shellfish use since the mid-Holocene (e.g. O'Connor 1999). While surface observations at Albatross Bay do not suggest any obvious longer term changes in mound composition, it is feasible that subtle changes may have occurred that are not obvious from external observations of these sites. For example, earlier deposits may indicate a less focussed production strategy with more substantive use of non-molluscan fauna, or a more diverse range of shellfish. As such, the specialised production model proposed here is argued to principally apply to the past ~1,000 years. However, it nevertheless has implications for broader understandings of longer-term models of the late Holocene in Cape York Peninsula and other parts of northern Australia. It is to this issue that I now turn.

10.3 Broader implications

A prominent question that has emerged from this research is whether the specialised production model proposed here is applicable to pre-1,000 cal BP deposits at Albatross Bay as well as those at Princess Charlotte Bay on eastern Cape York. In both cases deposits are sufficiently similar in composition to post-1,000 cal BP shell mounds at Albatross Bay for this model to be more broadly applicable, albeit in a tentative way. As such, the following discussion explores the broader implications of the model proposed for shell mounds around Albatross Bay.

There is very little direct evidence on the character of longer-term trends toward the development of these specialised production systems. At Princess Charlotte Bay, earlier rockshelter deposits indicate high proportions of *A. granosa* alongside low proportions of molluscan and non-molluscan fauna. These date to ~ 4,700 BP at Walaemini Rockshelter and ~ 3,400 BP at Alkaline Hill Rockshelter (Beaton 1985) and may signal the early beginnings of a similarly focussed production system. However, understanding longer-term trends is complicated by the likelihood of a +1 m sea level high stand during the period 2,700-3,000 cal BP (Lewis *et al.* 2008) which points to the possibly that pre-3,000 cal BP, open sites on low-lying substrates adjacent to the coast were destroyed. At Princess Charlotte Bay coastal cheniers had began forming at 4,000 BP (~3,550 cal BP) yet it was 2,000 radiocarbon years later before open sites appear. A similar scenario is envisaged at Albatross Bay with shell mound sites dating only to within the past ~2,300 cal BP. Thus, the most accurate estimate for the emergence of these production strategies at both Albatross Bay and Princess Charlotte Bay is that they emerged after 4,000 cal BP and by 2,000 cal BP, respectively but that refining this estimate is significantly complicated by the destruction of older sites.

Although the coastal archaeological record in Cape York is lacking in respect of longer-term trends, as outlined in Chapter 4, a suite of demographic, social, technological and economic changes have been documented in south east Cape York after 3,700 cal BP (David 2002; David and Lourandos 1997; Haberle and David 2004). Within this context, shell mounds have been proposed to represent a new kind of intensive economic strategy employed at this time. The evidence presented here supports such a general scenario, however it is also possible to build upon it in several ways. Shell mounds are argued to be an example of a production strategy that was specialised, inherently flexible and able to be scaled up or down as the circumstance allowed. It is thus suggested that this form of production was part of this broader suite of changes toward more intensive occupation patterns at this time and possibly indicative of the way Indigenous societies in the late Holocene engaged with landscapes more broadly. Other niche environments may have also been exploited in similarly episodic and at times intensive ways and areas such as freshwater swamps, small offshore islands or rich dune woodland environments are other possible examples where such strategies may have been employed.

Flexible strategies such as these are likely to have enabled more intensive exploitation of resources whose abundance and reliability varied or were episodically or seasonally available. Veitch (Veitch 1999b:60) compared the production strategies associated with shell mound formation in north western Australia with those employed in the context of seed grinding, proposing that a “shift in emphasis toward *A. granosa* on the coasts of northern Australia may have allowed larger populations in some areas, and habitation of other such as Princess Charlotte Bay for the first time”. It is possible to expand this argument here: as a resource, seeds are arguably more reliable and more likely to be locally available from year to year compared with shellfish resources whose abundance was not reliable nor consistent and further, were not always easily accessible. As such, in order for mudflat shellfish to be more intensively exploited, a flexible and episodic production strategy was required that maximised production of this dynamic and variable resource via social mechanisms oriented around cooperative labour. When unavailable, other resources and other environments are likely to have been used at different levels of intensity. In short, a new form of production may have emerged mid- to late Holocene population increases that enabled more intensive usage of not only marginal resources as conventionally defined, but resources whose abundance varied both seasonally and inter-annually.

An important element of such production systems is that they are necessarily grounded in both detailed knowledge of and familiarity with local environments, including seasonal or inter-annual opportunities and constraints. Without such intimate knowledge, local populations are less likely to have been able to as effectively exploit short-term resource opportunities available within a given area, or to adequately cope with short-term localised constraints. This may have been significant in the context of a demographic shift towards greater regionalisation and higher populations after ~3,700 cal BP (David 2002, Haberle and David 2004) and it is tentatively proposed here that increasing regionalisation may have been partly facilitated by greater degrees of knowledge about and familiarity with local resource opportunities and constraints. In short, a key factor underlying these trends may have been a more intimate knowledge of local environments.

Lourandos (1988) proposed that a key reason for intensifying production in south east Australia related to the competition between social and political groups to host large-scale social events involving hundreds of people. He suggested that a key incentive for intensification of production came via the social and political advantages that came to groups able to host these large-scale events; yet hosting these events was dependent upon the ability to produce sufficiently abundant resources to enable large aggregations of people to occur, thus creating what he termed a ‘self-amplifying dynamic’. The example of shell mounds suggests that in Cape York, intensive production events associated with cooperative labour may not have been restricted to very large social gatherings, but also operated at a much smaller scale than suggested by Lourandos. These strategies may have facilitated more frequent social gatherings, providing opportunities for trade and exchange, social interaction, the settling of disputes and ceremonial activities on a more regular basis and probably provided a range of associated social and political advantages to hosts. However, given the argument proposed above that these types of intensive production strategies were dependent upon detailed knowledge of local environmental constraints and possibilities, it is further suggested that regular, small scale gatherings may have also facilitated much more rapid information sharing than otherwise possible, including knowledge related to resource production.

Specialised production strategies associated with mound formation may represent one way in which late Holocene societies mediated greater short-term environmental and resource variability, particularly in terms of maximising the use of resource abundances available in niche environments for short periods. The ethnographic literature reviewed in Chapter 3 clearly demonstrates that resource possibilities were highly variable and dynamic, both in a spatial sense – in terms of resource distribution across different environments – but also in a temporal sense with seasonal and inter-annual variations in abundance or availability. Thus, the broader scenario proposed here has similarities to Lourandos’ ‘self amplifying dynamic’ model (1988). Increasing familiarity with and knowledge of local environments facilitated more nuanced, specialised production of variable resources within niche environments. Social networks were important in this context as they provided a mechanism through which these dynamic short-term resource abundances could be maximally exploited – through cooperative labour – and with attendant social advantages. This also had the advantage that it facilitated more frequent small scale social gatherings than would have otherwise been possible and also may have encouraged more rapid information sharing, including information that contributed to increasing familiarity with local environments. Thus, in a longer term perspective, it is possible that this may have led to increasingly nuanced and sophisticated production strategies such as those that are well documented in the ethnographic literature in western Cape York, and elsewhere.

It is also proposed that this model may provide further insights into shell mound deposits elsewhere in northern Australia. Dates for the earliest appearance of shell mounds across north Australia decrease in a west-east gradient with the earliest mounds sites at around 4,200 BP in north western Australia and the youngest occurring at Princess Charlotte Bay and Albatross Bay on Cape York (O'Connor 1999). In most cases, these share strong similarities in terms of composition, form and stratigraphy. While more detailed work will be required to properly assess whether this model is applicable elsewhere, some preliminary comments can be made here.

The polarised nature of the debate between ‘cultural’ and ‘environmental’ explanations for the onset of shell mound formation or economic, social and demographic changes in the late Holocene (Bourke *et al.* 2007; O'Connor 1999; Veitch 1999b) is in many ways considered to be redundant here. There is little question that the appearance of shell mounds is tied to the appearance of the associated resource base in local environments. Similarly, where substantive changes in these local environments occur – such as those associated with the 'big swamp' phase – it can be reasonably expected that these changes will be mirrored in the archaeological record. The emergence of shell mounds principally after 4,000 cal BP in northern Australia is likely tied to the emergence of suitable environments for this resource base. However, simply noting correlations between environmental and archaeological signatures provides little insight into the shorter-term cultural responses to these environmental changes. Both issues are important, however in isolation neither provides a sufficient explanation of past human-environment interactions. It is contended here that in order to address key questions about the reason for the emergence of these sites, more detailed investigations into how people engaged with environments within a short-term, local context are required. A reliance upon longer-term studies arguably glosses over many of the important details likely only observable by approaches focussing on understanding shorter-term phenomena.

Faulkner has recently suggested that *A. granosa* was a fallback food used relatively intensively, providing a more reliable and less seasonally variable resource base enabling greater levels of sedentism (2006:287). This interpretation is considered unlikely to be applicable at Albatross Bay; rather than being a fallback, marginal food, I argue *A. granosa* exploitation was part of a specialised yet flexible production system focussed on a niche environment and represents a cultural response to a seasonally variable mudflat shellfish resource base. Indeed, the arguments developed here are more in line with those proposed by Bourke (Bourke 2000, 2005) for Darwin Harbour, who suggested that mounds were the result of relatively focussed production and were associated with episodic aggregations of people, often around formal ceremonies. The key point of difference here is that mounds are proposed to be associated with social gatherings and cooperative labour at different scales of intensity, depending upon the resource base and access issues. It is likely that ceremonial activities were undertaken in some contexts, however this is in itself is not considered the primary reason for their formation. Mudflat shellfish were a marginal resource whose abundance varied and at times – through cooperative labour – larger abundances of this resource could be produced supporting larger scale social gatherings. Indeed, it has been argued here that the social importance of such gatherings were an important factor behind the development of these production strategies. However, regardless of the scale of production involved, shell deposits were important as a heat retainer and provided a broad range of advantages as camp sites in the short term.

Chapter 11: Conclusion

This thesis set out to improve our understanding of late-Holocene societies of the Albatross Bay region through targeted investigations of one of the most prominent classes of archaeological deposits found there: shell mounds and other shell matrix sites. Of particular concern was the goal of exploring the types of production strategies associated with the formation and use of shell mound deposits. Production was defined broadly to not only include past subsistence or diet, but also the contingent social and cultural factors influencing past food collection, preparation, consumption and discard activities. Further, it was argued that in order to adequately explore the archaeology of production thus defined, short-term decadal scale modelling was required in preference to a focus on longer-term (century-scale) trajectories. To this end, the bulk of the thesis was preoccupied with systematically reviewing archaeological, environmental, ethnographic and other data that could inform a short-term model of the production strategies associated with shell mound formation at Albatross Bay.

It was also contended that short-term modelling of the production strategies associated with shell mound formation might have implications for our understanding of mid- to late Holocene archaeological trends beyond the immediate study area. Thus, a secondary aim of this thesis was to explore the implications of models developed for the Albatross Bay for questions about the appearance of shell mounds more broadly in northern Australia in the late Holocene. It was proposed that this issue was best addressed within the constraints of this thesis by drawing upon

Cape York Peninsula as a case study owing to the depth of previous research in the area.

Chapter 2 introduced the reader to the contemporary environments of the study area, as well as reviewing current palaeoenvironmental evidence of relevance to the present research. In doing this, two key points were noted to have specific relevance to understanding late Holocene occupation at Albatross Bay. Firstly, there is strong evidence that seas reached their maximum levels at ~7,000 cal BP with low amplitude oscillations of up to ~1 m above current sea levels at two key periods: 4,800 to 4,500 cal BP and 3,000 to 2,700 cal BP. The limited extent of coastal geomorphological work at Albatross Bay means that there are no data available that may directly yield light on the extent of these oscillations in this region.

Secondly, current evidence strongly indicates that the mid-Holocene was a period of peak environmental productivity associated with the HCO. However, a major feature of post-HCO environments after around 4,000 BP is increased environmental variability as a result of stronger ENSO activity, with the highest degree of variability evident after 3,000 BP. Evidence from a range of pollen sites suggest this manifested in overall drier conditions, resulting in an expansion of sclerophyll woodland and an intensified fire regime, though it has been suggested that this also resulted in more seasonal precipitation patterns (Stephens and Head 1995). Although some have argued for marked periods of enhanced aridity in northern Australia, particularly during the LIA at around 600-100 BP (Bourke *et al.* 2007), it is argued here that this claim is an inaccurate interpretation of extant palaeoenvironmental literature, with current evidence indicating this event was most likely a northern-hemispheric phenomenon only. Although there is evidence for an enhanced fire regime in a number of pollen sites across north eastern Australia during the past ~1,000 cal years BP, these have all been interpreted to be a direct result of increased frequency of anthropogenic fires (Luly *et al.* 2006; Prebble *et al.* 2005; Rowe 2007).

Chapter 3 developed a detailed model of production strategies employed during the ethnographic present (1880s-1940s). Anthropological sources from the Wik region, near Aurukun were used as the basis for constructing this model in preference to historical or early ethnographic observations from the Albatross Bay region itself because the former data was obtained during long-term anthropological fieldwork and thus considered to be more methodologically sound. Key issues explored in this chapter included resource use and scheduling, demography and social organisation, material culture and the social dimensions of production.

Chapter 4 reviewed previous archaeological research in Cape York and the Torres Strait, particularly that with some relevance to understanding mid- to late Holocene occupation trends in Cape York. After the mid-Holocene a suite of archaeological changes can be observed including increasingly regionalised settlement patterns, new artefact technologies, evidence for increasingly intensive settlement patterns and use of new resources; these have variously been interpreted by others as reflecting a series of cultural transformations between about 2,700 and 2,000 years ago (Haberle and David 2004). Within this context, a seemingly parallel suite of changes occur in the Torres Strait Islands, with initial permanent occupation of more southerly islands from ~3,800 cal BP that has been argued to be associated with the same demographic expansion documented in south eastern Cape York (Crouch *et al.* 2007; David *et al.*

2004; McNiven *et al.* 2006). This strongly suggests that this expansion occurred throughout Cape York and was unlikely an exclusively local phenomena. Post ~2,600 cal BP, archaeological changes documented in many parts of the Torres Strait have been argued to be associated with settlement by Papuan peoples rather than from the Australian mainland (McNiven *et al.* 2006).

The explanation preferred here for the suite of changes that occurred after the mid-Holocene is that advocated by Haberle and David (2004). In summary, they suggested a broad spectrum revolution involving economic, social and symbolic innovations that enabled larger population levels to be sustained after the end of the HCO and the onset of increased environmental variability after about 3,700 years ago. However, a key limitation in this argument was identified: that the characteristics of what are presumably new forms of production associated with this period are relatively poorly documented, particularly in coastal areas. Given that shell mounds are one type of site frequently used in support of these arguments, it was suggested that work on shell mounds at Albatross Bay is particularly pertinent to helping to further expand our understanding of late Holocene economic and social changes in Cape York.

Chapters 5, 6, 7 and 8 reported the methods and results of field survey, excavation, and analyses carried out at Albatross Bay as part of this thesis. Overall, the field data presented here substantially expands our knowledge of shell matrix sites in the region. Chapter 9 presented a detailed synthesis of this data and identified a number of key points. Key among these was that composition of shell mounds excavated as part of this project are predominantly mudflat shellfish species, notably *A. granosa* and *M. hiantina*. Both species are prone to seasonal and inter-annual variation in the locations of shellfish beds and also in terms of their abundance. In short, both species would have represented highly dynamic resources: they are able to quickly occupy niche environments, rapidly forming large biomasses within preferred conditions. However, they are equally prone to sudden local population losses as a result of environmental perturbations such as large storms, sudden temperature changes or changes in salinity levels. Hence, on a year to year basis these resources are likely to have been variable and dynamic; the implication of this is that associated production strategies are also argued to have been equally variable.

Non-molluscan fauna are poorly represented in shell mound sites excavated as part of this project, a tendency that is not explained by sampling or taphonomic biases. Thus, at this stage the most likely explanation is that low non-molluscan faunal representation is primarily a cultural phenomena and that few such materials were discarded on mounds. This, in combination with the clear dominance of mudflat shellfish species in mound sites, is taken here to indicate that non-molluscan fauna were a resource of secondary importance within a specialised production strategy focussing on mudflat shellfish. This is not to say they were unimportant, but that they were a secondary focus in a strategy specifically targeting mudflat shellfish.

The occurrence of numerous small *A. granosa* dominant shell scatters within the context of larger shell mound sites is argued to provide important insights into the discard activities associated with these production strategies. The occurrence of these scatters indicates that mounds are likely to be the cumulative result of multiple discrete discard events, each only a few metres in diameter. Numerous such discard events probably took place within particular localities depending upon the characteristics of the local environment (eg presence of ridges or the orientation of prominent landscape features such as shorelines) and the presence of pre-existing deposits. Chronological data indicates that the mean accumulation rates on mounds is highly variable with an average of ~35 cm/100 yrs though as high as ~69-62 cm/100 years on some sites. Although the data is relatively coarse due to low numbers of determinations on individual mounds, there is good evidence that mound accumulation rates increased as mounds grew in height and the overall area for discard became more constrained.

Chronological data on mound group formation also provides important insights into associated production strategies. Work at *Prunung* and *Bweening* provide strong evidence for archaeologically contemporaneous discard across a number of individual mound sites over a 600-500 year period. While radiocarbon data is too coarse to understand more subtle trends in patterns of mound accumulation and abandonment, it nevertheless indicates that at times groups of mounds within particular locales are likely to have been used contemporaneously. At a decadal scale, discard activities are likely to have been focussed across a number of individual foci within particular locales.

Over longer periods of time those locales that were the focus of repeated discard activities also shifted, most likely in response to changing character of landscapes. This is best illustrated at *Uningan*, *Lueng* and *Idholga* where it is clear that over centuries or millennia, the focus of discard shifted in response to Holocene infilling. On these substrates there is a tendency for mound sites to increase in age with distance from the present shorelines, with the earliest deposits occurring at the landward margin of coastal plains. This scenario is only appropriate in cases where mounds are distributed across coastal plains of Holocene age, and may not neatly apply in cases where large mound groups occur in areas where shorelines were more stable. At present, mound groups in such areas lack sufficient numbers of dated sites to understand longer-term chronological patterns. Thus, in summary, current chronological data indicates that on a decadal time scale mound formation activities were focussed on multiple foci or mound sites within specific locales (i.e. within small groups of mounds) but over centuries or millennia, these locales shifted resulting in the formation of much larger groups of mounds over periods of centuries and in some cases, millennia.

Chapter 9 concluded with the development of a model based exclusively upon archaeological data rather than through reliance upon ethnographic data available for the region. Such an approach is considered important, partly due to recent criticisms of the reliance upon ethnographic data in the interpretation of shell mound sites (Faulkner 2006; Hiscock 2008; Hiscock and Faulkner 2006; O'Connor 1999). The archaeological evidence indicates that the production strategies associated with shell mound formation and use were characterised by focussed, episodic exploitation of mudflat shellfish resources at varying levels of intensity. A clinal scenario is argued to provide the most versatile explanation for this: at one extreme, at times when large abundances of mudflat shellfish were locally available, larger aggregations of people are proposed to have been engaged in short-duration intensive mudflat shellfish exploitation. At the other extreme, when mudflat shellfish resources were less abundant, the evidence is indicative of low-intensity exploitation by smaller numbers of people. The evidence also indicates that only a limited range and quantity of other resources were used at these times and thus suggests these were of supplementary importance within an overall specialised strategy focussed upon production of mudflat shellfish resources.

Little is known at present about the specific character of broader patterns of landscape use around Albatross Bay. However, the limited quantities of faunal materials found in shell mound deposits, the high variability in mudflat shellfish availability and the likely necessarily short-duration over which such a specialised and focussed strategy could be employed collectively indicate that even large groups of shell mounds are unlikely to have been semi-permanent residential bases as has been argued previously (Bailey 1977). Further, the presence of other sorts of sites across the landscape clearly demonstrates that people made use of a very wide range of environments, including inland creeks and water bodies, as well as other coastal locales. Thus, the most parsimonious explanation of the role of specialised mudflat shellfish production strategies within the broader economy is that they represented one element of a dynamic and sophisticated economic system encompassing a much broader range of environments and resources. The archaeological manifestation of production strategies oriented around mudflat shellfish are simply much more visible compared to others that are likely to have been employed in the region.

Chapter 10 sought further insights into the character of the mudflat shellfish productions strategies by drawing upon the ethnographic data presented in Chapter 3. This data contributes significantly to refining our understanding of one of the most fundamental questions relating to shell mounds: why mounds? The most likely scenario is that a range of benefits came from using mounds as camp sites, regardless of the specific environment in which particular sites are found. In some cases they probably provided flood free occupation areas as suggested by Bailey (1977), but in addition to this they likely offered a range of other attractive attributes, including shade, a clear and dust free occupation area, greater access to breezes and the loose shell may have also been well suited to the construction of huts or shelters. In addition, it is proposed that the very matrix of the mounds themselves was of importance, in that it provided an abundant source of clean, dead shell that could be used to construct expedient 'shell ovens' to quickly steam large hauls of freshly collected shellfish.

The ethnographic data also provides insights into the social dynamics potentially associated with shell mound formation. There is unequivocal evidence that in the early contact period people employed flexible and specialised production strategies oriented around niche environments that offered seasonally variable resource opportunities. It is argued here that there may have been similarities between these and the specialised mudflat shellfish production strategies associated with shell mound formation. In particular, the variation in scale of these specialised events is consistent with the archaeological scenario proposed in Chapter 9. Based on the ethnographic data, it is tentatively proposed that at their largest scale up to 50 people may have been cooperatively involved in specialised mudflat shellfish production but that at other times, when resources were less abundant, lower intensity exploitation took place by much smaller groups of people. In both cases, it is argued that these events were fundamentally dynamic in character: they were episodic, flexible in scale and most likely of short duration reflecting constraints on access and resource abundance or availability. Although further systematic work is required on the question of timing and seasonality of these events, it is suggested that annual tidal phases along with shellfish abundance were both likely to have been important factors influencing the timing of larger scale mudflat shellfish production events.

In addition, it is also proposed that short-term social dynamics such as familial relationships, age, gender or other cultural protocols, political alliances and so on may have had a structuring spatial influence during events held at particular locations. The specific character of these dynamics is well beyond the reach of archaeological data, however it seems clear from the ethnographic data that in the early contact period these sorts of factors had a strong influence on small-scale spatial variation in camp site selection or choice of activity areas within particular locales. The key point proposed here therefore is that the formation of multiple, closely spaced and archaeologically contemporaneous deposits within particular locales is indicative of these types of dynamics being in operation over longer periods of time.

It is arguably the case that at times, cooperative events of this nature were an important means through which large surpluses could be generated. One incentive for this may have been that the ability to host such gatherings had attendant social advantages. Social gatherings enabled greater degrees of social interaction such as arrangement of marriages, formation or maintenance of social alliances, exchange, performance of small scale ritual or ceremonial activities, or opportunities to maintain familial or other such relationships. The ethnographic data indicates that places enabling these kinds of events also had correspondingly greater symbolic, social and political importance within broader cultural landscapes. One important but challenging area for future research is to attempt to identify archaeological evidence for whether certain groups of mounds had higher levels of symbolic, social or political importance, particularly in the case of the larger, almost monumental mounds that occur in some areas. It is intriguing to note recent observations in the Pilbara region in Western Australia that there are both greater numbers and a greater diversity of style in rock engravings located near larger concentrations of shell matrix sites (McDonald and Veth 2009).

This model represents a significant shift from earlier interpretations of shell mound deposits as semi-permanent residential base camps used during broad-based exploitation of surrounding environments (Bailey 1977, 1999). Such a model is not supported by current evidence which indicates that mounds had a short-term and specialised role within a broader but – at this stage – poorly understood economic system. Particular mound groups likely formed out of episodic activities that varied substantially in scale. This scenario is also somewhat different to the more recent proposal that mounds were typically associated with very large gatherings of people (Morrison 2003b); this is unlikely to be the case and instead it is more likely that while large gatherings did occur, much smaller scale events are also likely to have taken place.

The specialised production model proposed to explain shell mounds at Albatross Bay also provides insights into the emergence of shell mounds at other locations on Cape York. The proposal by earlier researchers that these sites represent new, more intensive economic systems (David 2002; David and Lourandos 1997; Lourandos

1997; McNiven *et al.* 2006) is supported and extended upon here. A key attribute of these systems may have been that they allowed not only use of marginal resources, but, more importantly, may have effectively maximised production of niche resources whose abundance was significantly variable at the local level and in a short term context (ie seasonally or inter-annually). Social mechanisms including cooperative labour are argued here to have enabled more intensive exploitation of these types of resources, however as well as this these strategies were premised on a high degree of knowledge of local environmental constraints and opportunities. Thus, more frequent small scale social gatherings associated with these kinds of specialised production strategies may have also created opportunities for more rapid sharing of information about local resource constraints and opportunities, encouraging more rapid dissemination of particularly innovative or effective strategies. Of course, much more work is needed to understand the characteristics of the production strategies employed in a range of different environments before this model could be more broadly applied, though it is raised here as a key question for further research in the Cape York region, and beyond.

11.1 Further research

Shell mound sites are a relatively unique type of site providing detailed, dateable evidence about the nature of production strategies in the late Holocene in northern Australia. They are particularly important at Albatross Bay owing to a general paucity of other types of dateable archaeological deposits in the region. Significantly, there are numerous avenues for further research both in the Albatross Bay region and beyond that have not been addressed here.

Developing models of broader patterns of landscape use within the mid- to late Holocene period in the region is pivotal both in terms of understanding and assessing the overall significance of mudflat shellfish production strategies, and also in terms of understanding late Holocene economies more broadly. Although the research potential on many of the open surface lithic assemblages of Albatross Bay is somewhat limited owing to a lack of chronological control, this is not to say that research on these assemblages is without merit. Indeed, work elsewhere demonstrates that significant insights into mobility patterns, resource use and so on can be gleaned from analysis of open lithic deposits (Hiscock 1996; Hiscock 2008; Holdaway and Stern 2004). Earth mounds that have been documented in the region are also a high priority for future research as they have good potential to broaden our knowledge of the range of production strategies employed in different environments, and potentially, at different times. However, at this stage a more pressing question relates to the origin of earth mound features, particularly within the context of earlier debates about natural or anthropogenic formation of shell mound deposits. This is proposed here to represent one of the most crucial research questions within the Albatross Bay region at the present time.

There also remains a range of questions that need to be addressed through further investigations of shell matrix sites. Of particular note are questions relating to seasonality of mound formation and use via quantitative methods used elsewhere (Claassen 1998; Milner 1999, 2001). It is probable that the wet season exerts a strong influence on patterns of shell growth of a range of species of shellfish at Albatross Bay; as such, bioarchaeological investigations comparing modern and archaeological samples may provide some insights into seasonality of collection. In addition, detailed studies of taphonomic processes that may be occurring within shell mound deposits are also important in order to explore the issue of preservation of non-molluscan fauna. Although it has been argued here that no such processes are evident, it nevertheless remains a question that needs to be taken up in future research both at Albatross Bay and also on shell mound deposits elsewhere in northern Australia.

Thirdly, it is also crucial that further detailed work be carried out on complexes of shell mounds that date to earlier periods, or that occur in different environmental contexts. While there is no indication based on present evidence of significant spatial or temporal variations in composition it remains a possibility that needs to be explored through future systematic research. Systematic compositional and chronological data from shell matrix sites that date to before about 1,000 cal BP is particularly pivotal in this context and should be a specific target of future investigations.

Finally, higher resolution dating to ascertain patterns of mound growth are also important. Employing methods aimed at answering questions about the unique depositional histories of specific mounds may yield crucial information about past mound use; for example, geophysical data, multiple chronological sequences and use of low-disturbance coring or column sampling may all generate important data on the formation and use of individual mounds. Relatively uniform dome shaped mounds may provide the best opportunities for such investigations, as they are more likely to have a more consistent depositional history compared with larger mounds that have more complex morphology.

It has been the good fortune of the author to have worked closely with a number of Traditional Owner groups in the Albatross Bay region over the course of production of this thesis. It is clear from this work that shell mound sites are among the most culturally significant features present in landscapes around Albatross Bay. Mound sites are often seen to be alive and a direct physical manifestation of the Old People (ie spirits of ancestors) in the landscape. It has often been the case during fieldwork that particular mounds have been interpreted by Traditional Owners as having 'grown' or 'changed' since their last visit. There are also important oral histories and traditional knowledge's surrounding shell mounds that are yet to be systematically documented. Thus, a further prospect for future research in the region is to document the contemporary cultural heritage significance of these features to Traditional Owners in order to support community oriented management strategies.

Appendix 1: Radiocarbon dating methods

All archaeologists who have worked in the Albatross Bay region have relied upon radiocarbon dating to understand chronological issues to do with the shell matrix features that they have investigated. Many of these determinations have been on samples of *A. granosa*. It is widely acknowledged that radiocarbon determinations on marine shellfish require correction for the marine reservoir effect (see Ulm 2002a) and that calibration curves are applicable to those of late Holocene age. Both of these issues are seen to be of some concern here because of the influence they can have on subsequent interpretations.

There are a number of software applications available for calibrating conventional radiocarbon dates and for applying ΔR values. Throughout this thesis all conventional radiocarbon ages (CRAs) from the Albatross Bay region have been calibrated with CALIB version 5.0 (Stuiver and Reimer 1993; Stuiver, Reimer and Reimer 2005) using data from the Marine04 calibration curve (Hughen, Baillie, Bard, Bayliss, Beck, Bertrand, Blackwell, Buck, Burr, Cutler, Damon, Edwards, Fairbanks, Friedrich, Guilderson, Kromer, McCormac, Manning, Bronk Ramsey, Reimer, Reimer, Remmele, Southon, Stuiver, Talamo, Taylor, van der Plicht and Weyhenmeyer 2004) for marine samples or the SHCal04 for charcoal samples (McCormac, Hogg, Blackwell, Buck, Higham and Reimer 2004).

Ulm (2002a) has illustrated the importance of carefully choosing appropriate ΔR value for marine shell. The regional average ΔR for north east Australia calculated by Reimer and Reimer (2004) used widely by a range of researchers is 50±31 BP.

This is based on a small number of samples from the Torres Strait and northern Cape York Peninsula. Ulm has calculated a sub-regional Gulf of Carpentaria average of 52±42 BP (Ulm 2002b) by disregarding the ΔR values of shell samples from the Torres Strait.

The Gulf of Carpentaria sub-regional average calculated by Ulm is the weighted average of ΔR estimates calculated for two separate pre-1950 marine shell samples. However, it has been demonstrated that ΔR estimates can be inconsistent when obtained on different shellfish species sourced from different estuarine environments (for example, see Higham and Hogg 1995; Spennemann and Head 1996; Ulm 2002a). The two samples used to calculate the Gulf of Carpentaria sub-regional average were obtained on samples of *A. granosa* and *Telescopium telescopium*. The latter is well known to occupy both the intertidal zone as well as mangrove forests and therefore may contain both terrestrial and marine-derived carbon. Alternatively, *A. granosa* is exclusively an intertidal species, most often occurring in the lower portions of that zone (Broom 1982b, 1982a, 1983; Morrison 2003b; Tookwinas 1985) and therefore less likely to be directly influenced by terrestrial carbon.

While the Gulf of Carpentaria sub-regional average calculated by Ulm is used here, it is used with caution. The *T. telescopium* ΔR value of -17±60 is possibly problematic because this species occupies environments higher in the tidal zone within mangrove forests and are more likely to be influenced by terrestrial carbon. The ΔR value of the *A. granosa* sample is 122±61 BP and clearly quite different to that of the *T. telescopium* sample. However, only one *A. granosa* sample exists and it is unclear whether this may be an anomalous. Given that most of the 80 or so radiocarbon dates in the region are on marine shell, a strong case can be made for further refinement of local ΔR values based exclusively on *A. granosa* samples through future research.

Despite possible problems with the ΔR values, a preference is given here towards citing calibrated age spans rather than conventional radiocarbon ages. All radiocarbon data from previous research in the study area, including conventional radiocarbon ages, are presented in a single table in Appendix 2. All radiocarbon results obtained by the author are provided separately in Appendix 5. All calibrated dates are provided as the median of the age-range at 1σ along with the suffix ‘cal BP’.

Appendix 2: Radiocarbon data from Albatross Bay prior to 2002

Lab Code	CRA	Cal BP (1 σ)	d13C	Site[1]	Depth	Material[2]	Reference
I-1738	810±105	675(692)717	0	393	Base	C	Wright 1971
I-1737	235±110	154(186)286	0	393	Surface	C	
SUA-147	710±100	573(591)655	0	393	35	C	Bailey 1977
SUA-148	855±80	691(725)734	0	393	150	C	
SUA-149	1180±80	986(1014)1055	0	393	295	C	
ANU4408	790±60	323(379)427	-1.6	96	Middle	Ag.	Beaton (unpub) in Stone 1995
ANU4409	760±75	302(356)401	-2	96	Basal	Ag.	
ANU4410	360±100	Invalid		96	Surface	Ag.	
ANU4411	580±70	108(160)245	-2.4	187	Surface	Ag.	
ANU4412	710±75	261(308)359	-2.3	189	Surface	Ag.	
ANU4413	1420±80	867(914)967	-2.9	193	Basal	Ag.	
ANU4414	1250±80	684(739)777	-2.5	190	Surface	Ag.	
ANU4415	1210±60	660(705)736	-3.8	193	Surface	Ag.	
ANU4416	180±50	Invalid		185	Surface	Ag.	
ANU4417	520±80	invalid	-3.6	186	Basal	Ag.	
ANU4418	770±70	309(364)410	-2	186	Surface	Ag.	
ANU4419	1460±60	907(956)1000	-2.8		Surface	Ag.	
ANU4420	710±60	261(308)359	-3	196	Surface	Ag.	
ANU4421	970±60	486(525)553	-1.1	147	Basal	Ag.	
ANU4423	870±70	424(456)494	-2.4	166	Basal	Ag.	
ANU4424	630±60	145(209)271	-4.3	166	Middle	Ag.	
ANU4425	2070±60	1521(1584)1638	-3.5	171	Basal	Ag.	
ANU4426	720±60	269(320)366	-2.7	171	Middle	Ag.	
ANU4427	2100±80	1560(1618)1677	-2.3	161	Basal	Ag.	
ANU4428	1810±80	1266(1306)1342	-4.3	161	Surface	Ag.	
ANU4429	2010±80	1440(1510)1564	-3.4	160	Basal	Ag.	
ANU4430	1800±80	1260(1298)1335	-2.3	159	Basal	Ag.	
ANU4431	1580±80	1032(1083)1150	-2.3	159	Surface	Ag.	
ANU4432	890±80	440(471)503	-3.3	396	Surface	Ag.	
ANU4433	1390±80	825(880)927	-3.8		Surface	Ag.	
ANU4434	1790±90	1253(1290)1329	-3.4		Surface	Ag.	
ANU4435	1520±80	954(1014)1058	-3.5		Surface	Ag.	
ANU4436	1330±80	775(823)883	-2.7		Surface	Ag.	
ANU4437	270±70	Invalid			Surface	Ag.	
ANU4438	960±60	483(518)545	-3.7		Surface	Ag.	
ANU4439	500±70	Invalid	-3.8		Surface	Ag.	
ANU4440	220±50	Invalid			Surface	Ag.	
ANU4441	800±70	332(388)438	-3.6±0.1		Surface	Ag.	
ANU8021	630±40	145(209)271	-2±0.1	393	0	Ag.	
ANU8022	670±70	149(264)312	-2.3±0.1	393	40	Ag.	
ANU8023	1030±40	532(571)610	-1.8±0.1	393	70	Ag.	
ANU8024	980±40	490(532)563	-1.6±0.1	393	100	Ag.	
ANU8025	990±70	497(540)592	-1.6±0.1	393	140	Ag.	
ANU8026	930±80	467(497)525	-1.8±0.1	393	170	Ag.	
ANU8027	830±80	376(419)476	-0.8±0.1	393	200	Ag.	
ANU8028	900±80	448(478)508	-1.4±0.1	393	230	Ag.	
ANU8029	910±90	455(484)514	-1.7±0.1	393	270	Ag.	
ANU8030	890±70	440(471)503	-1.1±0.1	393	300	Ag.	
ANU8770	870±80	424(456)494	0	42	Base (flank)	Ag.	Bailey *et al* 1994
ANU8772	1570±70	1011(1072)1132	0	13	Surface	Ag.	
ANU8773	1560±60	997(1059)1119	0	13	Base (flank)	Ag.	
ANU8774	2700±110	2288(2335)2395	0	21	Base (flank)	Ag.	

ANU8775a	790±110	323(379)427	0	96	Base	Ag.	
ANU8775b	1060±130	923(930)933	0	96	Base	C	
ANU8782	1940±90	1380(1433)1491	0	17	Base (flank)	Ag.	
ANU8783	790±70	323(379)427	0	9	Surface	Ag.	
ANU8784	1120±70	597(634)675	0	9	Base (flank)	Ag.	
ANU8785	890±70	440(471)503	0	96	Surface	Ag.	
Wk16362	708±35	259(306)359	-2.2	217	3.5	Ag.	Morrison 2005
Wk16363	784±35	319(374)421	-1.3	217	43.5	Ag.	
Wk16364	1167±35	637(672)706	-1.3	217	77	Ag.	

Previous radiocarbon determinations from the Albatross Bay region

Notes: 1) Number of site used Chapter 5 and in site datbase. 2) Dating material: Ag, Anadara granosa; C, charcoal. See Appendix 1 for calibration and correction methods.

Appendix 3: Shell matrix site data

Site Identification Numbers					Type of Place	Length (m2)	Width (m2)	Diam (m2)	Height (m2)	Base (m2)	Volume (m3)	Dominant Shellfish Species	Morphology	Substrate
FINAL	*RTA*	*Bailey 1972*	*Bailey 1994*	*Bailey Cluster No*										
1					Shell Mound	30	30		1	802		*Anadara granosa*	Dome	Coastal Plain
2					Shell Mound	80	30		3.5	519		*Anadara granosa*	Elongated	Mangroves
3					Shell Mound	8	4		1	477		*Anadara granosa*	Dome	Mangroves
4					Shell Mound	40	40		4	545		*Anadara granosa*	Conical	Bauxite plateau
5					Shell Midden	129	21		0.3	2408		*Anadara granosa*	Composite	Bauxite plateau
6					Shell Mound	10	8		0.5	398		*Anadara granosa*	Dome	Bauxite plateau
7					Shell Mound	63	15		0.5	829		*Anadara granosa*	Elongated	Dune/Sand Ridge
8					Shell Mound	103	32		0.5	2373		*Anadara granosa*	Elongated	Dune/Sand Ridge
9					Shell Mound	36	30		6	790		*Anadara granosa*	Conical	Coastal Plain
10					Shell Mound	24	24		2.5	324		*Anadara granosa*	Dome	Coastal Plain
11					Shell Mound	15	7		0.8	34		*Anadara granosa*	Dome	Mangroves

12					Shell Mound	22	10		1	178		*Anadara granosa*	Elongated	Mangroves
13					Shell Mound	20	15		5	441		*Anadara granosa*	Truncated	Mangroves
14					Shell Mound	21	9		0.3	191		*Anadara granosa*	Elongated	Bauxite plateau
15					Shell Scatter	10	5		0	2373		*Anadara granosa, Saccostrea Cucullata*	Scatter	Bauxite plateau
16					Shell Mound	20	15		6	816		*Anadara granosa*	Truncated	Mangroves
17					Shell Mound	100	45		10	3199		*Anadara granosa*	Composite	Coastal Plain
18					Shell Mound	9	7		1	70		*Anadara granosa*	Dome	Mangroves
19					Shell Mound	70	7		3	1118		*Anadara granosa*	Composite	Coastal Plain
20					Shell Mound	8	5		1.5	146		*Anadara granosa*	Elongated	Mangroves
21					Shell Mound	15	12		2	395		*Anadara granosa*	Dome	Bauxite plateau
22					Shell Mound	15	10		2.5	362		*Anadara granosa*	Dome	Coastal Plain
23					Shell Mound	10	10		0.5	314		*Anadara granosa*	Dome	Bauxite plateau
24					Shell Mound	50	12		4	1134		*Anadara granosa*	Elongated	Coastal Plain
25					Shell Mound	5	5		0.2	97		*Anadara granosa*	Dome	Bauxite plateau
26					Shell Midden	15	7		1	410		*Anadara granosa*	Elongated	Bauxite plateau

27					Shell Mound	15	15		0.5	381		*Anadara granosa*	Dome	Bauxite plateau
28					Shell Mound	90	8		5	3559		*Anadara granosa*	Elongated	Bauxite plateau
29					Shell Mound	40	8		1	905		*Anadara granosa*	Elongated	Bauxite plateau
30					Shell Scatter	5	10		0	876		*Anadara granosa*	Scatter	Bauxite plateau
31					Shell Mound	10	8		1.5	296		*Anadara granosa*	Dome	Bauxite plateau
32					Shell Mound	80	13		0.5	876		*Anadara granosa*	Elongated	Bauxite plateau
33					Shell Mound	10	5		0.5	212		*Anadara granosa*	Dome	Bauxite plateau
34					Shell Mound	40	40		0.5	436		*Anadara granosa*	Dome	Bauxite plateau
35					Shell Mound	30	12		1	933		*Anadara granosa*	Elongated	Bauxite plateau
36					Shell Mound	100	30		4	2567		*Anadara granosa*	Composite	Ridge on Coastal Plain
37					Shell Mound	70	20		1.5	970		*Anadara granosa*	Elongated	Bauxite plateau
38					Shell Scatter	5	4		0.2	77		*Anadara granosa*	Scatter	Coastal Plain
39					Shell Mound	12	4		0.5	162		*Anadara granosa*	Dome	Ridge on Coastal Plain
40					Shell Scatter	15	9		0	101		*Anadara granosa*	Scatter	Coastal Plain
41					Shell Mound	12	8		0.5	452		*Anadara granosa*	Dome	Ridge on Coastal Plain

42					Shell Mound	200	55		10	7163		*Anadara granosa*	Composite	Coastal Plain
43					Shell Mound	15	10		1.5	334		*Anadara granosa*	Dome	Coastal Plain
44					Shell Mound	50	25		3	2311		*Anadara granosa*	Composite	Dune/Sand Ridge
45					Shell Mound	50	15		2	432		*Anadara granosa*	Dome	Coastal Plain
46					Shell Scatter	10	8		0	191		*Anadara granosa*	Scatter	Bauxite plateau
47					Shell Scatter	15	8		0	82		*Anadara granosa*	Scatter	Bauxite plateau
48					Shell Mound	50	40		8	1659		*Anadara granosa*	Truncated	Coastal Plain
49					Shell Mound	40	24		5	1014		*Anadara granosa*	Truncated	Coastal Plain
50					Shell Scatter	9	5		0	41		*Anadara granosa*	Scatter	Bauxite plateau
51					Shell Scatter	6	5		0	27		*Anadara granosa*	Scatter	Bauxite plateau
52					Shell Scatter	9	7		0	69		*Anadara granosa*	Scatter	Bauxite plateau
53					Shell Mound	30	30		0.3	693		*Anadara granosa*	Shell ring	Bauxite plateau
54					Shell Scatter	14	11		0	141		*Anadara granosa*	Scatter	Bauxite plateau
55					Shell Midden	85	36		0	2209		*Anadara granosa*	Composite	Dune/Sand Ridge
56					Shell Scatter	5	5		0	2209		*Anadara granosa*	Scatter	Coastal Plain
57					Shell Mound	27	14		0.3	728		*Anadara granosa*	Dome	Coastal Plain

58					Shell Mound	52	22		1	728		*Anadara granosa*	Elongated	Coastal Plain
59					Shell Mound	24	18		1.5	377		*Anadara granosa*	Truncated	Ridge on Coastal Plain
60					Shell Mound	21	17		0.4	418		*Anadara granosa*	Dome	Ridge on Coastal Plain
61					Shell Scatter	17	10		0	418		*Anadara granosa, Saccostrea Cucullata*	Scatter	Ridge on Coastal Plain
62					Shell Mound	12	7		0.1	418		*Anadara granosa*	Dome	Ridge on Coastal Plain
63					Shell Scatter	4	4		0	127		*Polymesoda*	Scatter	Dune/Sand Ridge
64					Shell Scatter	80	80		0	127		*Volema cochlidium*	Scatter	Dune/Sand Ridge
65					Shell Scatter	15	5		0	127		varied	Scatter	Dune/Sand Ridge
66					Shell Mound	8	8		1.5	127		*Anadara granosa*	Dome	Dune/Sand Ridge
67					Shell Mound	10	5		0.5	272		*Anadara granosa*	Dome	Dune/Sand Ridge
68					Shell Mound	8	8		1.7	426		*Anadara granosa*	Dome	Dune/Sand Ridge
69					Shell Mound	8	8		1	404		*Anadara granosa*	Dome	Dune/Sand Ridge
71					Shell Scatter	50	20		0	404		*Anadara granosa*	Scatter	Dune/Sand Ridge
73					Shell Scatter	50	30		0	296		*Anadara granosa*	Scatter	Bauxite plateau

74					Shell Scatter	45	45		0	300		*Anadara granosa*	Scatter	Dune/Sand Ridge
75					Shell Mound	29	13		1.5	296		*Anadara granosa*	Elongated	Dune/Sand Ridge
76					Shell Mound	9	9		0.75	65		*Anadara granosa*	Dome	Dune/Sand Ridge
78					Shell Scatter	75	40		0	65		*Anadara granosa*	Scatter	Dune/Sand Ridge
79					Shell Mound	25	10		1	300		*Anadara granosa*	Elongated	Dune/Sand Ridge
80					Shell Midden	100	50		0	83		*Anadara granosa*	Non-mounded	Dune/Sand Ridge
81					Shell Mound	75	40		1	1060		*Anadara granosa*	Composite	Ridge on Coastal Plain
82					Shell Scatter	15	7		0	1060		*Anadara granosa*	Scatter	Ridge on Coastal Plain
83					Shell Scatter	9	6		0	185		*Anadara granosa*	Scatter	Bauxite plateau
84					Shell Scatter	5	10		0	185		*Anadara granosa*	Scatter	Bauxite plateau
85					Shell Scatter	60	5		0	260		*Anadara granosa*	Scatter	Dune/Sand Ridge
86*					Shell Mound	25	15		0.5	260		*Anadara granosa*	Dome	Dune/Sand Ridge
87					Shell Scatter	20	5		0	260		*Anadara granosa*	Scatter	Dune/Sand Ridge
88*					Shell Mound	18	13		0.75	185		*Anadara granosa*	Dome	Dune/Sand Ridge
89					Shell Scatter	10	10		0	329		*Anadara granosa*	Scatter	Dune/Sand Ridge

90					Shell Mound	28	15		0.7	329		*Anadara granosa*	Dome	Dune/Sand Ridge
91*					Shell Mound	5	5		0.3	95		*Anadara granosa*	Dome	Dune/Sand Ridge
92					Shell Mound	30	10		1.4	1591		*Anadara granosa*	Elongated	Dune/Sand Ridge
93*					Shell Mound	50	30		1.8	529		*Anadara granosa*	Elongated	Dune/Sand Ridge
94					Shell Mound	100	18		2	1300		*Anadara granosa*	Composite	Dune/Sand Ridge
95					Shell Mound	8	8		1.2	97		*Anadara granosa*	Dome	Dune/Sand Ridge
96					Shell Mound	40	23		2	556		*Anadara granosa*	Elongated	Dune/Sand Ridge
97					Shell Mound	24	14		1.3	269		*Anadara granosa*	Dome	Bauxite plateau
98					Shell Scatter	20	20		0	186		*Anadara granosa, Saccostrea Cucullata*	Scatter	Bauxite plateau
99					Shell Mound	31	20		0.8	401		*Anadara granosa*	Dome	Bauxite plateau
100					Shell Scatter	15	13		0	156		*Anadara granosa*	Scatter	Bauxite plateau
101					Shell Mound	27	27		3	558		*Anadara granosa*	Dome	Bauxite plateau
102					Shell Scatter	11	9		0	173		*Anadara granosa*	Scatter	Bauxite plateau
103					Shell Mound	15	12		1	232		*Anadara granosa*	Dome	Bauxite plateau
104					Shell Scatter	3	1.6		0	4		*Anadara granosa*	Scatter	Bauxite plateau

105					Shell Scatter	3.7	1.6		0	5		*Anadara granosa*	Scatter	Bauxite plateau
106					Shell Scatter	3	2.7		0	6		*Anadara granosa*	Scatter	Bauxite plateau
107					Shell Scatter	2.3	1.8		0	3		*Anadara granosa*	Scatter	Bauxite plateau
108					Shell Scatter	2.7	2.1		0	4		*Anadara granosa*	Scatter	Bauxite plateau
109					Shell Scatter	1.8	1.3		0	2		*Anadara granosa*	Scatter	Bauxite plateau
110					Shell Scatter	3	1.3		0	3		*Anadara granosa*	Scatter	Bauxite plateau
111					Shell Scatter	3	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
112					Shell Scatter	60	5		0	1222		*Anadara granosa*	Scatter	Dune/Sand Ridge
113					Shell Scatter	10	50		0	232		*Anadara granosa*	Scatter	Bauxite plateau
114*					Shell Mound	75	30		0.2	1222		*Anadara granosa*	Non-mounded	Bauxite plateau
115*					Shell Mound	18	10		0.2	208		*Anadara granosa*	Non-mounded	Bauxite plateau
116*					Shell Midden	7	13		0	232		*Anadara granosa*	Non-mounded	Bauxite plateau
117					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Unknown	Bauxite plateau
118					Shell Scatter	1.5	1.5		0	5		*Anadara granosa*	Scatter	Bauxite plateau
119					Shell Scatter	1.5	1.5		0	4		*Anadara granosa*	Scatter	Bauxite plateau
120					Shell Scatter	1.7	1.7		0	1		*Anadara granosa*	Scatter	Bauxite plateau

121					Shell Scatter	1.4	1.4		0	1		*Anadara granosa*	Scatter	Bauxite plateau
122					Shell Scatter	1	1		0	3		*Anadara granosa*	Scatter	Bauxite plateau
123*					Shell Scatter	1.3	1.3		0	5		*Anadara granosa*	Scatter	Bauxite plateau
124					Shell Scatter	1.2	1.2		0	6		*Anadara granosa*	Scatter	Bauxite plateau
125					Shell Scatter	0	0		0	4		*Anadara granosa*	Scatter	Bauxite plateau
126*					Shell Mound	15	6		0.3	60		*Anadara granosa*	Dome	Bauxite plateau
127					Shell Scatter	1.5	1.5		0	4		*Anadara granosa*	Scatter	Bauxite plateau
128					Shell Scatter	1	1		0	4		*Anadara granosa*	Scatter	Bauxite plateau
129					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
130					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
131					Shell Scatter	1.5	1.5		0	10		*Anadara granosa*	Scatter	Bauxite plateau
132					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
133					Shell Scatter	1.5	1.5		0	4		*Anadara granosa*	Scatter	Bauxite plateau
134					Shell Scatter	2	2		0	3		*Anadara granosa*	Scatter	Bauxite plateau
135					Shell Scatter	6	4		0	21		*Anadara granosa*	Scatter	Bauxite plateau

136*					Shell Mound	18	14		0.5	216		*Anadara granosa*	Dome	Bauxite plateau
137*					Shell Mound	6	9		0.3	55		*Anadara granosa*	Dome	Bauxite plateau
138					Shell Scatter	3	3		0	6		*Anadara granosa*	Scatter	Bauxite plateau
139					Shell Scatter	1.5	1.5		0	5		*Anadara granosa*	Scatter	Bauxite plateau
140					Shell Mound	8	16		0.3	170		*Anadara granosa*	Dome	Bauxite plateau
141					Shell Scatter	2	2		0	2		*Anadara granosa*	Scatter	Bauxite plateau
142					Shell Scatter	4	2		0	8		*Anadara granosa*	Scatter	Bauxite plateau
143					Shell Scatter	4	2		0	6		*Saccostrea cucullata*	Scatter	Bauxite plateau
144					Shell Scatter	2	2		0	4		*Anadara granosa*	Scatter	Bauxite plateau
145					Shell Mound	10	10		0.3	101		*Anadara granosa*	Dome	Bauxite plateau
146					Shell Scatter	3	3		0	9		*Anadara granosa, Saccostrea Cucullata*	Scatter	Bauxite plateau
147					Shell Mound	75	15		1.5	888		*Anadara granosa*	Elongated	Bauxite plateau
148					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
149					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
150					Shell Mound	1.5	1.5		0.1	3		*Anadara granosa*	Dome	Bauxite plateau

151					Shell Scatter	1.5	1.5		0	4		*Anadara granosa*	Scatter	Bauxite plateau
152					Shell Scatter	0.5	0.5		0	1		*Anadara granosa*	Scatter	Bauxite plateau
153					Shell Scatter	1	1		0	2		*Anadara granosa*	Scatter	Bauxite plateau
154					Shell Scatter	1	1		0	2		*Anadara granosa*	Scatter	Bauxite plateau
155					Shell Scatter	1.5	1.5		0	4		*Anadara granosa, Saccostrea Cucullata*	Scatter	Bauxite plateau
156					Shell Scatter	1.5	1.5		0	3		*Anadara granosa*	Scatter	Bauxite plateau
157					Shell Scatter	1	1		0	2		*Anadara granosa*	Scatter	Bauxite plateau
158					Shell Scatter	1	1		0	2		*Anadara granosa*	Scatter	Bauxite plateau
159					Shell Mound	40	25		0.8	259		*Anadara granosa*	Composite	Bauxite plateau
160					Shell Mound	25	18		1.3	206		*Anadara granosa*	Truncated	Bauxite plateau
161					Shell Mound	15	15		0.8	199		*Anadara granosa*	Dome	Bauxite plateau
162					Shell Mound	10	10		0.6	140		*Anadara granosa*	Dome	Bauxite plateau
163					Shell Mound	50	18		1.8	508		*Anadara granosa*	Elongated	Bauxite plateau
164					Shell Mound	5	5		0.3	93		*Anadara granosa*	Dome	Bauxite plateau
165					Shell Mound	45	15		1.5	393		*Anadara granosa*	Elongated	Bauxite plateau

166					Shell Mound	45	30		3	554		*Anadara granosa*	Composite	Coastal Plain
167					Shell Mound	60	30		3.2	800		*Anadara granosa*	Composite	Coastal Plain
168					Shell Mound	13	8		1.4	383		*Anadara granosa*	Dome	Coastal Plain
169					Shell Mound	25	20		0.7	289		*Anadara granosa*	Dome	Coastal Plain
170					Shell Mound	18	15		2.5	316		*Anadara granosa*	Truncated	Bauxite plateau
171					Shell Mound	15	25		1.5	389		*Anadara granosa*	Dome	Bauxite plateau
173					Shell Mound	45	9		0.5	477		*Anadara granosa*	Elongated	Bauxite plateau
174					Shell Mound	30	15		1.2	365		*Anadara granosa*	Dome	Bauxite plateau
175					Shell Mound	10	10		1	219		*Anadara granosa*	Dome	Bauxite plateau
176					Shell Mound	170	30		3	3628		*Anadara granosa*	Composite	Coastal Plain
177					Shell Mound	50	40		2	557		*Anadara granosa*	Dome	Coastal Plain
178					Shell Mound	70	50		5	1900		*Anadara granosa*	Composite	Mangroves
179					Shell Mound	23	18		1.3	221		*Anadara granosa*	Dome	Coastal Plain
180					Shell Mound	45	25		4	1363		*Anadara granosa*	Elongated	Coastal Plain
181					Shell Mound	50	10		1.5	1425		*Anadara granosa*	Elongated	Coastal Plain
182					Shell Mound	80	15		5	1871		*Anadara granosa*	Dome	Coastal Plain

183					Shell Mound	8	8		1.5	437		*Anadara granosa*	Dome	Coastal Plain
184					Shell Mound	40	15		3	2165		*Anadara granosa*	Elongated	Bauxite plateau
185					Shell Mound	70	30		4	3500		*Anadara granosa*	Composite	Coastal Plain
186					Shell Mound	15	15		0.6	498		*Anadara granosa*	Dome	Coastal Plain
187					Shell Mound	65	35		5	1654		*Anadara granosa*	Composite	Coastal Plain
188					Shell Mound	21	19		0.3	261		*Anadara granosa*	Dome	Coastal Plain
189					Shell Mound	45	28		4	675		*Anadara granosa*	Dome	Coastal Plain
190					Shell Mound	26	31		3	462		*Anadara granosa*	Dome	Coastal Plain
191					Shell Scatter	20	16		0	216		*Anadara granosa*	Scatter	Dune/Sand Ridge
192					Shell Scatter	50	12		0	432		*Anadara granosa*	Scatter	Dune/Sand Ridge
193					Shell Mound	24	13		0.5	243		*Anadara granosa*	Dome	Dune/Sand Ridge
194					Shell Mound	26	22		0.5	532		*Anadara granosa*	Dome	Dune/Sand Ridge
195					Shell Mound	29	21		2	491		*Anadara granosa*	Dome	Dune/Sand Ridge
196					Shell Mound	0	0		0.5	1063		*Anadara granosa*	Dome	Dune/Sand Ridge
197					Shell Mound	15	15		0.5	1063		*Anadara granosa*	Dome	Dune/Sand Ridge

198					Shell Mound	5	8		0.3	331		*Anadara granosa*	Dome	Bauxite plateau
199					Shell Mound	8	5		0.8	402		*Anadara granosa*	Dome	Bauxite plateau
200					Shell Scatter	4	3		0	37		*Anadara granosa*	Scatter	Bauxite plateau
201					Shell Mound	8	8		0.3	539		*Anadara granosa*	Dome	Bauxite plateau
202					Shell Mound	15	15		1	339		*Anadara granosa*	Dome	Bauxite plateau
203					Shell Mound	25	20		2	601		*Anadara granosa*	Dome	Bauxite plateau
204					Shell Mound	31	22		2	575		*Anadara granosa*	Dome	Bauxite plateau
205					Shell Mound	15	15		1	151		*Anadara granosa*	Dome	Bauxite plateau
206					Shell Mound	70	60		2	3115		*Anadara granosa*	Dome	Dune/Sand Ridge
207					Shell Mound	191	66		4	8126		*Anadara granosa*	Elongated	Dune/Sand Ridge
208					Shell Midden	100	50		0	8126		*Anadara granosa*	Non-mounded	Dune/Sand Ridge
209	WP-SM38				Shell Mound	14	13		0.1	216		*Anadara granosa*	Dome	Bauxite plateau
210	WP-SM39				Shell Mound	18	14		0.1	216		*Anadara granosa*	Dome	Bauxite plateau
211	WP-SM40a				Shell Mound	13	10		0.1	216		*Anadara granosa*	Dome	Bauxite plateau
212	WP-SM41				Shell Mound	48	15		0.1	432		*Anadara granosa*	Dome	Bauxite plateau
213	WP-SM42				Shell Mound	18	14		0.1	243		*Anadara granosa*	Dome	Bauxite plateau

214					Shell Scatter	5	2		0	210		*Anadara granosa*	Scatter	Bauxite plateau
215					Shell Scatter	20	20		0	0		*Anadara granosa*	Scatter	Bauxite plateau
216					Shell Scatter	30	25		0	0		*Polymesoda erosa*	Scatter	Bauxite plateau
217					Shell Mound	40	30		1.2	774		*Anadara granosa*	Dome	Dune/Sand Ridge
218					Shell Mound	110	30		4	1435		*Anadara granosa*	Composite	Dune/Sand Ridge
219					Shell Mound	40	20		0.3	484		*Anadara granosa*	Dome	Dune/Sand Ridge
220					Shell Mound	170	60		3.5	5784		*Anadara granosa*	Composite	Dune/Sand Ridge
221					Shell Scatter	25	10		0	397		*Anadara granosa*	Scatter	Dune/Sand Ridge
222					Shell Scatter	30	20		0	402		*Anadara granosa*	Scatter	Dune/Sand Ridge
223					Shell Mound	20	20		0.2	399		*Anadara granosa*	Dome	Dune/Sand Ridge
224		1	151	1	Shell Mound	10	10	10	1	80	40	*Anadara granosa*	Unknown	Coastal Plain
225		10	142	1	Shell Mound	10	10	10	0.5	80	20	*Anadara granosa*	Unknown	Bauxite plateau
226		100	49	6	Shell Mound	20	8		0.2	120	10	*Anadara granosa*	Unknown	Coastal Plain
227		101	48	6	Shell Mound	16	8		0.2	100	10	*Anadara granosa*	Unknown	Coastal Plain
228		102	83	6	Shell Mound	10	10	10	0.2	80	10	*Anadara granosa*	Unknown	Bauxite plateau
229		103	82	6	Shell Mound	12	10		0.2	100	10	*Anadara granosa*	Unknown	Bauxite plateau

230		104	81	6	Shell Mound	20	14		1.5	230	50	*Anadara granosa*	Unknown	Bauxite plateau
231		105	80	6	Shell Mound	27	12		0.5	280	60	*Anadara granosa*	Unknown	Bauxite plateau
232		106	47	6	Shell Mound	40	10		1	320	140	*Anadara granosa*	Unknown	Ridge on Coastal Plain
233		107	46	6	Shell Mound	28	15		1.5	300	190	*Anadara granosa*	Unknown	Ridge on Coastal Plain
234		108	45	6	Shell Mound	22	10		0.2	190	50	*Anadara granosa*	Unknown	Ridge on Coastal Plain
235		109	44	6	Shell Mound	23	10		1	200	100	*Anadara granosa*	Unknown	Ridge on Coastal Plain
236		11	141	1	Shell Mound	12	12	12	1	110	60	*Anadara granosa*	Unknown	Bauxite plateau
237		12	140	1	Shell Mound	10	10	10	0.2	80	10	*Anadara granosa*	Unknown	Bauxite plateau
238		129	24	8	Shell Mound	20	10		0.5	160	40	*Anadara granosa*	Unknown	Mangroves
239		13	139	1	Shell Mound	5	5	5	0.25	20		*Anadara granosa*	Unknown	Bauxite plateau
240		130	23	8	Shell Mound	5	5	5	0.5	20	10	*Anadara granosa*	Unknown	Bauxite plateau
241		131	22	8	Shell Mound	5	5	5	0.2	80	10	*Anadara granosa*	Unknown	Coastal Plain
242		132	21	8	Shell Mound	12	6		0.2	60	10	*Anadara granosa*	Unknown	Coastal Plain
243		133	20	8	Shell Mound	10	10	10	0.5	80	10	*Anadara granosa*	Unknown	Coastal Plain

244		134	19	8	Shell Mound	20	10		3	180	270	*Anadara granosa*	Unknown	Coastal Plain
245		135	18	8	Shell Mound	18	10		1	140	70	*Anadara granosa*	Unknown	Mangroves
246		136	17	8	Shell Mound	19	19	19	2	280	250	*Anadara granosa*	Unknown	Coastal Plain
247		137	16	8	Shell Mound	26	18		2	440	170	*Anadara granosa*	Unknown	Bauxite plateau
248		14	138	1	Shell Mound	22	18		4	310	780	*Anadara granosa*	Unknown	Bauxite plateau
249		149	4	12	Shell Mound	200	25		3	3100	1010	*Anadara granosa*	Unknown	Bauxite plateau
250		15	137	1	Shell Mound	9	9	9	0.3	60	10	*Anadara granosa*	Unknown	Bauxite plateau
251		153	1	11	Shell Mound	8	3		0.2	10		*Anadara granosa*	Unknown	Bauxite plateau
252		154	2	11	Shell Mound	10	10		0.2	80		*Anadara granosa*	Unknown	Bauxite plateau
253		155	3	11	Shell Mound	19	15		0.2	230	10	*Anadara granosa*	Unknown	Bauxite plateau
254		156	4	11	Shell Mound	18	18	18	0.2	250	10	*Anadara granosa*	Unknown	Bauxite plateau
255		157	5	11	Shell Mound	100	19		0.2	1770	90	*Anadara granosa*	Unknown	Bauxite plateau
256		158	6	11	Shell Mound	12	12	12	0.2	110	10	*Anadara granosa*	Unknown	Bauxite plateau
257		159	7	11	Shell Mound	12	12	12	0.1	180		*Anadara granosa*	Unknown	Bauxite plateau
258		16	136	1	Shell Mound	20	20	20	1	310	140	*Anadara granosa*	Unknown	Bauxite plateau
259		160	8	11	Shell Mound	4	4	4	0.1	20		*Anadara granosa*	Unknown	Bauxite plateau

260		161	9	11	Shell Mound	139	27		4.5	3000	4880	*Anadara granosa*	Unknown	Bauxite plateau
261		162	10	11	Shell Mound	58	58		0.5	2640	570	*Anadara granosa*	Unknown	Bauxite plateau
262		163	11	11	Shell Mound	26	26	26	1	530	230	*Anadara granosa*	Unknown	Bauxite plateau
263		164	12	11	Shell Mound	15	8		0.1	100	10	*Anadara granosa*	Unknown	Bauxite plateau
264		165	13	11	Shell Mound	31	15		0.1	420	10	*Anadara granosa*	Unknown	Bauxite plateau
265		166	14	11	Shell Mound	139	23		0.1	2750	70	*Anadara granosa*	Unknown	Bauxite plateau
266		167	15	11	Shell Mound	27	27	27	1.5	570	370	*Anadara granosa*	Unknown	Bauxite plateau
267		168	16	11	Shell Mound	8	8	8	0.1	50		*Anadara granosa*	Unknown	Bauxite plateau
268		169	17	11	Shell Mound	12	12	12	0.5	110	30	*Anadara granosa*	Unknown	Bauxite plateau
269		17		1	Shell Mound	14	10		0.25	450	60	*Anadara granosa*	Unknown	Bauxite plateau
270		170	18	11	Shell Mound	23	15		1	360	160	*Anadara granosa*	Unknown	Bauxite plateau
271		171	19	11	Shell Mound	15	15	15	0.1	180	10	*Anadara granosa*	Unknown	Bauxite plateau
272		172	20	11	Shell Mound	21	8		0.1	140		*Anadara granosa*	Unknown	Bauxite plateau
273		173	21	11	Shell Mound	23	15		1	250	40	*Anadara granosa*	Unknown	Bauxite plateau
274		174	22	11	Shell Mound	18	18	18	0.2	250	30	*Anadara granosa*	Unknown	Bauxite plateau
275		175	23	11	Shell Mound	100	19		3	1600	1470	*Anadara granosa*	Unknown	Bauxite plateau

276		176	24	11	Shell Mound	92	42		0.5	130	30	*Anadara granosa*	Unknown	Coastal Plain
277		177	25	11	Shell Mound	19	8		0.5	130	30	*Anadara granosa*	Unknown	Coastal Plain
278		178	26	11	Shell Mound	9	9	9	0.1	60		*Anadara granosa*	Unknown	Bauxite plateau
279		179	27	11	Shell Mound	17	17	17	1	230	100	*Anadara granosa*	Unknown	Bauxite plateau
280		18		1	Shell Mound	80	47		10.5	2750	9380	*Anadara granosa*	Unknown	Coastal Plain
281		180	28	11	Shell Mound	23	8		0.1	180		*Anadara granosa*	Unknown	Bauxite plateau
282		181	29	11	Shell Mound	46	19		1.5	640	410	*Anadara granosa*	Unknown	Coastal Plain
283		182	30	11	Shell Mound	50	19		0.5	600	130	*Anadara granosa*	Unknown	Bauxite plateau
284		184	32	11	Shell Mound	15	12		0.1	150		*Anadara granosa*	Unknown	Bauxite plateau
285		185	33	11	Shell Mound	39	23		0.1	710	40	*Anadara granosa*	Unknown	Bauxite plateau
286		186	34	11	Shell Mound	184	19		3	2690	1240	*Anadara granosa*	Unknown	Bauxite plateau
287		187	35	11	Shell Mound	8	8	8	0.1	50		*Anadara granosa*	Unknown	Bauxite plateau
288		188	36	11	Shell Mound	19	10		0.2	150	20	*Anadara granosa*	Unknown	Bauxite plateau
289		189	37	11	Shell Mound	19	19	19	1	280	120	*Anadara granosa*	Unknown	Bauxite plateau
290		19	134	1	Shell Mound	20	20	20	2	310	270	*Anadara granosa*	Unknown	Coastal Plain
291		190	38	11	Shell Mound	9	9	9	0.1	60		*Anadara granosa*	Unknown	Bauxite plateau

292		191	39	11	Shell Mound	8	8	8	0.1	50		*Anadara granosa*	Unknown	Bauxite plateau
293		192	40	11	Shell Mound	8	8	8	0.1	50		*Anadara granosa*	Unknown	Bauxite plateau
294		193	41	11	Shell Mound	8	8	8	0.1	50		*Anadara granosa*	Unknown	Bauxite plateau
295		194	42	11	Shell Mound	8	8	8	0.1	50		*Anadara granosa*	Unknown	Bauxite plateau
296		195	43	12	Shell Mound	39	18		1.5	540	350	*Anadara granosa*	Unknown	Coastal Plain
297		196	44	12	Shell Mound	25	12		1	250	130	*Anadara granosa*	Unknown	Coastal Plain
298		197	45	12	Shell Mound	46	31		4.5	800	1080	*Anadara granosa*	Unknown	Coastal Plain
299		198	46	12	Shell Mound	25	12		5	650	1590	*Anadara granosa*	Unknown	Coastal Plain
300		199	47	12	Shell Mound	42	19		1.5	700	280	*Anadara granosa*	Unknown	Coastal Plain
301		2	150	1	Shell Mound	12	12	12	0.5	110	30	*Anadara granosa*	Unknown	Coastal Plain
302		20	133	2	Shell Mound	10	10	10	0.25	30	10	*Anadara granosa*	Unknown	Bauxite plateau
303		201	49	12	Shell Mound	14	8		1	100	40	*Anadara granosa*	Unknown	Coastal Plain
304		202	50	13	Shell Mound	107	40		2.5	1840	1780	*Anadara granosa*	Unknown	Bauxite plateau
305		203	51	13	Shell Mound	42	39		4.5	1090	1550	*Anadara granosa*	Unknown	Bauxite plateau
306		204	52	13	Shell Mound	27	14		1	450	200	*Anadara granosa*	Unknown	Bauxite plateau
307		205	53	13	Shell Mound	35	18		2	490	280	*Anadara granosa*	Unknown	Bauxite plateau

308		206	54	13	Shell Mound	31	8		0.1	200	10	*Anadara granosa*	Unknown	Bauxite plateau
309		207	55	13	Shell Mound	131	19		1.5	2400	1030	*Anadara granosa*	Unknown	Bauxite plateau
310		208	56	13	Shell Mound	19	19		0.2	280	30	*Anadara granosa*	Unknown	Bauxite plateau
311		209	57	13	Shell Mound	46	39		1.5	1200	780	*Anadara granosa*	Unknown	Bauxite plateau
312		21	132	2	Shell Mound	12	12	12	1	110	60	*Anadara granosa*	Unknown	Bauxite plateau
313		210	58	13	Shell Mound	65	10		0.2	500	10	*Anadara granosa*	Unknown	Bauxite plateau
314		211	59	13	Shell Mound	19	15		0.5	300	50	*Anadara granosa*	Unknown	Bauxite plateau
315		212	60	13	Shell Mound	15	15	15	1	180	80	*Anadara granosa*	Unknown	Bauxite plateau
316		213	61	13	Shell Mound	12	12	12	0.25	110	10	*Anadara granosa*	Unknown	Bauxite plateau
317		214	62	13	Shell Mound	42	17		1.5	530	350	*Anadara granosa*	Unknown	Bauxite plateau
318		215	63	13	Shell Mound	8	8	8	0.2	80	10	*Anadara granosa*	Unknown	Bauxite plateau
319		216	64	13	Shell Mound	19	11		0.2	180	20	*Anadara granosa*	Unknown	Bauxite plateau
320		217	65	13	Shell Mound	77	39		0.25	2500	270	*Anadara granosa*	Unknown	Bauxite plateau
321	WP-SM49				Shell Scatter	0	0		0	40		*Anadara granosa*	Scatter	Bauxite plateau
322		22	131	2	Shell Mound	14	14	14	1.5	150	80	*Anadara granosa*	Unknown	Bauxite plateau
323	WP-SM50				Shell Mound	20	20		0.7	330		*Anadara granosa*	Dome	Bauxite plateau

324	WP-SM51				Shell Scatter	16	14		0	189		*Anadara granosa*	Scatter	Bauxite plateau
325	WP-SM52				Shell scatter	0	0		0	40		*Anadara granosa*	Scatter	Bauxite plateau
326		23	130	2	Shell Mound	35	23		4	690	1190	*Anadara granosa*	Unknown	Bauxite plateau
327	WP-SM53				Shell Mound	24	19		0.5	357		*Anadara granosa*	Dome	Bauxite plateau
328	WP-SM54				Shell Mound	42	18		0.8	674		*Anadara granosa*	Elongated	Bauxite plateau
329	WP-SM55				Shell Mound	55	45		1.5	1926		*Anadara granosa*	Composite	Bauxite plateau
330	WP-SM56				Shell Scatter	3	3		0	40		*Anadara granosa*	Scatter	Bauxite plateau
331	WP-SM57				Shell Mound	19	13		0.3	216		*Anadara granosa*	Dome	Bauxite plateau
332	WP-SM58				Shell Mound	23	15		1	364		*Anadara granosa*	Dome	Bauxite plateau
333	WP-SM59				Shell Mound	30	15		0.3	486		*Anadara granosa*	Elongated	Bauxite plateau
334	WP-SM60				Shell Mound	12	12		0.3	146		*Anadara granosa*	Dome	Bauxite plateau
335	WP-SM61				Shell Mound	12	8		0.3	93		*Anadara granosa*	Dome	Bauxite plateau
336	WP-SM62				Shell Scatter	12	12		0.15	99		*Anadara granosa*	Scatter	Bauxite plateau
337		24	129	2	Shell Mound	35	10		2	300	300	*Anadara granosa*	Unknown	Bauxite plateau
338	WP-SM63				Shell Mound	30	20		1.3	538		*Anadara granosa*	Dome	Bauxite plateau
339	WP-SM64				Shell Mound	17	13		0.8	171		*Anadara granosa*	Dome	Bauxite plateau

340	WP-SM65				Shell Mound	16	13		1.2	188		*Anadara granosa*	Dome	Bauxite plateau
341	WP-SM66				Shell Mound	13	21		1.4	330		*Anadara granosa*	Elongated	Bauxite plateau
342	WP-SM67				Shell Mound	15	13		0.4	173		*Anadara granosa*	Dome	Bauxite plateau
343		25	128	2	Shell Mound	10	10	10	1	80	40	*Anadara granosa*	Unknown	Bauxite plateau
344	WP-SM68				Shell Mound	14	11		0.3	142		*Anadara granosa*	Dome	Bauxite plateau
345	WP-SM69				Shell Mound	11	10		1.3	89		*Anadara granosa*	Dome	Bauxite plateau
346	WP-SM70				Shell Mound	40	13		0.8	429		*Anadara granosa*	Elongated	Bauxite plateau
347	WP-SM71				Shell Mound	10	7		0.8	65		*Anadara granosa*	Dome	Bauxite plateau
348	WP-SM72				Shell Mound	20	15		1.4	272		*Anadara granosa*	Dome	Bauxite plateau
349	WP-SM73				Shell Mound	10	10		1.2	86		*Anadara granosa*	Dome	Bauxite plateau
350	WP-SM74				Shell Mound	17	14		1.2	210		*Anadara granosa*	Dome	Bauxite plateau
351	WP-SM75				Shell Mound	27	15		1.9	363		*Anadara granosa*	Dome	Ridge on Coastal Plain
352		26	127	2	Shell Mound	20	20	20	0.5	310	80	*Anadara granosa*	Unknown	Bauxite plateau
353	WP-SM76				Shell Mound	35	17		2.3	419		*Anadara granosa*	Elongated	Bauxite plateau
354	WP-SM77				Shell Mound	45	20		2.5	646		*Anadara granosa*	Elongated	Bauxite plateau

355	WP-SM78				Shell Mound	13	11		1.6	122		*Anadara granosa*	Dome	Bauxite plateau
356	WP-SM79				Shell Mound	15	10		0.6	113		*Anadara granosa*	Dome	Bauxite plateau
357	WP-SM80				Shell Mound	22	17		1.6	318		*Anadara granosa*	Dome	Bauxite plateau
358		266	51	16	Shell Mound	23	23	23	0.5	420	90	*Anadara granosa*	Unknown	Ridge on Coastal Plain
359		267	52	16	Shell Mound	18	12		1.5	160	120	*Anadara granosa*	Unknown	Ridge on Coastal Plain
360		268	53	16	Shell Mound	162	19		1.5	2300	1480	*Anadara granosa*	Unknown	Ridge on Coastal Plain
361		269	54	17	Shell Mound	46	15		0.2	550	10	*Anadara granosa*	Unknown	Ridge on Coastal Plain
362		27	126	2	Shell Mound	20	20	20	1	310	160	*Anadara granosa*	Unknown	Bauxite plateau
363		270	55	17	Shell Mound	39	39		0.5	1150	40	*Anadara granosa*	Unknown	Ridge on Coastal Plain
364		271	56	17	Shell Mound	49	33		1.5	2530	510	*Anadara granosa*	Unknown	Ridge on Coastal Plain
365		272	57	17	Shell Mound	19	15		0.1	210	50	*Anadara granosa*	Unknown	Ridge on Coastal Plain
366		273	58	17	Shell Mound	19	12		0.1	180		*Anadara granosa*	Unknown	Ridge on Coastal Plain

367		274	59	17	Shell Mound	23	23	23	1	420	210	*Anadara granosa*	Unknown	Ridge on Coastal Plain
368		275	60	17	Shell Mound	8	4		0.1	30		*Anadara granosa*	Unknown	Ridge on Coastal Plain
369		276	61	17	Shell Mound	23	12		0.1	210	10	*Anadara granosa*	Unknown	Ridge on Coastal Plain
370		277	62	17	Shell Mound	62	23		1.5	1100	960	*Anadara granosa*	Unknown	Ridge on Coastal Plain
371		278	63	17	Shell Mound	23	15		1	260	110	*Anadara granosa*	Unknown	Ridge on Coastal Plain
372		279	64	17	Shell Mound	42	19		3.5	700	790	*Anadara granosa*	Unknown	Ridge on Coastal Plain
373		28	125	2	Shell Mound	35	35	35	3.5	960	1320	*Anadara granosa*	Unknown	Bauxite plateau
374		280	65	17	Shell Mound	15	15		1	190	120	*Anadara granosa*	Unknown	Ridge on Coastal Plain
375		281	66	17	Shell Mound	31	31	31	2	1260	670	*Anadara granosa*	Unknown	Ridge on Coastal Plain
376		282	67	17	Shell Mound	18	18	18	1.5	250	160	*Anadara granosa*	Unknown	Ridge on Coastal Plain
377		283	68	17	Shell Mound	19	19	19	0.5	280	70	*Anadara granosa*	Unknown	Ridge on Coastal Plain

378		284	69	17	Shell Mound	31	31	31	1	760	370	*Anadara granosa*	Unknown	Ridge on Coastal Plain
379		285	70	17	Shell Mound	6	4		0.1	0		*Anadara granosa*	Unknown	Ridge on Coastal Plain
380		286	71	17	Shell Mound	15	8		0.1	90		*Anadara granosa*	Unknown	Ridge on Coastal Plain
381		287	72	17	Shell Mound	46	15		0.1	460	10	*Anadara granosa*	Unknown	Ridge on Coastal Plain
382		288	73	17	Shell Mound	9	9		0.1	40		*Anadara granosa*	Unknown	Ridge on Coastal Plain
383		289	74	17	Shell Mound	18	18	18	0.5	250	60	*Anadara granosa*	Unknown	Ridge on Coastal Plain
384		29	124	2	Shell Mound	20	20	20	1.5	310	200	*Anadara granosa*	Unknown	Bauxite plateau
385		290	75	18	Shell Mound	23	23	23	0.5	420	90	*Anadara granosa*	Unknown	Bauxite plateau
386		291	76	18	Shell Mound	108	46		5.5	1490	2320	*Anadara granosa*	Unknown	Mangroves
387		292	77	18	Shell Mound	77	31		4	1210	1610	*Anadara granosa*	Unknown	Bauxite plateau
388		293	78	18	Shell Mound	39	19		0.2	550	10	*Anadara granosa*	Unknown	Bauxite plateau
389		294	79	18	Shell Mound	27	12		0.5	240	60	*Anadara granosa*	Unknown	Bauxite plateau
390		295	80	18	Shell Mound	54	19		0.2	750	80	*Anadara granosa*	Unknown	Bauxite plateau

391		296	81	18	Shell Mound	46	23		1	740	320	*Anadara granosa*	Unknown	Bauxite plateau
392		297	82	18	Shell Mound	19	19	19	0.75	280	90	*Anadara granosa*	Unknown	Bauxite plateau
393		298	83	18	Shell Mound	100	40		3	3220	2250	*Anadara granosa*	Unknown	Bauxite plateau
394		299	84	18	Shell Mound	124	20		0.2	1000	30	*Anadara granosa*	Unknown	Bauxite plateau
395		3	149	1	Shell Mound	55	40		7.5	1330	3280	*Anadara granosa*	Unknown	Coastal Plain
396		30	123	2	Shell Mound	70	48		13	2270	8840	*Anadara granosa*	Unknown	Coastal Plain
397		31	122	2	Shell Mound	14	10		1	450	230	*Anadara granosa*	Unknown	Bauxite plateau
398		32	121	2	Shell Mound	8	6		0.5	40	10	*Anadara granosa*	Unknown	Coastal Plain
399		33	120	2	Shell Mound	6	6	6	0.5	30	10	*Anadara granosa*	Unknown	Coastal Plain
400		34	119	2	Shell Mound	12	10		1	380	160	*Anadara granosa*	Unknown	Coastal Plain
401		35	118	2	Shell Mound	46	23		4	910	1330	*Anadara granosa*	Unknown	Coastal Plain
402		36	117	2	Shell Mound	65	20		12	1920	6730	*Anadara granosa*	Unknown	Coastal Plain
403		37	116	2	Shell Mound	10	10	10	1	80	40	*Anadara granosa*	Unknown	Coastal Plain
404		38	115	2	Shell Mound	8	8	8	0.2	50	10	*Anadara granosa*	Unknown	Bauxite plateau
405		39	114	2	Shell Mound	13	13	13	1.5	130	100	*Anadara granosa*	Unknown	Bauxite plateau

406		4	148	1	Shell Mound	22	14		3	1020	1190	*Anadara granosa*	Unknown	Coastal Plain
407		40	113	2	Shell Mound	15	15	15	1	180	100	*Anadara granosa*	Unknown	Bauxite plateau
408		41	112	2	Shell Mound	6	6	6	0.75	30	10	*Anadara granosa*	Unknown	Bauxite plateau
409		42	111	2	Shell Mound	10	10	10	0.03	80		*Anadara granosa*	Unknown	Bauxite plateau
410		43	110	2	Shell Mound	77	46		1.5	1710	1110	*Anadara granosa*	Unknown	Bauxite plateau
411		44	109	2	Shell Mound	10	10	10	1	80	40	*Anadara granosa*	Unknown	Coastal Plain
412		45	108	2	Shell Mound	35	31		7	660	1630	*Anadara granosa*	Unknown	Coastal Plain
413		46	107	2	Shell Mound	17	6		0.5	400	100	*Anadara granosa*	Unknown	Coastal Plain
414		47	106	2	Shell Mound	5	5	5	1	20	10	*Anadara granosa*	Unknown	Coastal Plain
415		48	105	2	Shell Mound	53	26		7	1250	3370	*Anadara granosa*	Unknown	Coastal Plain
416		49	104	2	Shell Mound	34	31		7	1330	2320	*Anadara granosa*	Unknown	Coastal Plain
417		5	147	1	Shell Mound	121	36		10.5	2900	5720	*Anadara granosa*	Unknown	Coastal Plain
418		50	103	2	Shell Mound	5	5	5	0.5	80	20	*Anadara granosa*	Unknown	Coastal Plain
419		51	102	2	Shell Mound	6	6	6	0.3	30	10	*Anadara granosa*	Unknown	Coastal Plain
420		52	101	2	Shell Mound	6	6	6	1	30	20	*Anadara granosa*	Unknown	Bauxite plateau

421		53	100	2	Shell Mound	3	3	3	0.2	10		*Anadara granosa*	Unknown	Bauxite plateau
422		54	99	2	Shell Mound	5	5	5	0.3	20		*Anadara granosa*	Unknown	Bauxite plateau
423		55	98	2	Shell Mound	12	12	12	0.25	110	30	*Anadara granosa*	Unknown	Bauxite plateau
424		56	97	2	Shell Mound	8	8	8	0.2	50	10	*Anadara granosa*	Unknown	Bauxite plateau
425		57	96	2	Shell Mound	8	8	8	0.2	50	10	*Anadara granosa*	Unknown	Bauxite plateau
426		58	95	2	Shell Mound	10	10	10	0.2	80	10	*Anadara granosa*	Unknown	Bauxite plateau
427		59	94	2	Shell Mound	24	15		1	310	130	*Anadara granosa*	Unknown	Bauxite plateau
428		6	146	1	Shell Mound	12	12	12	0.75	110	40	*Anadara granosa*	Unknown	Bauxite plateau
429		60	93	2	Shell Mound	65	45		8.5	2000	5410	*Anadara granosa*	Unknown	Coastal Plain
430		61	92	3	Shell Mound	30	13		1	350	150	*Anadara granosa*	Unknown	Coastal Plain
431		62	91	3	Shell Mound	20	20	20	3	310	470	*Anadara granosa*	Unknown	Coastal Plain
432		63	90	3	Shell Mound	50	28		6.5	1000	2040	*Anadara granosa*	Unknown	Coastal Plain
433		64	89	3	Shell Mound	20	15		3	250	330	*Anadara granosa*	Unknown	Coastal Plain
434		65	88	3	Shell Mound	68	20		5.5	1010	1950	*Anadara granosa*	Unknown	Coastal Plain
435		66	87	3	Shell Mound	6	6	6	0.75	30	10	*Anadara granosa*	Unknown	Bauxite plateau

436		67	86	3	Shell Mound	7	7	7	1.5	40	10	*Anadara granosa*	Unknown	Bauxite plateau
437		68	85	3	Shell Mound	6	6	6	1	30	10	*Anadara granosa*	Unknown	Bauxite plateau
438		69	84	3	Shell Mound	6	6	6	0.5	30	10	*Anadara granosa*	Unknown	Bauxite plateau
439		7	145	1	Shell Mound	14	14	14	1	150	80	*Anadara granosa*	Unknown	Bauxite plateau
440		70	79	3	Shell Mound	100	15		1.5	1450	940	*Anadara granosa*	Unknown	Bauxite plateau
441		71	78	3	Shell Mound	14	8		0.5	100	20	*Anadara granosa*	Unknown	Bauxite plateau
442		72	77	3	Shell Mound	18	18	18	0.5	250	60	*Anadara granosa*	Unknown	Bauxite plateau
443		73	76	3	Shell Mound	30	16		1.5	400	260	*Anadara granosa*	Unknown	Bauxite plateau
444		74	75	3	Shell Mound	45	20		1	600	260	*Anadara granosa*	Unknown	Bauxite plateau
445		75	74	3	Shell Mound	65	26		3	1180	870	*Anadara granosa*	Unknown	Bauxite plateau
446		76	73	3	Shell Mound	48	19		1	610	310	*Anadara granosa*	Unknown	Bauxite plateau
447		77	72	4	Shell Mound	24	15		0.5	230	60	*Anadara granosa*	Unknown	Coastal Plain
448		78	71	4	Shell Mound	10	10	10	0.5	80	20	*Anadara granosa*	Unknown	Coastal Plain
449		79	70	4	Shell Mound	30	25		5.5	520	1670	*Anadara granosa*	Unknown	Coastal Plain
450		8	144	1	Shell Mound	16	10		1	530	270	*Anadara granosa*	Unknown	Bauxite plateau

451		80	69	5	Shell Mound	18	18	18	1.5	250	110	*Anadara granosa*	Unknown	Bauxite plateau
452		81	68	5	Shell Mound	6	6	6	0.03	30		*Anadara granosa*	Unknown	Bauxite plateau
453		82	67	5	Shell Mound	10	10	10	0.03	80		*Anadara granosa*	Unknown	Bauxite plateau
454		83	66	5	Shell Mound	12	12	12	0.03	110		*Anadara granosa*	Unknown	Bauxite plateau
455		84	65	5	Shell Mound	20	20		0.3	310	40	*Anadara granosa*	Unknown	Bauxite plateau
456		85	64	5	Shell Mound	18	10		0.2	150	20	*Anadara granosa*	Unknown	Bauxite plateau
457		86	63	5	Shell Mound	18	12		1.5	170	110	*Anadara granosa*	Unknown	Bauxite plateau
458		87	62	5	Shell Mound	19	11		2	170	150	*Anadara granosa*	Unknown	Bauxite plateau
459		88	61	5	Shell Mound	27	25		3	680	850	*Anadara granosa*	Unknown	Coastal Plain
460		89	60	6	Shell Mound	10	10	10	0.5	80	20	*Anadara granosa*	Unknown	Coastal Plain
461		9	143	1	Shell Mound	12	12	12	1	110	60	*Anadara granosa*	Unknown	Bauxite plateau
462		90	59	6	Shell Mound	10	10	10	0.5	80	20	*Anadara granosa*	Unknown	Coastal Plain
463		91	58	6	Shell Mound	20	20	20	0.5	310	80	*Anadara granosa*	Unknown	Coastal Plain
464		92	57	6	Shell Mound	45	22		4.5	810	1830	*Anadara granosa*	Unknown	Coastal Plain
465		93	56	6	Shell Mound	16	16	16	4.5	200	530	*Anadara granosa*	Unknown	Coastal Plain
466		94	55	6	Shell Mound	16	16	16	3	200	280	*Anadara granosa*	Unknown	Coastal Plain

Appendix 4: Archaeological features

Site ID.	Type	Dominant Material	No. of Artefacts	Shell Mound Tonnage	Data source/Reference
1	Artefact and Shell Scatter	Stone artefacts and marine shell			Rio Tinto Data
2	Artefact and Shell Scatter	Stone artefacts and marine shell			Rio Tinto Data
3	Shell Mound Group	Marine shell		3060	Evans 1957
4	Shell Mound Group	Marine shell		93	Evans 1957
5	Shell Mound Group	Marine shell		760	Evans 1957
6	Shell Mound Group	Marine shell			Evans 1957
7	Shell Mound Group	Marine shell		2350	Evans 1957
8	Shell Mound Group	Marine shell		117	Evans 1957
9	Shell Mound Group	Marine shell		77	Evans 1957
10	Shell Mound Group	Marine shell		34	Evans 1957
11	Shell Mound Group	Marine shell		1280	Evans 1957
12	Shell Mound Group	Marine shell		2000	Evans 1957
13	Shell Mound Group	Marine shell		2550	Evans 1957
14	Shell Mound Group	Marine shell		280	Evans 1957
15	Shell Mound Group	Marine shell		1060	Evans 1957
16	Shell Mound Group	Marine shell		124	Evans 1957
17	Shell Mound Group	Marine shell		620	Evans 1957
18	Shell Mound Group	Marine shell			Evans 1957
19	Shell Mound Group	Marine shell		1940	Evans 1957
20	Shell Mound Group	Marine shell			Bailey 1972
21	Shell Mound Group	Marine shell			Bailey 1972
22	Shell Mound Group	Marine shell			Morrison Aerial Photography
23	Shell Mound Group	Marine shell			Bailey 1972

24	Shell Mound Group	Marine shell			Bailey 1972
25	Shell Mound Group	Marine shell			Bailey 1972
26	Shell Mound Group	Marine shell			Bailey 1972
27	Shell Mound Group	Marine shell			Bailey 1972
28	Shell Mound Group	Marine shell			Bailey 1972
29	Shell Mound Group	Marine shell			Cribb 1995
30	Shell Mound Group	Marine shell			Cribb 1995
31	Shell Mound Group	Marine shell			Cribb 1995
32	Shell Mound Group	Marine shell			Cribb 1995
33	Shell Mound Group	Marine shell			Cribb 1995
34	Shell Mound Group	Marine shell			Cribb 1995
35	Shell Mound Group	Marine shell			Cribb 1995
36	Shell Mound Group	Marine shell			Cribb 1995
37	Shell Mound Group	Marine shell			Cribb 1995
38	Shell Mound Group	Marine shell			Cribb 1995
39	Shell Mound Group	Marine shell			Cribb 1995
40	Shell Mound Group	Marine shell			Cribb 1995
41	Shell Mound Group	Marine shell			Cribb 1995
42	Shell Mound Group	Marine shell			Cribb 1995
43	Shell Mound Group	Marine shell			Cribb 1995
44	Shell Mound Group	Marine shell			Cribb 1995
45	Shell Mound Group	Marine shell			Cribb 1995
46	Shell Mound Group	Marine shell			Cribb 1995
47	Stone Artefact Scatter	Silcrete and Quartz	150		Rio Tinto Data
48	Stone Artefact Scatter	Silcrete and Quartz	156		Rio Tinto Data
49	Stone Artefact Scatter	Silcrete and Quartz	225		Rio Tinto Data
50	Stone Artefact Scatter	Silcrete and Quartz	27		Rio Tinto Data
51	Stone Artefact Scatter	Silcrete and Quartz	379		Rio Tinto Data

52	Stone Artefact Scatter	Silcrete and Quartz	35		Rio Tinto Data
53	Stone Artefact Scatter	Silcrete and Quartz	23		Rio Tinto Data
54	Stone Artefact Scatter	Quartz and silcrete	84		Rio Tinto Data

Appendix 5: Radiocarbon determinations obtained by the author

Location	Lab Code	CRA	Cal BP (1 σ)	d13C	Site No.[1]	Mean Depth (cm BS)	Dating Material[2]
Prunung	Wk14507	898± 37	430(473)516	-1.5±0.2	92	75	Ag.
	Wk14506	980±32	489(535)593	-1.8±0.2	90	40	Ag.
	Wk13788	469±43	Invalid	n/a	90	25	Ag.
	AMS NZA-19659	633±38	139(206)279	-1.6±0.2	88	21	Ag.
	Wk14509	780±35	309(372)424	-1.5±0.2	88	65	Ag.
	Wk11861	1096±42	558(613)656	-1.9±0.2	93	97	Ag.
	Wk11862	901±42	428(474)521	-2±0.2	93	63	Ag.
	Wk11863	853±46	378(432)498	-1.6±0.2	93	23	Ag.
	Wk13787	738±40	279(340)399	-1.7±0.2	86	30	Ag.
Bweening	Wk12155	1475±47	918(971)1014	-2.1±0.2	137	20	Ag.
	Wk12156	938±53	472(503)530	-2±0.2	126	2	Ag.
	Wk12157	896±55	445(475)506	-2.3±0.2	126	19	Ag.
	Wk12158	603±49	135(183)253	-1.9±0.2	123a	3.5	Ag.
	Wk12159	820±60	361(409)466	-2±0.2	116b	25	Ag.
	WK12160	740±61	285(341)383	-1.7±0.2	115a	4	Ag.
	Wk12161	816±47	338(404)461	-1.7±0.2	114c	17	Ag.
	Wk13786	917±41	459(489)518	-2.1±0.2	140a	20	Ag.
	Wk13784	1528±41	958(1022)1067	-1.2±0.2	147	130	Ag.
	Wk13785	715±41	265(314)362	-2.2±0.2	136	25	Ag.

Notes: 1) Number of site used Chapter 5 and in site database. 2) Dating material: Ag =*Anadara granosa*. See Appendix 1 for calibration and correction methods.

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