ARCHAEOLOGICAL SETTLEMENT PATTERNS
AND MOBILITY STRATEGIES ON THE LOWER
ADELAIDE RIVER, NORTHERN AUSTRALIA

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VOLUME I

A thesis submitted for the degree of Doctor of Philosophy in the Department of
Anthropology, Faculty of Law, Business and Arts, Northern Territory University.

August 2001
DECLARATION

I declare that the following work, now submitted as a thesis for the degree of Doctor of Philosophy, is the result of my own investigations, and all references to ideas and work of other researchers has been specifically acknowledged. I certify that the work contained in this thesis has not already been accepted in substance for any degree, and is not being currently submitted in candidature for any other degree.

Signed:  C. Brockle

Date:  17/8/01
ABSTRACT

This thesis investigates settlement patterns and mobility strategies on the lower Adelaide River in the late Holocene period. As earth mounds are the dominant site type in the study area and have a chronology spanning at least 4000 years, they provide opportunities for research into Aboriginal adaptive strategies in an environment that changed dramatically over the mid to late Holocene period. Earth mounds have been reported from a number of locations in northern Australia, but until now have not been studied intensively. Several themes raised by the literature in relation to the earth mounds in both northern and southern Australia will be addressed, including location, morphology, chronology, origins and the role that earth mounds play in wider settlement systems. The earth mounds are located next to the vast floodplains of the Adelaide River, one of the major tropical rivers draining the flat coastal plains of the north. The floodplains of the northern rivers underwent dynamic environmental change from extensive mangrove swamps in the mid Holocene, through a variable estuarine and freshwater mosaic environment c. 3000 years ago, to the freshwater floodplains that are extant today. Geomorphological research into floodplain evolution in northern Australia has provided a framework within which the archaeology can be interpreted. I will argue that the earth mounds represent base camps and that occupation of the floodplain margins has been the major settlement strategy in the region from at least 4000 years ago until the recent past. However within that time the occupants of the earth mounds have adapted their foraging patterns and altered their mobility strategies according to floodplain conditions.
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CHAPTER 1: MODELS, MOUNDS AND MOBILITY

1.1 INTRODUCTION

The aim of this thesis is to determine the nature of pre-contact settlement patterns and subsistence strategies on the lower Adelaide River (Map 1.1) against the backdrop of the dramatic environmental change that took place on the coastal plains of northern Australia in the mid to late Holocene period. This study is comparable with previous research undertaken on the floodplains of other rivers in the Top End of the Northern Territory of Australia (for example Allen 1996; Allen and Barton 1989; Baker 1981; Bowen 1996; Brockwell 1983; Brockwell 1989; Guse 1992; Guse and Majar 2000; Hiscock 1996; Hiscock et al. 1992; Kamminga and Allen 1973; Meehan 1991; Meehan et al. 1985; Schrire 1982; Woodroffe et al. 1988). The Top End is defined as that part of the Northern Territory north of the 15th parallel (Whitehead 1998:5).

Previous surveys on the floodplain margins of the lower Adelaide River (Brockwell 1996c; Schrire 1968; Smith 1981a) revealed that the majority of sites located in the area are earth mounds. As stratified sites, earth mounds provide a unique opportunity to investigate settlement patterns and subsistence strategies as they can be linked chronologically to the evolution of the coastal plains of northern Australia. Previously such investigations have been limited mainly to rockshelters in western Arnhem Land. Earth mounds are a common archaeological feature of the northern Australian coastal plains. However, there is so far little known about them in the Northern Territory, although they have been reported from several areas as an adjunct to other research (Baker 1981, Meehan 1988, 1991; Peterson 1973). In 1981 and 1983, I conducted research into large open sites on the floodplain margins of the South Alligator River in Kakadu. These investigations revealed that earth mounds were a common feature of the area which, it was hypothesised, played a seasonal role in prehistoric Aboriginal adaptive strategies of the region (Brockwell 1983, 1989; Meehan et al. 1985). The current inquiry has provided an opportunity to undertake an integrated regional study of northern Australian earth mounds, as well as to test hypotheses generated by the Kakadu research.
and to extend investigations of other types of open sites in the lower Adelaide River area. Such studies also have the potential to address broader themes derived from Holocene research elsewhere in Australia, such as the role of mounds in Aboriginal settlement strategies and, in particular, hunter-gatherer mobility in an environment which changed dramatically through the mid to late Holocene.

There have been numerous studies of mound sites, both in northern (cf. Baker 1981; Bailey 1975, 1977, 1994, 1999; Beaton 1985; Bourke 2000; Burns 1994, 1999; Cribb 1986, 1996; Cribb et al. 1988; McCarthy and Setzler 1960; Meehan 1982, 1988, 1991; Mitchell 1993; Mowat 1995; Peterson 1973; Roberts 1991, 1994; Sullivan and O'Connor 1993; Veitch 1994, 1999; Warner 1969) and southern Australia (Balme and Beck 1996; Berryman and Frankel 1984; Bonhomme 1990; Buchan 1980; Coutts 1980; Coutts et al. 1976, 1979; Frankel 1991; Klaver 1987, 1990, 1998; Lane 1980; Simmons 1980; Sullivan 1980; Williams 1988, 1994). Most of the studies in northern Australia have tended to be on shell mounds and coastal and estuarine exploitation, although there has been some overlap with earth mound studies and some of the questions associated with them. It seems that in one key way earth and shell mounds are alike in that they are strategically located at the junction of resources (Rowland 1994:147). This chapter will review investigations into earth mounds in southern and northern Australia and identify themes concerning their role in settlement strategies that will be addressed by the Adelaide River study.

1.2 EARTH MOUNDS IN SOUTHERN AUSTRALIA

In southern Australia there have been a number of specific studies of earth mounds and their role in settlement and subsistence strategies. These studies have identified a number of themes including location, morphology, chronology, function and seasonality that are relevant to an investigation of earth mounds in northern Australia. Below I will review the evidence from southern Australia.
**Western Victoria**

In a survey of the Western District of Victoria, Coutts et al. (1976:13,19) located 207 mounds, mostly near creeks, rivers, lakes and seasonally inundated land. Of these 75% were situated on natural rises (Coutts et al. 1976:12). The study area has a large number of swamps and lakes that attract large numbers of birds (Coutts et al. 1976:9). Most of the mounds were located at the junction of resource zones, including woodland and grassland as well as swamps, close to water bodies, many following the line of the Hopkins River which flows through the area. About 45% of mounds were grouped mostly in pairs but in groups of up to six within a radius of 500 m (Coutts et al. 1976:12-13, 19-20). The dimensions of the mounds are listed in Table 1.1. They are mostly circular in shape and contain black soil with charcoal and flakes (Coutts et al. 1976:19).

In the VAS survey of western Victoria, two of the mounds were excavated but not dated. They were found to contain stone arrangements, tentatively identified as fireplaces, human burials, stone artefacts, and faunal remains of freshwater mussels and crayfish, snakes, lizards, emu egg shell, birds, marsupials such as quolls, bandicoots, wallabies, kangaroos, swamp and other rats, rabbits, and dingoes (Coutts et al. 1976:20-38; Table 4). It was concluded that the mounds represent a diverse range of activities including food preparation and cooking, artefact manufacture and represent seasonal base camps, located strategically close to water sources and a range of environmental zones (Coutts et al. 1976:42-43).

Williams (1988) investigated earth mound sites in south-western Victoria in former swamp (many have been drained by farmers) and river country. She selected the field sites because earth mound sites were common and there was ethnographic information concerning their use at contact (1994:162). She defined three classes of mounds: mounds used as the basis for shelters, mounds used as ovens, and mounds used as general living areas; or a combination of all three classes as integrated settlements/base camps (1988:72-75; 1994:163). The mounds were oval or round in shape. They ranged in size from small and low (three metres in diameter and 0.3 m in height) to large and high (more
than 30 m in diameter and two metres in height). The smaller mounds were more common, ranging in size from 5-15 m in diameter (Williams 1994:163). At Caramut, she excavated two mounds and found that the mounds had been artificially built up in the top levels but not in the bottom layers which may mean that the mounds were located on natural rises (1988:72-135). Patches of wood and charcoal were interpreted as the remains of hut structures and hearths. The small amount of bone was too fragmented to be analyzed. Stone artefacts were made mainly from quartz with some flint, all of which were imported from 30-50 km away, and were manufactured in situ. There were two greenstone axes made from local material but not manufactured at the site. One mound was dated to c. 2000 years BP and the other to c. 1000 years BP. Williams concluded that the variety of activities carried out on the excavated mounds indicated that they were base camps, and the mound cluster was probably the remains of a village. Excavations in other areas revealed mounds used as ovens and general camping areas (Williams 1988:169, 206). She concluded that mound function as determined by the archaeological and geomorphological investigations confirmed the ethnographic observations (1988:163).

**Murray River**

Coutts *et al.* (1979:15) located 122 mounds in the Nyah Forest in the Murray Valley. They were mostly less than 20 m in diameter and about 30 cm high, though there were exceptions that were larger. Coutts *et al.* defined two types based on survey and excavation. Type A was smaller, uniform in composition, and contained burnt clay pellets, charcoal and sediment (1979:15,54). The upper layers of Type B contained the same materials as Type A with the addition of the remains of freshwater mussel and other fauna. The lower levels were more compact and contained higher concentrations of burnt clay and charcoal, and less stone and fauna (Coutts *et al.* 1979:15,52-54). They found the Type B mounds to be comparable with those in western Victoria, except that the Murray mounds lacked the activity areas found on mounds in western Victoria (1979:87). Other results from Lake Tyrrell indicate that no mounds were found outside of the Murray River floodplains suggesting that they were an adaptation to a regime of seasonal flooding (Coutts 1980:23).
In the Murray Valley Coutts et al. (1979:30) excavated three sites. DP/1, a Type B site, is a large mound, measuring 50 m by one metre, is located on a slight rise on the floodplains of the Murray River and becomes an island during floods. It is badly disturbed in its upper layers by rabbits, rabbit trappers, and soil removal for market gardens. It contains burnt clay, charcoal, a few sparse faunal remains of freshwater shellfish, emu egg shell, fish, rats, frogs, reptiles, macropods and birds, a lot of which was burnt. There were also a very few stone, bone and shell artefacts. The chert that was present came from a source over 100 km away. Several burials were recovered (Coutts et al. 1979:33, 57). The site was dated to 1375±130 years BP. They conclude from the scarcity of the remains that the site was occupied only intermittently (1979:57). DP/2 and DP/3, Type A sites, were low-level mounds located on a levee and an anabranch respectively. The clay loam matrices at both sites contained burnt clay fragments and charcoal throughout but no stone artefacts or faunal remains (Coutts et al. 1979:36-38). They concluded that the upper levels of DP/1 represent a seasonally occupied site built up on a base of cooking mound (1979:82). The limited faunal evidence indicate that the diet was composed of mainly aquatic species with a few land animals. On this basis, it was concluded that DP/1 was probably occupied post flood in spring and summer. On the other hand they interpret DP/2 and DP/3 as the build-up of rake-outs of cooking mounds (1979:84-85).

VAS continued a series of surveys in the Murray Valley in 1978-79 that tended to confirm previous results regarding mound sites (Coutts 1980). Three major excavations and three test pits were undertaken. Once again, on the same criteria, mounds were found to be either of Type A or Type B, or natural in origin (see below) (Coutts 1980:31-36). One mound, located on the margin of the floodplains, appeared to be a Type B site but also contained a rich faunal assemblage and an edge-ground axe. It was identified as a Type C site, and interpreted to be a base camp used to exploit the area during floods (Coutts 1980:36).
In the Murray Valley, Sullivan (1980) defined the environmental location of the two types of mound. 'Compact' mounds [Type A] containing virtually no cultural material except burnt clay occur on low rises, such as eroded levees, low discontinuous levee deposits or sandy hummocks on the backplain of tributary streams within the Murray floodplain. 'Soft' mounds [Type B] containing shell, bone, stone and burnt clay in a dispersed silty matrix occur on prominent rises such as distinct levees and sand hummocks, or on top of the lower 'compact' mounds. Soft mounds are also concentrated towards the Murray River, e.g. along tributary streams and on the sides of floodplain lakes nearest the Murray channel' (1980:54).

Surveys in New South Wales by Simmons (1980) covered two areas of the Murray River floodplains and terraces. Survey Area A was around the mouth of Speewa Creek, from Lake Jilleroo to Tooley Landing. Survey Area B covered a system of lakes and channels between the Murray River near Nyah 20 km north to the Wakool River. Among other site types the surveys revealed the existence of 75 mound sites, 16 in Area A and 59 in Area B (Simmons 1980:63). In Area A of his Murray River survey Simmons (1980:64-65) defined two types of mounds based on morphology and location. The first type were large isolated mounds with clearly defined boundaries measuring between 30 to 40 m in diameter and up to 0.75 m high, located on levees along the river. He described this type as being similar to 'Type B' mounds described by Coutts et al. (1979:15) for the Nyah Forest. The second type was found in clusters on promontories on the edge of the floodplain and is generally smaller than the isolated mounds. In Area B the mounds were located on the margins of lakes and alluvial flats. They were relatively small being between 10 to 25 m in diameter and 0.2 to 0.6 m high, full of burnt clay pellets (Simmons 1980:69-70). None of the mounds in Simmons' Murray River survey were excavated and contents were judged from surface remains (1980:73). The mounds were made up of a matrix of dark silty soil, and contained numerous burnt clay nodules, charcoal, bone, egg shell and the remains of freshwater mussels and crayfish confirming their cultural origins (Simmons 1980:63-64,73-78). Stone artefacts were rare. Most were found on only two mounds in an atypical location on the red mallee sands high above the water. Simmons
interpreted these sites as seasonal base camps. He assumed that the burnt clay pellets associated with the Area B mounds were used in cooking. He concluded that 'the distributions of mounds, isolated finds, hearths, shell middens, scarred trees and burials found in close association with the floodplains, anabranches and lake systems clearly indicate the importance of aquatic resources and lake systems in local Aboriginal economies. Further, the high density of sites, the contents of the mounds, and in some cases their enormous volumes, indicate that these resources had been used for a long time.'

Lane (1980) conducted a survey of archaeological sites along the Little Murray River. She located 81 mounds associated with water bodies conveniently located to exploit fresh water swamp resources. The average height of the mounds on the Little Murray River was 30 cm. As most of them were highly disturbed by farming activities, Lane (1980:115) commented that they were probably originally higher, perhaps up to one metre. They had an area of between 80 and 1300 m² and 75% were less than 500 m², comparable in size to the Nyah Forest sites. She confirmed Coutts et al.'s (1979:15) analysis of two site types distinguishable according to mound size and distribution: one type with few large mounds; the other with many small mounds (1980:115). Lane (1980) did not date or excavate any of the mounds located on the Little Murray River. The only remains found on the surface were freshwater shellfish. Lane (1980:116) interpreted the mounds as ovens and campsites and said they were unlikely to have been occupied during flood times (winter) when they would have been inundated.

Buchan (1980) conducted a survey at Lake Coomeroop and nearby areas in the Murray Valley, southern New South Wales, where she located a number of mounds associated with the lake, along a creek connecting the lake to the river, and along the Murray River itself. The mounds fell into two site types: large mounds with dark silty soil containing baked clay pellets, charcoal, freshwater mussel and other faunal remains; and low circular mounds containing baked clay pellets and sometimes freshwater mussel shell (Buchan 1980:46-47). She highlighted the difficulty of determining whether the mounds are
natural or cultural in origin, especially those that contain material that is not unequivocally cultural, like the low circular mounds (1980:47). In order to address this problem, Sullivan and Buchan (1980) conducted a series of test excavations and augers on eight sites that had been identified previously as archaeological. Three of these mounds were unequivocally Aboriginal in origin and provided a benchmark for the others (Sullivan and Buchan 1980:89). They concluded that of those mounds containing only burnt clay pellets and charcoal, the cultural mounds have dark, compact matrices and are steep-sided and flat bottomed (1980:96-97). Otherwise there was a continuum between natural (often the result of burnt tree stumps) and cultural mounds, and detailed investigation is required to identify the differences.

Berryman and Frankel (1984; Frankel 1991) and Bonhomme (1990) surveyed the Wakool River and the Barmah Forest respectively in the Murray Valley. Both studies surveyed a number of different landforms, including sand dunes, river/creek margins, swamp/floodplain margins and plains. Mounds were found associated with the floodplains/swamps, lagoons, and creeks and river, with the majority located next to swamps (Berryman and Frankel 1984:23-25; Bonhomme 1990:53-56). Their dimensions are listed in Table 1.1.

In the Barmah Forest the largest mounds were associated with lagoons that hold water for a long time, and are located near to swamps (Bonhomme 1990:62). Some stone (quartz) artefacts and shell (freshwater mussel) were found on the surface of the mounds in the Barmah Forest (Bonhomme 1990:73,76). The quartz consistently showed bipolar working on both flakes and cores, a feature that Hiscock (1996) suggests may be indicative of sedentary behaviour. Bonhomme (1990:83) concluded that the mounds served a variety of functions including as processing sites, ovens and base camps. Bonhomme (1990:84-85) also concluded that 'the abundance and stability of the resources may have encouraged a semi-sedentary lifestyle, especially during the last 2000 years. In addition there are descriptions of vigorous ceremonial and trading activity along...
the Murray river, and more particularly around the Barmah area and the junction of the Goulburn and the Murray River.'

Berryman and Frankel (1984) excavated three mounds on the Wakool River and found nothing apart from some minute fragments of bone and shell, and clay balls used in ovens. The mounds were dated using carbon 14 and thermoluminescence (TL) on charcoal and burnt clay samples respectively and were found to be from 2753-2612 years CALBP (Downey and Frankel 1992:35). Because of the lack of finds, Berryman and Frankel (1984; Frankel 1991:80) were able only to guess at mound function, suggesting that the mound containing clay balls was an oven while the larger mounds were campsites. This interesting interpretation was based on mound size vis-à-vis location. The larger mounds were located adjacent to waterholes with permanent water, just as Bonhomme (1990:83) found in the Barmah Forest. Frankel (1991:80-82) suggested that this correlation exists because when swamps are full people can camp anywhere. However when swamps dry up in the summer, the population would be concentrated next to permanent water. He concluded that 'mound placement reflects water levels and presumably access to other resources such as fish, shellfish and yabbies in the river and waterholes and plant foods in the surrounding areas. During the height of the flood the small islands formed by the mounds could still be reached by bark canoes, providing a base for exploiting the area even when the main campsites had moved to the edge of the floodwater' (1991:82).

**Central Murrumbidgee Riverine Plain**

In a regional survey of the central Murrumbidgee riverine plain Klaver (1998) recorded a total of 581 sites, of which 311 were mounds (Klaver 1998:245). Mounds were defined as being comprised of a number of different components including ovens, heat retainers, hearths and occupation floors (Klaver 1998:132-35). They mainly occurred in alluvial valley plains containing riverine and creek corridors (Klaver 1998:258). They were found in association with other site types such as small ovens, artefact scatters, middens, hearths and scarred trees but Klaver pointed out that only the upper exposed parts of the mounds
could be considered contemporary with the surface sites (Klaver 1998:262). She subsequently excavated four mounds, two small ovens and a shell midden (1998:143). The mounds contained few stone artefacts or faunal remains apart from some turtle carapace, degraded mussel shell, bird, marsupial mouse and unidentifiable burnt fragments of bone. They were mainly composed of burnt clay heat retainers, oven pits and sediment sometimes containing ash and carbon (Klaver 1998:172-73, 176, 179, 181, 217). One oven pit was lined with a sheet of bark that she suggested was one explanation of scarred trees in the vicinity (1998:172). She obtained a suite of dates from the sites ranging from 2890±90 years BP to 390±70 years BP. She concluded that the mounds were all originally ovens but two of the larger sites containing ‘diverse domestic residues’ represented base camps, probably used seasonally during the summer months (Klaver 1998:279, 284).

**Macquarie Marshes**

Balme and Beck (1996) discussed 63 mounds located in the Macquarie Marshes area of the Macquarie River, New South Wales. These mounds were all situated on seasonally inundated fluvial sediments, never on higher ground or ground that was perennially wet or flooded only in peak rainfall years (Balme and Beck 1996:40). They were described as being roughly circular or oval in shape and their dimensions are listed in Table 1.1.

The mounds were not excavated. Burnt clay was littered on the surfaces. There was no bone found, but wetlands exploitation was indicated as there was shell found on top of one mound and a yabbie carapace on another. There were stone artefacts on only five mounds as little suitable local stone for flaking was available. An augur sample revealed that the deposit was fairly uniform dark grey sediment with charcoal and burnt clay throughout. A date of c. 1000 years BP was obtained from the base (Balme and Beck 1996:40-42). Comparing these mounds to analogous evidence from Papua New Guinea, Balme and Beck (1986:48) speculated that mounds in south eastern Australia were originally built up for use as gardens to grow tubers to support semi-sedentary populations. The burnt clay in the sites they interpreted as the result of burning to clear
the sites for gardens rather than as oven debris (Balme and Beck 1996:45). This hypothesis is difficult to test archaeologically as the tuber in question, daisy yam, does not appear to yield phytoliths, which would provide evidence of the presence of the garden species at the sites (Boyd and Lynch 1996:50).

1.3 DISCUSSION

Location
Balme and Beck (1996) and Williams (1988) summarized the evidence on mounds located in south-eastern Australia. They found that all mounds are located in seasonally inundated, poorly drained areas associated with floodplains, water bodies and/or water courses (Coutts et al. 1979:86; Williams 1988:213). Coutts et al. (1976:12), Klaver (1998:65), Sullivan (1980:54) and Williams (1988:135; 1994:164) all point out that mounds are often located on natural rises, suggesting that they are part of a settlement strategy to cope with local flooding. Balme and Beck (1996:48) observed that mounds occur in discrete locations although similar micro-environments are available on other river systems. They interpret this fact as being due to 'regional diversity in resource use ...which may be characteristic of later Holocene societies' (1996:48).

Chronology
The mounds in central and western Victoria and central New South Wales all date to the late Holocene period within the last 3000 years. Most are less than 2000 years old and the majority were established after 1500 years BP (Balme and Beck 1996:42; Bird and Frankel 1991; Coutts and Witter 1977; Klaver 1998; Williams 1988:217). The Murray Valley mounds appear to be older, returning basal dates of 4160±300 to 2250±105 years BP for four mounds on the Wakool River (Berryman and Frankel 1984:26). Klaver (1998:190-92) argued that mounds in south-eastern Australia were not occupied continuously, and when considered in this light, the rate of mound establishment post 1500 years BP is reduced.
**Morphology**

Earth mounds in southern Australia tend to be either roughly oval or circular in shape and occur singly, clustered or in pairs less than 200 m from each other (Balme and Beck 1996:42; Williams 1988:128). They are usually less than 15 m in diameter, though the range is huge: from as little as one metre to 150 m in diameter, with heights ranging from 0.2 m to two metres (Balme and Beck 1996:42; Klaver 1998:18; Williams 1988:12-14). Their average dimensions are listed in Table 1.1 (Figure 1.1).

**Origins**

There was some discussion of the formation of the mounds and whether they are natural or cultural in origin and how to determine the difference. Cultural explanations are usually linked to the original function of the mound. Mounds are often located on natural rises but alteration of their sediments, cultural remains, hearths and hut foundations indicate that they have formed as the result of human occupation (Williams 1994:164).

On the basis of the ethnography and the archaeological evidence of the burnt clay heat retainers, Downey and Frankel (1992:31) and others (Coutts et al. 1979; Berryman and Frankel 1984; Frankel 1991) believe that the mounds of the central Murray region are all originally oven mounds with additional natural and cultural deposition contributing to the construction of the larger mounds. Klaver (1998:65) argues that whatever the later uses of mounds, the majority in south-eastern Australia were formed originally as oven pits.

Balme and Beck (1996) suggest that earth mounds were originally formed as gardens, although they did point out that plant propagation has been recorded rarely in south-eastern Australia (1996:48). Klaver (1998:61-62) disagrees with this conclusion. She says that Balme and Beck (1996) have failed to explain the presence of oven pit features and heat retainers in many excavated mounds. Klaver (1998:61) says that their argument that burnt clay in mounds is the result of burning to clear the gardens could not be supported. She cites experimental work that demonstrated that bushfires do not raise soil temperatures deeper than two centimetres below ground beyond 100 degrees Celsius.
Baked clay pellets from the Murray Valley mounds were fired at temperatures exceeding 700 degrees Celsius, which is consistent with earth oven temperatures (Klaver 1998:61).

**Function**

As many of the mounds in southern Australia have not been excavated, interpretation of function has often depended on size, surface contents, augur samples and observation. Interpretations have included base camps, ovens, hut foundations, gardens and combinations of these functions.

Coutts et al. (1979:1; Coutts 1980:36) defined three types of mound sites in Victoria. Type A was made up of only one stratigraphic layer of clay containing charcoal and burnt clay pellets, but was devoid of any features, faunal remains or stone artefacts. Type B was relatively homogenous in composition but contained burnt clay pellets, freshwater mussels and other faunal remains. Mounds labelled Type C they interpreted as base camps containing features such as burials, pits, hearths and ovens, and the remains of fauna such as shellfish and egg shell and abundant stone artefacts, including flakes and formal tool types.

In a review of mounds in south-eastern Australia, Klaver (1998:64-65) identified a number of functions: ovens, ash dumps, domestic hearths, dwelling platforms, gardens, ceremonial mounds, burial mounds and semi-cultural mounds that were defined as natural mounds, such as bird mounds, tree stumps etc. that were later occupied by humans. She concurred with Coutts et al.'s (1979) division of A, B and C type mounds but suggested that the definitions could be conflated and based on functional differences between sites (1998:193-94). Under this scheme Type A mounds have a compact core deposit, contain fragmented heat retainers and few other cultural remains, and are associated with larger site complexes. Type C have a soft deposit with large heat retainers and are the result of using earth ovens repeatedly. Type B are a combination of Type A and Type C. Mounds
with hut features as recorded by Lourandos (1980) and Williams (1988) do not fit into this typology and must be considered a separate site type (Klaver 1998:194).

Frankel (1991:84-85) raises a number of questions regarding mounds in Victoria. He says that the Murray Valley mounds are mainly oven mounds while those in western Victoria are clearly occupation sites. In arguing the case for mounds having been originally constructed as gardens, Balme and Beck (1996:44-45) have warned against the use of ethnohistoric interpretations as they say many of the accounts are second hand and do not give definitive information regarding mound origin.

**Mounds and Settlement Systems**

Both Frankel (1991:84) and Williams (1988:135,169,206; 1994:163) note that mounds are often associated with other non-mound occupation in the form of artefact scatters, stone huts not located on mounds, and possibly fish traps, suggesting that mound sites were part of a complex settlement system. Klaver (1998:63) pointed out that there is general concurrence among researchers in south-eastern Australia that mounds were part of general occupation sites. However, she says that multiple dates from individual mounds in the central Murrumbidgee indicate that mounds were formed over long periods, and warns against simplistic assumptions of simultaneous occupation with associated artefact scatters and other site types (1998:IV).

There has been some debate over the role of mounds within settlement systems. Some authors argue that they are simply an environmental adaptation to the occupation and exploitation of seasonally inundated wetlands. Others argue that they are the result of changes in mobility strategies and social organization. Their appearance in the late Holocene has given rise to speculation about their function as an adaptive settlement strategy relating to increased population and production that has led to increased sedentism. Still others have raised the possibility that they are culturally significant markers of territory.
Coutts et al. (1979:86) consider the mounds in the Nyah Forest in the Murray Valley and conclude that 'key areas of the floodplain were selected, high mounds were slowly constructed, so that the resources of the area could be better exploited while it was still flooded and during post-flood periods when the surrounding areas were still wet and uninhabitable. Such mounds became islands during flood periods and were visited by Aborigines for short periods of time. However, during such periods, base camps...were probably located along the margins of the floodplain...The pattern of settlement in the Nyah Forest, coupled with the rich food resources available in that area, suggest that the people who built the mounds might have been semi-sedentary.' They go on to suggest, like Lourandos and Williams (see below) that 'some groups of Aboriginals in southeastern Australia had gone beyond the simplest hunter-gatherer levels and, through adaptive systems, had increased the efficiency of their hunting and gathering strategies' (1979:88).

Lourandos (1983:86) concludes that the earth mounds in southwest Victoria 'were aquatic adaptations which facilitated semi-sedentary occupation of wetlands (which were very extensive during the autumn-winter months) and which in turn gave inland populations access to a wide range of resources which otherwise would have been beyond their reach.' Lourandos (1983:87) goes on to use this evidence to build his case for late Holocene population expansion into 'marginal resource zones'. He argues that wetlands could be regarded as marginal despite their rich resources, because access was limited by autumn-winter flooding hence the need for the mound-building adaptation. He does not consider that the wetlands were more probably occupied during spring when flooding had receded and the mounds were constructed to avoid the muddy ground rather than the flood waters, and that the occupants were exploiting a major, not a marginal, resource zone.

Williams (1988) took Lourandos’ argument one step further. Based on nineteenth century observations of an Aboriginal ‘village’ in the area and excavation, she concluded that the mounds at Caramut were the site of this village and that they had been built up through
occupation from some 2000 years ago until recent times (1988:67, 135). She concluded that mound-building in the Western District of Victoria was not only an environmental adaptation associated with exploitation of swampy areas but also linked to changes in social networks that led to increases in production (1988:220-21). It allowed more sedentary occupation of sites and a consequent increase in population. Williams (1988:216) states that '[e]xcept for the sandy deposits, all soils in this region (whether on high or low ground) become waterlogged for a number of months every year. Mounds make a more intensive settlement of the region possible because settlements need no longer be restricted to well-drained sediments such as the lunettes. As well as being associated with poorly drained soils, mounds can also be linked to a number of other features, including a more sedentary form of occupation...Mounds can be surfaced with long-term use and the largest clusters are found in areas where sedentism would have been possible because of an abundance and diversity of food resources'.

However, there are those who disagree with social explanations for mound building. Head (1990:85) points out that mounds may simply be one of a range of strategies for wetlands exploitation and have nothing at all to do with sedentary populations and increased production. She says that while Williams claimed that the mounds in south western Victoria were the result of the emergence of complex hunter-gatherer societies, her questions were temporal rather than spatial. As Williams was unable to establish contemporaneity between the mounds she excavated, Head argues that she did not identify sedentism or environmental manipulation. Head claims that mounds are just one means of utilizing wetlands. She says that distinguishing between the possibilities (ie social change versus environmental adaptation) 'requires more rigorous and generally agreed upon archaeological tests of complexity, sedentism and social change than people are using' (1990:85).

Frankel (1991:85) does not necessarily agree that mound building in western Victoria equates with a significant change in social organization. He offers the alternative explanation that mounds may have built up due to repeated occupation and become
favoured sites for seasonal occupation during wet months and their appearance post 2500 years BP is the result of an ecological adaptation to wetter conditions at that time. Bird and Frankel (1991:7) say that deliberate construction of earth mounds as bases for huts (implying some kind of cooperative undertaking) was unlikely. A more likely process was that the mounds built up slowly through incorporation of material in oven construction and were later used secondarily as hut foundations. They also dismiss the ‘village’ concept as they said that even though mounds often occur in clusters, they can be separated temporally by long periods of time (1991:8). While acknowledging that mounds are a distinct site type that began to accumulate in western Victoria from c. 2500 year BP, they (1991:8) suggest that earth mounds may be just another manifestation of ‘open inland’ sites and that it is all to do with drainage as mound sites do not occur in equivalent circumstances in neighbouring South Australia where soils are better drained (Luebbers 1978).

Klaver (1998:284-86) concurs with this point of view and concludes that inhabitants of the Murrumbidgee River employed a relatively mobile settlement strategy that involved seasonal relocation between the riverine corridor and the hinterland. Mounds were built up through repeated short-term seasonal occupation by small mobile bands over a long period of time rather than deliberately constructed by large, sedentary populations.

**Mounds as Cultural Markers**

Frankel (1991:82) addresses this point when he notes that the mounds on the Wakool River in the Murray Valley are placed at regular distances from each other and asks whether this is related to social spacing. He concludes that it is unlikely that they would have been occupied concurrently but does not elaborate on reasons why he thinks this to be so. He then goes on to ask ‘Why then are they [the mounds] so evenly spaced? Did people deliberately distance themselves from older mounds? Did they identify mounds as significant features on the landscape, marking previous occupation of the area? If so, can we suggest that some mounds became signals of particular or group ownership of territory and resources?’ (1991:82).
Bonhomme following Pardoe (1988) also explores this theme in relation to the mounds of the Murray Valley. Pardoe (1988) argues that in areas of valuable resources people need symbols to signal ownership and control of resources, hence the importance of cemeteries in south eastern Australia. Bonhomme points out this could equally apply to mounds. She says 'The existence of sites, such as mounds, fish weirs and cemeteries, are indicators of changes in the way people relate to one another and organize the space around them, including the resources contained therein' (1990:82-84). She goes on to say that the notion of symbols of ownership in the Murray Valley is supported by the existence of cemeteries and ceremonial grounds, as well as mounds, in the resource rich Barmah Forest (1990:83-84).

Klaver (1998:286) said that there is evidence that populations on the Murrumbidgee River congregated at locations with abundant resources and that the ethnography suggests that these locations were actively managed through the use of fish traps, dams and organized burning. It is possible that these locations also represented social boundaries but she points out that the evidence is inconclusive on this point (1998:286).

1.4 EARTH MOUNDS IN NORTHERN AUSTRALIA

The review of mounds in southern Australia has raised a number of themes that have relevance for the study of earth mounds in northern Australia. These themes include location, chronology, origins, morphology, function and the role of mounds in the context of wider settlement systems, which includes considerations of seasonal occupation, mobility and mounds as cultural markers. In the following section I will examine these themes in relation to earth mounds in northern Australia.

Apart from the previous investigations on the Adelaide River (Schrire 1968; Smith 1981a, 1981b), investigations into earth mounds in northern Australia have been conducted by a number of researchers, including Baker (1981) on the Mary River, Bourke (2000) on Darwin Harbour, Brockwell (1989) on the South Alligator River, Cribb (1986).
Guse and Majar (2000) on the Reynolds River, Meehan (1988, 1991) on the Blyth River, Peterson (1973) at the Arafura Swamp on the Glyde River, and Roberts (1994) at Milingimbi. Except for Peterson’s (1973) study, this body of research was usually concerned with wider investigations, of which earth mounds were only one site type. The information recorded includes both archaeological information and data on the ethnographic uses of the mounds.

**Aurukun**

Cribb (1986) describes earth mound sites or ‘mounded middens’ as he calls them, in the Aurukun region of western Cape York. The area is coastal and contains mainly shell middens. The mounds were placed at the junction of a number of resource zones (Cribb 1986:150-51). They were located on Pleistocene dunes or on the silt plains that contain extensive freshwater wetlands systems bordering open woodland. The dunes provided shade and soft sand for camping. Vegetation consisted of dune scrub community and vine thicket, containing vegetable resources and fruit trees. Apart from swamps, creeks and lagoons, water was available from wells at the dune-savanna interface (Cribb 1986:139-140). Unlike the nearby shell mounds, they were composed mainly of earth with a low proportion of estuarine shell. Some also contained stone artefacts.

Cribb (1996; Cribb et al.1988) concludes that the earth mounds were used for what he referred to as ‘domiculture’. Hynes and Chase (1982:38) have defined domiculture as selective environmental knowledge and resource strategies applied at a specific time to a specific area. For example, in tropical Australia, taking only the yam tuber and replanting its top with the vine intact ensures continued growth (Hynes and Chase 1982:40). The domicultural focus can shift as people move between camp sites and ecological zones within their domain (Hynes and Chase 1982:38). Cribb (1996:151-52) says that the domiculture of various floral species on mounds of the Love River implies custodianship or ownership of resources by a particular group or individual. Hynes and Chase (1982:40) have also addressed this notion and cite examples where yam patches, coconut trees and fig trees are ‘owned’ by various families. This ownership confers certain privileges, for
example ownership of a campsite, and the trees act as boundary markers. Cribb (1986:145,153; 1996:161; Cribb et al. 1988:68-69) also points out that the Love River mounds have taken on mythical status and form part of the Dreaming stories where ancestral beings camped.

**Milingimbi**

Roberts (1994:180) undertook site surveys and excavated a series of test pits into mounds at Milingimbi. He identified earth mounds as one of a range of mound types, including mudflat mounds, midden mounds, conical shell heaps, base site mounds and geomorphological or natural mounds of shell. The earth mounds were located in semi-deciduous vine thickets on dunes interspersed with grasslands and paperbark swamps, bordering mangroves and mudflats (Roberts 1991:119,122). The mounds are elongated in shape and conical in cross-section, mainly composed of sand and forest humus and contained few remains (Roberts 1991:118,119). There was some shell from the mangrove and upper mudflats, the dominant species being *Anadara granosa*, and the remains of food preparation, namely hearths with stones and ash and turtle carapace (Roberts 1991:118-19; 1994:182). He concluded from their shape, location in monsoon rainforest, and lack of remains, and from observation of current usage by megapodes that these mounds were formed originally by the scrub fowl *Megapodius reinwardt*, and only occasionally used by hunter gatherers as 'dinnertime camps' (Roberts 1991:118-19,122-23; 1994:186). There were no dates from the earth mounds but nearby shell middens at Garki returned dates within the last 1500 years BP (Roberts 1994:179).

Roberts (1991:123) observed people at Milingimbi using earth mounds sporadically as dinnertime camps to cook turtle and shellfish. He said that they were chosen as soft, sandy, 'comfortable' sites that afforded shade and were convenient to shell beds. He was also told about one earth mound that was occupied in the late wet and used as a 'dinnertime camp' from which to harvest waterlilies and the corms of *Eleocharis* sp.
Roberts (1991:81-82) does not specifically discuss the earth mound sites at Milingimbi in relation to religious beliefs but says that the Yolngu view some middens as made by people in the past and the more spectacular examples as being created during the Dreaming.

Roberts (1994:183) says that ‘The majority of these features [mounds] at Milingimbi represents resource harnessing in places on the island with respect to the territories of tribal groups that inhabited the island before the turn of the century’. Approximately 35 sites are found in each of these territories.

**Arafura Swamp**

Peterson (1973:176) recorded earth mounds at the Arafura Swamp located around the floodplains of the Glyde River in clusters of two to 20 or more. The ground around them became flooded in the wet season. They had dimensions of less than 13 m in diameter and slightly over a metre in height (Peterson 1973:175). He has pointed out that earth mounds are often found located at the junction of a number of habitats, thereby reducing exploitation effort in areas that would be otherwise uninhabitable (1973:175). These habitats are the freshwater stream and swamp complex, the sandy fan delta complex, monsoon forest and tall open forest (Peterson 1973:181). He suggests that they were deliberately constructed through the use of termite nest for ovens (1973:177). However the people today do not recognise the mounds as being man-made but as part of the landscape (Peterson 1973:186).

Mounds were located in places where food was seasonally abundant but the ground was either flooded or damp (Peterson 1973:190). He points out that even a slight elevation will confer benefits of dryness and catching breezes to disperse insects (1973:175, 179). The photograph of one mound at Arafura Swamp is in a similar environmental location and looks exactly the same as the ones that occur on the floodplain margins of the Adelaide River (Peterson 1973: Plate I). Faunal remains on the surface of the mounds at Arafura Swamp included blue tongue lizard (*Tiliqua scincoides*), freshwater fish, long
necked turtle (*Chelodina rugosa*), wallaby (*Macropus* sp.) and freshwater mussel (*Velesunio angasi*). Other remains included termite nest ovens with food debris of the above, paperbark used in cooking, pestles and mortars, ground edge axes, and stone flakes (Peterson 1973:192). These mounds were still being used at the time of the study. Typically one mound in the cluster would be used for cooking and another would contain a shelter (Peterson 1973:177).

Peterson (1973:186) says '[a]ll six clusters of earth mounds seen are located in the sandy fan delta complex less than a mile from the foot of the escarpment and always close to pools of water that do not disappear until the dry season is well advanced. Each area where the mounds are located is one where it is desirable to camp when the streams on the plateau have stopped running but where the ground is either flooded or remains muddy and damp under foot for several months. By the height of the dry season all the clusters of mounds are high and dry with no water close by'.

Peterson (1973:185-86) noted that availability of water is the prime determinant of camp site location. Peterson's (1973:187-88) observations suggest that the mounds represent early to mid dry season habitations. During the wet season the people move to the tall open forest near a seasonal stream. When the rains cease they move down to the sandy fan delta to live on the mounds in the early to mid dry season. Later in the season when the swamps have retreated, they are able to move out onto the dried out floodplains themselves and camp next to permanent water till forced off by rains. In this scenario, the open scatters of artefacts along the floodplains represent late dry season habitations.

Peterson (1973:190-91) concluded that '[t]he mounds represent a regular pattern of behaviour for at least 1000 years in Cape York and 1400 years in Arnhem Land. Further investigation may add to their antiquity. The data support the suggestion that the mounds are constructed at places where it was desirable to camp because of the availability of seasonally abundant foods, but where the ground was either flooded or damp at the
time...mounds are evidence for long periods of efficient exploitation of the land. Such adaptations could only arise if there was continuity of practice in the area.'

**Blyth River**

Dotted around Balpildja Swamp, a large freshwater swamp used by the Gidjingali of the Blyth River, are mounds, 20 m long, 10 m wide and 2 m high, made from termite nest. Again they are located at the junction of resources between the swamp and the open woodland. Remains included bone, shellfish, eggshell and stone artefacts. Djibena mound was dated at the base to c. 1500 years BP (Meehan 1988:2; 1991:205).

From ethnographic observation, Meehan (1988:12-13; 1991:205) concluded that the earth mounds were constructed from termite nest which is used as heat retainers in earth ovens to cook wallabies, geese, ducks and turtles. Aborigines still inhabited the mounds in August 1955 (Meehan 1988:6). Although they no longer use the mounds as camp sites, locals recall living on the mounds in the early dry season when the swamps were full of water. They exploited the corms of spike rush (*Eleocharis dulcis*), other plant foods and the eggs of water birds. The mounds provided well-drained camp locations and some relief from mosquitoes (Meehan 1988:6). Meehan (1982:26) noted that after water, insect pests are the most important factor in camp site location, which is why the Anbarra locate their wet season camps on the beach to catch the insect dispersing winds.

The Anbarra view themselves as ‘sedentary saltwater people who live chiefly on fish and shellfish’ (Meehan 1991:202). However at certain times of the year swamp foods form an important part of their diet especially late dry season. Between September and October 1979, swamp food accounted for 30% of food collected (Meehan 1991:201-202). Meehan (1991:205) observed the swamp being used mainly in the late dry season when the ground was dry and people were camped away from the mounds on the edge of the water.

Large ceremonies were held in the late dry season and swamp foods from Balpildja Swamp were exploited extensively during this time (Meehan 1988:14). The mounds were
of religious significance and Anbarra say that they were either made or visited by Dreamtime ancestors (Meehan 1988:13).

Meehan (1982:179) records a similar figure to Roberts (1994) for the number of sites in the territory inhabited by the Anbarra. She recorded 32 dinnertime camps and two home bases occupied during the month of April 1973 (early dry season).

**Kakadu**

A number of mounds have been reported for the Magela Creek area but have not been described (Kamminga and Allen 1973; Allen and Barton 1989:106; Allen 1996;199). On the eastern side of the South Alligator River, the site of Kina is located on a peninsula jutting into the freshwater billabong. The site consists of an extensive scatter of stone artefacts and several discrete mounds containing freshwater mussel shells in a dark clay matrix (Meehan et al. 1985:117). One of the mounds measured 50 m by 40 m. It was excavated to a basal depth of 80 cm where it rested on a laterite surface. A charcoal sample from 45-60 cm below surface was dated to 280±140 years BP (Meehan et al. 1985:147,152). The assemblage consisted of stone artefacts and shell (almost exclusively the freshwater mussel *Velesunio* sp., though there were two examples of mangrove shell *Geloina* sp. in the lower layers). Faunal remains consisted mainly of freshwater turtle and fish, although they have not been fully analyzed (Meehan et al. 1985:148-52). Although there was no marked stratigraphy and goanna burrows had disturbed the mound, analysis revealed a two-fold sequence of occupation. There was a change in the proportions of lithic raw materials from the lower to the upper levels, although artefact discard did not change significantly, and the density of freshwater mussel shell increased over time (Meehan et al. 1985:148-150). However Meehan et al. (1985:150) attributed this to taphonomic factors. Meehan et al. (1985:152) and Jones (1985a:292) linked Kina to the establishment of freshwater conditions on the neighbouring floodplain at least 1400 years BP and suggested that Kina has a likely basal age of c. 500-1000 years BP.
Ethnographic testimony from the traditional owners did not provide specific information about the earth mounds except to say that the general site of Kina was occupied in the late dry season in the recent past (Meehan et al. 1985:119). Meehan et al. (1985:135) suggest that the South Alligator floodplains sites were used as large dry season base camps where the wetlands owners were joined by neighbouring clans to take advantage of wetlands resources, especially in the late dry season when biomass productivity peaks. On the basis of ethnographic observations from the Blyth River, a comparable wetlands area in central Arnhem Land, they proposed that such gatherings were sanctioned by joint ceremonies and trade (1985:135).

Malakanbalk, another site on the western side of the South Alligator River, consists of a group of three mounds located in monsoon rainforest on another headland jutting into the floodplains adjacent to the main river channel (Meehan et al.1985:126-27). They ranged in size from 30-40 m in diameter and from 0.5 to one metre in height. They were composed of dark grey silt and littered with stone artefacts made from a wide variety of raw materials. Stone artefact types included retouched flakes, points, polished flakes, axes, mortars and pestles. There was some speculation that the mounds may have been originally scrub fowl mounds because of their location in monsoon rainforest (Meehan et al. 1985:126). The scrub fowl (*Megapodius reinwardt*) lives exclusively in monsoon rainforest and builds large mounds to incubate its eggs.

Brockwell (1983; 1989:158-162) recorded two groups of mounds on the eastern side of the South Alligator River located in open woodland some 200 m from the floodplains edge adjacent to an old river channel well above flood level. The southernmost group consisted of three mounds, while there were six mounds in the group located 500 m to the north. Their dimensions are listed in Table 1.2. The mounds were not excavated or dated but their surfaces were littered with stone artefacts. On the basis of location and elevation Brockwell (1989:212) suggests that these sites were occupied in the wet season and that the wetlands owners were able to maintain year-round residence.
**Mary River**

Baker (1981:74-75) reports earth mound sites among a range of other site types from the coastal portion of the Mary River, including artefact scatters, shell mounds, pounder sites, contact sites and artefact scatters on scrub fowl mounds. The earth mounds were found on the black soil plains conveniently located close to the coast, monsoon forest, pandanus fringe and a mangrove creek. He says that elevation of these sites is insufficient for them to be above flood levels in the wet season and on this basis speculates that they may have been occupied either early or late wet season (1981:75). He says that the location of the mounds has advantages over the monsoon forest that was full of biting insects, and where a survey revealed no sites (1981:73-75). These earth mounds contained mangrove shells, stone artefacts, and pounders.

Like Cribb (1986) in Aurukun, Baker (1981:80) also found a number of earth mounds located on beach ridges. He draws a distinction between these earth mounds and those found on the black soil plains. The beach ridge earth mounds lack a dense scatter or wide range of stone artefacts and contain very little shell, although they are close to shell mounds also located on the beach ridges. Baker (1981:80-81) speculates that if they are contemporaneous with each other, it may be that people built and lived in shelters on the beach ridges while eating shellfish at the middens. He goes on to say that these earth mounds were probably wet season occupations that did not require a wide range of stone tools as wet season resources of fish, shellfish, and wet season vegetables and fruits require only an ephemeral material culture for exploitation.

The Mary River earth mounds were not dated but Baker (1981:77) speculated that the beach ridge sites may be considerably younger than the beach ridges themselves. Woodroffe and Mulrennan (1993:63; Woodroffe et al. 1993:269) report that chenier building ceased c. 3000 years BP on the Mary River. Other authors have claimed later dates of up to 1720 years BP from chenier ridges at Point Stuart where some of the beach ridge sites are located (Clarke et al. 1979) or as late as 870 years BP (Lees 1987).
**Adelaide River**

On the basis of the stone assemblages and faunal remains excavated from the earth mound HD1 on the Adelaide River, Schrire (1968) interpreted wet season habitation (land-based indicators - savanna animals, stone points) with some early or late wet season occupation when freshwater floodplain resources were also exploited. Smith (1981a) recorded seven earth mounds along the floodplain margins of the Adelaide River, adjacent to Beatrice Lagoon and at the top of Middle Point. He remarked that there were a number of edible plant species associated with the mounds that were out of their natural context, including several species of yams and fruiting trees that normally grow in monsoon rainforest.

**Darwin Harbour**

Bourke (2000; Burns 1999:64-67) recorded several earth mounds at Hope Inlet on Darwin Harbour some 60 km west of the Adelaide River clustered together with shell mounds 50 to 100 m apart. She excavated two of them. One (HI6) was located inland while the other (HI97) was in the hinterland bordering salt flats and near to a small seasonal creek. There were a few weathered shells on the surface and very few stone artefacts: quartz flakes and a quartzite mortar in HI97 and porcellanite flakes in HI6. Burns points out that this paucity of stone is in stark contrast to the rich and diverse surface scatters on nearby salt flats. She likens the Hope Inlet earth mounds to those described by Baker (1981) for the Mary River (Bourke 2000). Site HI97 returned a basal date of c. 1350 years BP (Burns 1999:66). Faunal remains included macropod, snake, rodent, crab and a small quantity of fish. The highly fragmented nature of the *Anadara* shell and pieces of termite nest recovered from the excavation led Bourke (2000) to conclude that these were the remains of hearths, similar to features described by Williams (1988:88,155) and Coutts *et al.* (1976:24-25) from earth mounds in western Victoria. The lack of otoliths also strengthened the argument for HI97 being used as an oven. Otoliths are made from calcium carbonate and do not survive burning, while shell and fish bone do (Bourke 2000). Burns (1999:67) concluded that the shell and earth mounds in the Darwin Harbour and Hope Inlet areas were consistent with wet season occupation at the juncture of a
number of resource zones, which provided refuge from low-lying seasonally inundated areas. On the basis of ethnographic evidence she further suggested that the clusters of shell and earth mounds represented the remains of semi-permanent camps for large groups of people, perhaps involved in ceremonial gatherings (1999:67).

**Reynolds River**

Guse and Majar (2000) recorded 39 earth mounds on the Reynolds River, many of them located close to freshwater wetlands. The mounds are associated with other site types including shell middens, artefact scatters, grinding hollows and quarries. The earth mounds consisted mainly of cultural deposit of dark humic soil and artefacts, shell and bone. They could basically be divided into two types, based on location and contents. Those located on relict chenier beach ridges had a base of chenier shell, overlain with midden shell of edible species in a dark humic matrix that was capped with an earth layer. Samples of *Anadara* taken from the midden layers of two chenier mounds returned one date of c. 4300 years BP and another c. 3500 years BP (Guse and Majar 2000:34,35-37).

The other type of mound, consisting only of earth, was located at the junction of the lowlands and freshwater floodplains of the Reynolds River, within 500 m of large freshwater billabongs or old river channels. Three mounds of this type returned dates of 626±77 years BP, 400±60 years BP and 197±57 years BP respectively (Guse and Majar 2000:34,36-37). It is unclear whether these are basal dates. Today the earth mounds are culturally significant for the traditional owners as an important Dreaming site is located nearby (Guse and Majar 2000:36).
1.5 DISCUSSION OF EARTH MOUNDS IN NORTHERN AUSTRALIA

Location
Earth mounds in northern Australia are located either in ill-drained areas associated with freshwater swamps associated with the floodplains of river systems or on chenier beach ridges. Earth mounds are usually situated at the junction of a number of resource zones, including swamps, rainforest and open woodland. In the case of the beach ridge earth mounds, the sea is also nearby. Earth mounds located near freshwater swamps are often found on the edge of headlands into the floodplains adjacent to a billabong or relict river channel.

Chronology
Unlike earth mounds in southern Australia, their chronology is not well established in northern Australia. However, like mounds in southern Australia, the dates that are so far available place them in the late Holocene. There are only five dates available. The oldest date so far recorded is 1500 years BP at the Blyth River (Meehan 1988:2). One earth mound from Hope Inlet on Darwin Harbour was dated to 1350 years BP (Bourke 2000). The only other dated earth mounds, one from Kina on the South Alligator River (Meehan et al. 1985) and three from the Reynolds River (Guse and Majar 2000), have all been dated to less than 600 years BP but may be older than that.

Morphology
Earth mounds in northern Australia can be divided into two types according to location and contents. Mounds located in coastal areas are composed of earth and coastal and/or estuarine shell. Mounds located inland are composed mainly of earth and any shell remains are likely to be from freshwater species. Like their southern counterparts, earth mounds tend to be oval or circular in shape. They range from an average of 39 m in length (R=11-80 m), 32 m in breadth (R=4-40 m) and 0.8 m in height (R=0.1-1.3 m) (Table 1.2; Figure 1.2).
**Origins**

Recently there has been much debate about the origins of both earth and shell mounds in Australia, i.e. whether they are the result of human activities or the nesting behaviour of the orange-footed scrub fowl *Megapodius reinwardt* (Burns 1994; Bailey 1991, 1994; Cribb 1991; Mitchell 1993; Roberts 1994; Rowland 1994; Stone 1989, 1991, 1992, 1993; Veitch 1994; Williams 1994). This megapode resides exclusively in monsoon rainforest that occurs in pockets on the coastal plains of northern Australia. It constructs large mounds in which it incubates its eggs. Stone (1989:61, 1991, 1992, 1993) argues that all mounds whether of earth or shell are the result of megapode nesting behaviour. He explains the presence of any associated artefactual remains as the result of the megapode incorporating such material from where it lies on the surrounding ground, or from serendipitous occupation by passing groups of hunter-gatherers. According to Stone (1989:61, 1991, 1992, 1993) this type of occupation would not have contributed significantly to mound formation.

It has been argued that mound composition and internal structure are two factors to be considered in solving the question of mound origins (Burns 1994; Bailey 1991, 1994; Cribb 1991; Mitchell 1993; Roberts 1994; Veitch 1994; Williams 1994). Constant reworking of active megapode mounds means that the stratigraphic context is likely to be featureless. Researchers who have investigated both earth and shell mounds in northern Australia have reported that not only do the mounds under consideration contain distinct stratigraphic features (Bailey 1977; Beaton 1985), they have also been deliberately built up by their human occupants through use as ovens (Meehan 1988:2; Peterson 1973:177). It is theoretically possible to determine origins through excavation and comparison between soil samples from the earth mounds, the surrounding ground and samples from active and abandoned scrub fowl mounds (Bailey 1994; Burns 1994; Mitchell 1993).

**Function**

Earth mounds have been variously attributed as camping sites (Baker 1981; Burns 1999; Cribb 1986; Meehan 1988, 1991, Peterson 1973; Schrire 1968), ‘dinnertime camps’
(Roberts 1991; 1994), ovens (Meehan 1988, 1991; Peterson 1973), and bases for shelters (Peterson 1973). These functions often overlap. Cribb (1996; Cribb et al. 1988) suggests they also functioned as sites for domiculture. Although Smith (1981a) does not draw any conclusions, he notes the presence of edible floral species out of context at the Adelaide River mounds. Several explanations of function are based on ethnographic observation, namely use as ovens and 'dinnertime camps'.

**Mounds and Settlement Systems**

The body of research on earth mounds in northern Australia has raised a number of issues concerning the role of earth mounds in Aboriginal settlement strategies. It appears that environmental explanations are favoured over explanations of 'intensification'. They are universally regarded as being part of a wider settlement system, usually as a seasonal strategy to avoid flooding and damp ground. Wet season occupation has been suggested based on considerations of mound location, their elevation, and the fact that wet season resources, eg. wet season fruiting trees and tubers, are often found nearby (Baker 1981; Burns 1999; Brockwell 1989; Cribb 1986; Schrire 1968). On the basis of ethnographic observation, late wet and early dry season occupation has also been suggested (Meehan 1988, 1991; Peterson 1973). Mobility is a more difficult issue to determine as it is uncertain whether mound sites are the remains of base camps, overnight camps, or sites for temporary subsistence, processing and consumption activities (Cribb 1986:148).

Peterson (1973:190-91) argues on the basis of shell mound dates from Arnhem Land that mound building reflected a continuity of efficient adaptation to environmental circumstances for at least the past 1000 years. He also points out that as a strategy that was present in widely diffuse regions it probably represented 'selection pressure on broadly similar economies in similar environmental situations' (1973:190).

While not specifically addressing the role of mounds in the regional economy of western Arnhem Land, Jones (1985a:292-93) and Meehan et al. (1985:152) argue that the increase in sites along the South Alligator River post-1000 BP represented an expansion
of occupation and use of the landscape post 1000 years BP. Jones (1985a:293) envisages a regional increase in population and a reorganization of the economy to take advantage of the new resources in the freshwater swamps at floodplain sites. However he cautions against explanations such as 'intensification' and says that environmental evidence such as the seasonal abundance of resources on the adjacent floodplains should be considered as well (Jones 1985a:294).

**Mounds as Cultural Markers**

Ethnographic evidence has pointed to the possible role that mounds may have played as cultural markers. They are often regarded as pre-dating human occupation of the landscape and hold cultural significance in relation to Dreamtime mythology (Cribb 1986; Guse and Majar 2000; Meehan 1988; Peterson 1973; Roberts 1991). This situation is similar to that in western Arnhem Land, where the Aboriginal people recognize rock art post-6000 years BP as being painted by their ancestors, while the earlier Dynamic art is said to have been done by the spirits of the Dreaming (Chippindale et al. 2000:68-69).

Mounds tend to be located in association with abundant resources at the juncture of a number of resource zones. On this basis, it has been suggested that they may have been used in connection with seasonal gatherings of large groups, sanctioned by ceremonies (Burns 1999). They may also have acted as territorial markers demonstrating ownership of resources (Cribb 1986).

**1.6 COMPARISONS BETWEEN EARTH MOUNDS IN NORTHERN AND SOUTHERN AUSTRALIA**

The literature review demonstrates that earth mounds in southern and northern Australia share many common points: location, chronology, origins, morphology and interpretations of roles in settlement systems. However it is obvious that there are also differences. Location is in ill-drained and seasonally flooded areas. Earth mounds appear in the late Holocene in both northern and southern Australia, though the chronology is not nearly so well-established in the north. Origin is debated at both ends of the continent, although popular consensus favours their genesis as earth ovens. Studies in
the north have raised the issue of mounds having been originally constructed by megapodes, an argument that Stone (1992:22) later applied to southern mounds as well.

The morphology of the southern and northern earth mounds is similar. They are both described mostly as elevated and round or oval in shape. The dimensions given for earth mounds in southern Australia mostly included diameter, while dimensions for northern Australia were expressed mostly as maximum length and breadth. To make a comparison between these dimensions, I have had to assume that average diameter for the southern mounds and average length for the northern mounds are the same measurement. The comparison between the two locations (Table 1.3, Figure 1.3) demonstrates that southern earth mounds cluster within a range of 30-40 m, while the northern mounds are relatively evenly spread over a range from 10-40 m. However, this is probably more a function of sample size than anything else. The number of southern earth mounds (1301) for which the relevant measurements were available far exceeds the number for northern Australia (61).

Similar functions have been attributed to mounds from both localities, although small mounds that functioned solely as earth ovens in the south seem to be absent from the north. However, this conclusion may also be the result of more extensive sampling in southern Australia. The interpretations of the role of earth mounds in both northern and southern settlement strategies have ranged from seasonal campsites to sedentary base camps and territorial markers. Their appearance in the late Holocene has generated speculation about changes in settlement and economic systems as a result of increasing population and sedentism.

**Mobility and Sedentism**

One of the major themes to emerge from earth mound studies at both ends of the continent has been mobility versus sedentism as an adaptive strategy. Level of mobility has been a key characteristic in the definition of hunter-gatherer settlement systems. However, levels of mobility may range from highly mobile to sedentary within a single
group, depending on a number of factors (Kelly 1992:44). Binford (1980) and Kelly (1992) have pointed out that it is more useful to think in terms of the objectives of mobility. Thus Binford (1980) defined two levels of mobility, 'residential mobility' and 'logistical mobility', and suggested that hunter-gatherer economic systems are a combination of both. Residential mobility is defined as the relocation of a whole group from one base camp to another. Logistical mobility comprises the movement of individuals or small groups on round trips from the base camp for specific purposes, such as hunting expeditions or the acquisition of lithic raw materials. Later Binford added what Kelly (1992:45) has described as the concept of 'long term mobility' to explain cyclical movements of groups over longer periods of time, probably to conserve depleted resources in response subsistence stress. To these definitions Kelly (1992:45) has added 'permanent migration' resulting from groups abandoning former territories either intentionally or unintentionally. Sedentism on the other hand has been defined as a settlement system whereby either a whole or a part of the population remains sedentary year-round. This definition is usually quantified by archaeologists to contrast with a previously existing condition of higher mobility (Kelly 1992:49).

Kelly (1983:301) has suggested that hunter-gatherer mobility strategies are closely linked to foraging strategies and factors that affect foraging behaviour will affect group mobility. Subsistence is seen as the primary variable determining levels of mobility (Binford 1980; Kelly 1992:46). However other environmental factors must also be considered such as access to raw materials, insect pests etc. Social factors such as politics, religion, kinship and trading networks are also influential and may be expressed ethnographically as the prime motivation for mobility. These, and subsistence factors, are not however mutually exclusive and subsistence may be the underlying or enabling reason (Kelly 1992:48).

Binford (1980:17) sees mobility as the key factor that determines assemblage variability in an archaeological context. In this context temporal as well as spatial issues need consideration and there is a need to distinguish between long and short-term trends. Any archaeological interpretation of mobility will rely more on environmental than social.
explanations, though the latter may be embedded within the former (Kelly 1992:48; Pickering 1994). As Bailey (1983:180) points out ‘... long-term processes are dominated by environmental and biological interactions, by relationships between genetics, demography, and economic exploitation of the natural environment, whereas short-term processes are dominated by social and psychological processes, by social rules and relationships and individual goals and motivations’. Pickering (1994:150) also emphasises the importance of discriminating between micro-scale phenomena (short-term, localised, individual) and macro-scale phenomena (long-term, regional, population). Types of mobility may be obscured by the passage of time and short-term trends such as seasonal occupation may not be visible in the archaeological record. Long-term trends that affect mobility, such as environmental change are more likely to be visible.

It is useful therefore to employ a hierarchy of explanation that is able to incorporate both long and short-term trends. Pickering (1994:158) provides testable models of mobility within landscapes. At the base is the physical landscape: the framework. Above that is archaeological evidence that includes data about technology, economy, settlement and subsistence patterns: the infrastructure. On top of that there is social structure and ideology: the superstructure. Infrastructure elements are directly affected by changes in environment while superstructures are less so (Huchet 1991:46; Pickering 1994:158).

Kelly (1992:54-56) reviewed several methods of studying mobility from archaeological remains, eg. measuring resource abundance, distance from source of lithic raw materials, stone artefact discard rates, inter-site differences, site size and the abundance and diversity of archaeological debris However, he maintains there are inherent problems in all these approaches and that a combination of factors must be considered. If all the elements are present it may give a good indication of the extent of mobility. He suggests that ‘archaeological, ethnographic, and ethno-historic data must be used creatively in developing methodological tools for the study of prehistoric mobility’ (Kelly 1992:60).
1.7 THE ARCHAEOLOGY OF THE LOWER ADELAIDE RIVER

On the lower Adelaide River, earth mounds are the dominant site type. A study of these mounds has the potential to provide possible answers to pre and post contact settlement patterns and subsistence strategies. Earth mounds are stratified and often contain organic material that can provide information on chronology, environmental conditions and subsistence strategies. The location of the sites within the broader physical landscape can provide useful information on settlement patterns. Once the parameters of the physical landscape are defined, the thesis can proceed to ask the question: What technological and social/cultural strategies did people employ to inhabit this environment?

Chapter 2 depicts the environment of the coastal plains of northern Australia and the formation processes that have resulted in the present day landscape. It discusses geology, climate, hydrology, geomorphology, land systems, flora, fauna and fire regimes. Chapter 3 describes the archaeological surveys undertaken in the study area, methodology, site distribution and description, excavations and chronology. It develops a chronological framework based on the evolution of the floodplains in the mid- to late- Holocene to which the archaeological evidence can be related. Chapter 4 discusses the aims, methods, results and conclusions of the analysis of lithic raw materials. It identifies raw material sources and distance to source from sites in order to establish the nature of mobility at the sites. It defines intra- and inter-site differences and relates the results to the chronological framework developed in Chapter 3, building up a picture of lithic raw material acquisition and use over the past 4000 years.

Chapter 5 examines the inter- and intra-site distribution of modified lithic raw materials with a view to defining patterns and further examining questions of landscape use and mobility strategies over time. Chapter 6 details the aims, methods, results and conclusions of the faunal analysis. The results are linked to the chronological framework and used to develop a model of foraging patterns spanning the last 4000 years.
Although the emphasis of the research is on pre-contact archaeology, ethnographic and historical evidence will be reviewed in Chapter 7 to determine whether settlement patterns recorded in the post-contact period reflect past cultural landscapes as defined by the archaeological investigations. And if so, what are the implications for archaeological interpretation? The final chapter places the archaeology of the Adelaide River in a regional perspective and uses the comparisons to construct a model of settlement systems operating in the Top End of northern Australia during the late Holocene.
CHAPTER 2: THE PHYSICAL LANDSCAPE: DEVELOPMENT AND RESOURCES OF THE ADELAIDE RIVER

2.1 INTRODUCTION

In the Holocene period northern Australia experienced dramatic environmental changes, including alterations to climate and landscape that greatly affected the ecology of plants and animals. The challenge for this thesis is to understand the economic and social consequences of these physical changes to the environment for the prehistoric population of the Adelaide River. This chapter is concerned with reconstructing the environment within which the inhabitants operated in the mid-late Holocene period. It contains information about the environment including geology, climate, hydrology, geomorphology, land systems, flora, fauna and fire regimes. It highlights the changes that have taken place, especially those that have a bearing on the interpretation of the archaeological record.

2.2 LOCATION OF THE STUDY AREA

The lower Adelaide River is located on the coastal plains of northern Australia which lie 12° south of the Equator in a subtropical savanna environment. The study area is located 60 km southeast of Darwin (Map 2.1). In the south it is bounded by the Arnhem Highway, to the east by the Adelaide River itself, to the west by Black Jungle Swamp and to the north by the floodplains of the Adelaide River. The study area covers some 2000 km².

The study area consists of flat country covered by open eucalypt woodland, except where land has been cleared for grazing and horticulture and an RAAF communications base. There are occasional patches of monsoon rainforest that stand out as green and lush compared with the dry savanna vegetation. Cycads are dotted through the eucalypt woodland and they too stand out as green especially after fire has burnt the grass and blackened the trees. Because the plains are so flat and relatively featureless, it is a surprise to encounter the vast floodplains of the Adelaide River. The
eastern edge of the floodplains cannot be seen nor can the river itself, except for a winding line of vegetation in the distance that marks it course. The only high land in the immediate area is Beatrice Hill, which rises 54 m above the floodplains to give spectacular views over the wetlands. Along the edge of the floodplains there are a series of freshwater lagoons, waterholes and backwater swamps.

In the dry season the bush becomes parched and dusty. The floodplains dry up completely, the vegetation dies and the black soil cracks open. The waterholes evaporate and become a series of mud puddles. Fogg Dam is the exception. Its man-made dam wall means that it retains water year round. It becomes a haven for bird life and is very attractive with flowering water lilies. The beginning of the wet season is marked by violent electrical storms. With the coming of the rains, the countryside is transformed. It becomes lush and green and the grass grows to stand over head height. The higher floodplains flood and become boggy and the waterholes and backwater swamps fill to overflowing.

2.3 GEOLOGY

The lower Adelaide River region can be divided into four main geological areas: the Pine Creek Geosyncline, the Koolpinyah Surface, the alluvial plains, and the estuarine and littoral plains of the Adelaide River. Each supports a variety of land systems (Williams 1969a:62-70; see below). The study area is located on the Koolpinyah Surface and the estuarine plains. The Pine Creek Geosyncline forms the dominant regional structure of the low rolling hill country in the region. It is made up of Lower Proterozoic meta-sediments that include quartzitic sandstone and siltstone, gneiss and schist (Needham and Stuart-Smith 1985; Williams 1969a; Woodroffe et al. 1993:258). Two formations of the Geosyncline that are members of the South Alligator Group (Wildman Siltstone) and the Mount Partridge Group (Koolpin Formation) occur in the study area (Needham and Stuart-Smith 1985). They are of relevance here as they were sources of lithic raw materials for the pre-contact inhabitants in an area that is short on good quality stone for flake production (Roddom 1997:8).
The Koolpinyah Surface is dated to the late Tertiary and comprises the rolling deeply weathered lateritic plains of the Top End. This surface is interrupted only by major river valleys, of which the Adelaide River is one. These plains are mainly of late Tertiary age and overlie planed-off Lower Proterozoic formations that stretch from the Arnhem Land escarpment in the east right through the study area (Williams 1969a:63-66).

Both the alluvial plains and the estuarine and littoral plains are late Quaternary formations over-lying the older structures. The alluvial plains consist of coarse or fine alluvium laid down in terraces by the Adelaide River, or sandy alluvium deposited in depressions on the Koolpinyah Surface by now defunct watercourses. The estuarine and littoral plains make up the in-filled estuaries of the Adelaide River flooded by the post-Pleistocene sea level rise (Williams 1969a:66-67). As the estuarine plains are of great relevance to the archaeology of the region, their formation is described in detail below.

2.4 THE CLIMATE TODAY

The coastal plains of northern Australia are located in the dry tropics. The climate is markedly seasonal with a long dry season, lasting roughly from April to November and a shorter wet season from December to March (Christian and Stewart 1953:29). This cycle is highly reliable from year to year in the Top End, a feature that distinguishes it from regions further to the south where it can be unreliable (McDonald and McAlpine 1991:19). Rainfall is high in the wet season with an average of 1380 mm per annum, about half of which occurs in January and February. The average daytime temperatures remain fairly stable throughout the year ranging from 31.2° C in July to 35.6° C in October. More significant in terms of human comfort is the variation in the night time temperatures, averaging from 15° C in July to 23.8° C in January and February, and the humidity which builds up from September and remains high throughout the wet season (Bureau of Meteorology 1997). The most
stressful time of year is the late dry season when both daytime and night time temperatures are high and the humidity builds up without the relief of rain.

**Hydrology**

The hydrology of the coastal plains of northern Australia is regulated by the strongly monsoonal climate. The ground-water builds up in the wet season and maximum run-off occurs late in the season (Chappell and Woodroffe 1985:90). Floodplain areas are inundated during the wet season making many places accessible only by watercraft. These areas dry out progressively through the dry season. By the late dry season most of the floodplains have dried out, except for low-lying areas which remain submerged for most or all of the year (see 2.5 Land Systems below). It is interesting to note that compared with wetlands on river systems further to the east, flooding on the Adelaide River is shallow and relatively short-lived, and areas of perennial swamp are much smaller (Kingston 1991:32, Map 2.1).

The Adelaide River rises in the Manton Hills and drains the dissected foothills of the laterized Koolpinyah land surface (see 2.5 Land Systems below). It can be divided into four sections. The upstream segment follows the strike valleys until it reaches the Koolpinyah surface where the valleys widen out into extensive alluvial flats with levees on the river bank. In the lower reaches the river meanders regularly in a sinuous shape with mangrove forests typical on the inside of each bend. These mangrove forests vary in width from about 100m upstream to 300m downstream. At its mouth it broadens into an estuarine funnel and it flows into Chambers Bay on the Van Diemen Gulf. Because of eight metre tides the river is tidal up to 130 km inland (Chappell and Woodroffe 1985:85; Story 1969a:17). The lower Adelaide River has an extensive wetland system that consists of a large irregular floodplain, traversed by a permanent sinuous river channel and estuary, numerous creeks, billabongs and a large lake. The coast line features broad tidal mudflats up to a kilometre across with mangrove forests and chenier sandridges up to three metres high parallel to the coast (CCNT 1993:7).
2.5 LAND SYSTEMS, SOILS AND VEGETATION

The two main geological regions in the study area, the Koolpinyah Surface and the estuarine plains can be divided into three environmental zones. These are hills and ridges, open woodland and the floodplains of the Adelaide River. These zones defined the objectives of the archaeological survey and, in the following chapter, have been used to group the archaeological sites that are contained within them. Within these three broad zones are a number of defined land systems that underpin the natural resources contained within each of them. The environmental zones are described in detail below.

**Hills and Ridges**
Beatrice Hill lies adjacent to the floodplains of the Adelaide River and is the highest point in the study area. It comprises the Baker land system, part of the Koolpinyah Surface, and consists of dissected uplands and isolated strike ridges of greywacke, sandstone and siltstone. It contains skeletal soils, with minor sandy red and yellow gradational soils. It supports evergreens and semi-deciduous eucalypt species (Williams *et al.* 1969:26). It is archaeologically significant because of the Gerowie tuff outcrops located there.

**Open Woodland**
Open woodland is located adjacent to the floodplains on the Koolpinyah Surface and contains the Keating, Kosher, Krokane and Kysto land systems. Areas that are significant for archaeological site location within these land systems are the floodplain margins and the margins of other water sources, for example lagoons, billabongs, creeks and other watercourses.

The Keating land system consists of undulating, deeply weathered and slightly eroded lowlands with gradational gravelly yellow and red sandy to loamy soils and sandy derivatives. It is dominated by tall open Eucalypt forest or woodland with a mixture
of *Alphitonia*, *Grevillea*, *Petalostigma pubescens* and *Canarium*, and heathy shrubs with short grass (Williams et al. 1969:38).

The Kosher land system consists of gently sloping margins of deeply weathered lowlands with colluvial gravelly and stony red and yellow gradational soils and sandy derivatives of Queue and Kay land systems soils. It supports patchy grassland, *Pandanus* scrub and mixed scrub, including *Eugenia*, *Acacia*, *Grevillea pteridifolia*, *Parinari*, *Tristania*, *Alphitonia*, *Alstonia*, *E. papuana*, *Schizachyrium*, *Stylosanthes*, *Thaumastochloa*, *Erogristis*, *Eriachne ciliata*, *Urochloa*, *Eleusine*, *Digitaria*, *Hyptis* and occasional patches of rainforest (Williams et al. 1969:41). All the Middle Point sites are located on this land system. Detailed studies related to horticultural potential of soils on the upper part of the Middle Point were undertaken. They provide an in-depth description of the land units on which the Middle Point mounds occur. They are located on footslopes abutting the plain and contain poorly drained alluvial soils consisting of stratified cracking clay. The vegetation ranges from grassland to low woodland, the dominant species being *Pandanus* sp., *Acacia auriculiformis* and *Melaleuca* sp. (Howe and Czachorowski 1979; Lucas 1980:32).

The Krokane land system is made up of internal drainage depressions and segmented valleys in deeply weathered lowlands, texture-contrast soils and uniform sands. It sustains paperbark forest with *Tristania*, *Melaleuca cajaputi*, *M. leucadendron*, *M. viridiflora* and *E. herbertiana*; grassland with scattered trees that form an open savanna and includes such species as *E. polycarpa*, *Pandanus*, *Melaleuca argentea* and *M. nervosa*; and herbaceous swamp vegetation in perennial billabongs (Williams et al. 1969:42).

The Kysto land system consists of low rises, swales and minor isolated strike ridges next to deeply weathered lowlands. It contains shallow stony and gravelly gradational red and yellow red soils and uniform red soils. The vegetation comprises bands of tall open eucalypt forest and woodland with much *Calytrix*. It also contains grassland with scattered trees or savanna, including such species as *Eriachne burkittii*, *Themeda*, *Cyperaceae*, *Vetiveria*, *Chrysopogon*, *Panicum delicatum*, *E. papuana*, *Melaleuca*
nervosa and Pandanus sp. (Williams et al. 1969:43). The earth mounds on North Point are located within this land system.

**The Floodplains**
The floodplains under discussion form part of the estuarine plains of the Adelaide River and can be divided into two areas according to their degree of inundation, the high floodplains and the backwater swamps. The high floodplains are made up of the Cyperus land system that consists of seasonally flooded coastal plains, with freshwater black cracking clays over mainly calcic estuarine muds. The majority of the vegetation consists of sedges (Williams et al. 1969:32). All the archaeological sites discussed here are located adjacent to the high floodplains of the Cyperus land system. The backwater swamps are made up of two systems, the Copeman and the Pinwinkle. The Copeman land system consists of low swampy coastal plains with freshwater black cracking clays over gleyed estuarine muds. It sustains mainly herbaceous swamp vegetation (Williams et al. 1969:29). Fogg Dam is an example of this land system. The Pinwinkle land system consists of swampy depressions on the coastal plains with black uniform freshwater cracking clays over gleyed estuarine muds, riverine sands, and texture contrast peaty loam over clay soils. The dominant vegetation is paperbark forest (Williams et al. 1969:46). Black Jungle Swamp on the western edge of the study area is an example of this land system. The backwater swamps are important because they contain water late into the dry season and are therefore a seasonal refuge for regional fauna.

### 2.6 PRODUCTIVITY

On a world scale, freshwater wetlands have a mean biomass (i.e. the weight of resources measured in g/m²) productivity rate of 3000 g/m² per year; the equivalent figure for estuarine systems being 1500 g/m² per year; savanna grasslands 900 g/m² per year; and woodland/shrublands 700 g/m² per year (Head 1987: 450-51) (Figure 2.1).
The diversity and abundance of flora within each zone affects the diversity and abundance of fauna within each zone. Broadly, the two main vegetation zones located within the study area are those of open woodland, also containing patches of monsoon rainforest, and the freshwater floodplains. The freshwater floodplains can be divided into the high floodplains and the low floodplains. The high floodplains flood only in the wet season and dry out rapidly thereafter. The productivity of this system can be compared with that of savanna grasslands. The low floodplains hold water for much longer into the dry season and their productivity is equivalent to that of freshwater wetlands. A change between environments equates to a change in productivity. This point becomes relevant when the evolution of the landscape in the mid to late Holocene is considered below.

The low biomass of woodlands is due to the low density and mobile nature of the fauna that live there. On the other hand, as can be seen from the list of resources (Table 2.1 and Table 2.2), freshwater wetlands are an exceptionally productive ecosystem with a high biomass of animals (Finlayson et al. 1988:110-11). However, this is not a year-round condition as the annual distribution of flora and consequently fauna of the northern floodplains is strongly influenced by the highly seasonal nature of the dry tropics and hydrological conditions. Despite periods of high floral productivity through the wet season and at the beginning of the dry season, as the floodplains dry out resources are concentrated around areas of permanent water, resulting in a high biomass located in a relatively small area by the late dry season.

As a result of this marked seasonality, tropical wetlands have an overall low mean nutrient availability that varies spatially across the floodplains and temporally according to season (Finlayson et al. 1988:110). Plants and animals dwelling in the freshwater wetlands of northern Australia have had to adapt to this boom and bust situation. Plants have mechanisms that allow them to survive the dry season drought. Animals have adjusted by being highly mobile so they can take advantage of resources elsewhere or have mechanisms that allow them to survive for periods with relatively little food intake (Finlayson et al. 1988:110-12). Below, I have listed floral and faunal resources important to Aboriginal subsistence according to the environmental zones in which they occur.
2.7 FLORAL RESOURCES

Open Woodland and Monsoon Forest
The main plant species that are important to Aboriginal subsistence in open woodland are mainly tree species. In monsoon rainforest there are several species of yams (Amorphophallus sp., Aponogeton elongatus, and Dioscorea spp.) and wet season fruiting trees. Table 2.1 is a list of floral resources from open woodland, monsoon rainforest and floodplains commonly used by Aboriginal people in the Top End that has been compiled from a number of different sources.

Floodplains
On the floodplains, there are water chestnuts (Eleocharis dulcis), water lilies (Nelumbo nucifera, Nymphaea spp.), wild rice (Oryza sp.) and yams (Ipomoea spp., and Triglochin procer) (Bowman and Wilson 1986; Howe and Czachorowski 1979; Russell-Smith 1985a, Russell-Smith et al. 1997; Smith 1981a). There are numerous other species that were both edible/used in the material culture.

A survey of species abundance was undertaken specifically for the floodplain opposite North Point on the Adelaide River (Bowman and Wilson 1986). As this survey was in a defined area and not exhaustive for the Adelaide River floodplains as a whole, there are probably more floodplains species present than were recorded. Several floral species useful to humans occur along the Adelaide River floodplains. Smith (1981a) recorded a number growing in the vicinity of the Middle Point mounds. Common names, part eaten/used and habitat were checked against botanic data compiled for other comparable areas in the Top End (Brock 1988; Russell-Smith 1985a; Russell-Smith et al. 1997; Story 1969b; and Williams et al. 1969) (Table 2.1).

Fire
Traditionally Aboriginal people burnt the landscape for a variety of reasons, encompassed within the general desire to ‘clean up’ the country, which Head (1994)
argues may be as old or older than the present day climatic boundaries which extend back 3000 years. Aborigines used fire for both ritual and pragmatic reasons that include attracting animals for hunting with regrowth, especially macropods, making travelling easier, signalling; ritually purifying the country after a long absence (Russell-Smith 1995:220). The long term adjustment of the landscape to regular firing is expressed in the number of species which are either fire adapted or require the creation of habitat diversity to satisfy their requirements (Russell-Smith 1995:221).

The use of fire in northern Australia was structured throughout the year so that there were no out of control blazes. Firing the country began in the wet season when moisture content was high so that fires were low intensity and controlled. With the progression of the seasons, the country was progressively burnt creating a mosaic pattern of burnt and unburnt country. Some areas were protected altogether, for example monsoon forests where there are valuable wet season plant resources. By the end of the dry season so much of the country had been burnt that high intensity fires were unlikely, even unplanned ones caused by lightning strike. However, occasionally plans went awry and fires did get out of control (Jones 1969).

With the arrival of Europeans and the depopulation of vast areas of country, traditional fire regimes ceased in may places and late dry season high intensity fires became much more common. This meant that many fire sensitive species were eliminated and fire tolerant species took over, reducing biological diversity in the landscape. Monsoon rainforests were one of the affected zones and they retreated to protected areas (see below).
2.8 FAUNAL RESOURCES

Open Woodland and Monsoon Rainforest
On the higher ground adjacent to the floodplains the vegetation is mainly open woodland with patches of monsoon forest. The main faunal species utilized by the Aboriginal people in these zones are wallabies, echidnas, flying foxes, goannas (Varanus spp.), snakes, bustards, emus, megapodes and their eggs, and partridges (Russell-Smith et al. 1997) (Table 2.2). All these animals are highly mobile. Although the open woodlands have a much lower density of fauna than the floodplains, the large size of woodland animals means that they make a significant contribution to the diet of Aboriginal hunter-gatherers.

Floodplains
The native dusky rat (Rattus colletti) is represented in extraordinarily large numbers on the western floodplains of the Adelaide River. Although the dusky rat was eaten by Aborigines in the past and was an important food in the late dry season, its presence is more significant for the fact that in large numbers it can support many carnivores, including the water python (Liasis fuscus). As a result, the Adelaide River floodplains have the highest known biomass of carnivores in the world, even exceeding that of the African savannas, because of the high seasonal density of water pythons and their prey, R. colletti (CCNT 1993:7-8; Madsen and Shine 1998, 1999; Shine and Madsen 1997; Russell-Smith et al. 1997).

The Adelaide River floodplains are a haven for bird life, especially waterbirds. Sixty-five species of these have been recorded and at least 16 breed there regularly, including the magpie goose, which is an important resource for Aboriginal people. The Adelaide River is one of the most important breeding grounds for magpie geese in Australia. The magpie goose breeding grounds occur in the backswamps of the middle to upper reaches of the river where the water chestnut (Eleocharis sp.) and wild rice (Oryza rufipogon) provide food and nest building materials (Bowman and Wilson 1986:76; CCNT 1993:6-7; Finlayson et al. 1988:110). The highest density breeding ground of this species in the world has been recorded near Black Jungle
Swamp. In the study area, the most important breeding grounds are on the Fogg Dam floodplains (Frith and Davies 1961:95, 116). The mangroves of the lower estuary and coast are important breeding grounds for herons, ibis and spoonbills, as are the western floodplains for the Rajah shelduck (Tadorna radjah) (CCNT 1993:6-7). Green pygmy geese (Nettapus pulchellus) and pelicans (Pelecanus conspicillatus) are also favoured foods at various times of the year (Russell-Smith et al. 1997).

Reptile species of the floodplains important to Aboriginal subsistence include crocodiles, both estuarine (Crocodylus porosus) and freshwater (C. johnstonii); freshwater turtles (Carettochelys insculpta, Chelodina rugosa, and Elseya dentata); several species of monitor, including two species of sand goanna (Varanus gouldii and V. panoptes) and the mangrove monitor (Varanus indicus); and two species of snakes, the Arafuran file snake (Acrochordus arafurae) and the water python (Liasis fuscus) (CCNT 1993; Finalyson et al. 1988; Russell-Smith et al. 1997). Swamps to the north of the study area are important breeding grounds for crocodiles.

There are also numerous fish species. Although other species are eaten, the most important ones are: the salmon catfish (Arius leptaspis) from the floodplains; black bream (Hephaestus fuliginosus), spangled grunter (Leiopotherapon unicolor) and archerfish (Toxotes chatareus) from the river, and barramundi (Lates calcarifer) and saratoga (Scleropages jardini) from the floodplains and the river (CCNT 1993; Finlayson et al. 1988:112; Russell-Smith et al. 1997).

The invertebrate species from the floodplains and the river that are most important to the Aboriginal population are freshwater mussels (Velesunio angasi) and the native bee (Trigonia spp.) for honey (Russell-Smith et al. 1997).

Of the numerous insect species that inhabit the wetlands areas, mosquitoes and sandflies most influence Aboriginal residential patterns, especially in the wet season when they are particularly pestilential. At that time, the Aborigines locate their camp sites on higher ground not only above rising flood waters but where breezes help to drive off the marauding insects (Peterson 1973:173; Meehan 1982:26). They also
build waterproof shelters in which smoky fires are lit to keep the insects at bay (Thomson 1948-49:26-27; Peterson 1973:179-80; Meehan 1982:152).

2.9 ABORIGINAL SUBSISTENCE AND SEASONALITY

Tables 2.3 to 2.6 are based on data provided from a study of Aboriginal exploitation of open woodland, monsoon rainforest and freshwater floodplains of the Alligator Rivers region in western Arnhem Land (Russell-Smith 1985a; Russell-Smith et al. 1997). The study was carried out over a period of two decades, mostly with elderly traditional owners (Russell-Smith 1985a; Russell-Smith et al. 1997:164). Although the South Alligator River lies some 200 km to the east of the Adelaide River, the existence of freshwater wetlands bordered by open woodland and monsoon rainforest, and their resources are common to both rivers.

Tables 2.3 and 2.6 (Figure 2.1) demonstrate that freshwater floodplains provided a large number of foods throughout the year, including a large number of staples both floral and faunal, especially in the mid to late dry season. I have listed staples only for the floodplains as the full number of foods available is too numerous to mention (cf Russell-Smith et al. 1997). The other environmental zones, open woodland (Table 2.4) and monsoon rainforest (Table 2.5), while not providing nearly the same number of staples, played key roles at times, mainly in the mid-wet to early dry seasons when floodplains resources were either flooded or dispersed. The wet season was a time of relative scarcity and resource bases alternative to the floodplains became important (Altman 1984:39; Jones 1980:123; Meehan 1982:153; Peterson 1973:182). Wet season fruits like Planchonia careya and Syzgium suborbiculare, and yams (Amorphophallus sp. and Dioscorea sp.) were harvested from the monsoon rainforest, and flooding and the noise of the wet season wind and rain made stalking wallabies easier in the open woodlands (Jones 1980:123; Jones and Bowler 1980:19; McConnel 1930-31:102; Meehan 1982:153; Peterson 1973:183; Russell-Smith et al. 1997:184). A similar seasonal round is described for other freshwater floodplain areas in western Arnhem Land and northern Australia (Beck 1986; Cahill 1914, 1916; Chaloupka

2.10 PALAEO-ENVIRONMENTS

The archaeological sites under discussion here were occupied between 4000 years BP and the recent past (see Chapter 3). This places them within the mid-late Holocene period in northern Australia. Below I have structured the discussion of the palaeo-environments according to time frames suggested by the evolutionary sequence of the floodplains and the radiometric dating of the archaeological sites.

Palaeo-Climates
Tacon and Brockwell (1995:678-80) have summarized climatic data from the mid-late Holocene. Post-Pleistocene amelioration of the climate meant that the environment became less harsh and Northern Australia an easier place to live. Precipitation increased with the warming of ocean temperatures, and a wetter and perhaps warmer period than at present has been proposed for the period between 10000 and 3000 years BP (Ash 1983:90; Chappell and Grindrod 1983:87; Hope 1983:97-98; Jennings 1975:251-52; Jones and Torgersen 1988; Nix and Kalma 1972:82-86; Stocker 1971; Torgersen et al. 1988). However, other researchers have argued that due to the increased rainfall this period was cooler (Aharon 1983:89; Kershaw 1983:100-101; Kershaw and Nix 1988:600). Vegetation was dominated by woodland and open forest much as it is today (Allen and Barton 1989:10) and the wetter conditions encouraged the spread of rainforest (Kershaw 1983, 1985; Stocker 1971). Evidence from southern Australia suggests that the continental climate became progressively drier from c. 5000 years. This drier trend is thought to have peaked at c. 3000 years BP and the climate subsequently became wetter from c. 1500 years BP (Bowler 1976:73; Bowler et al. 1976:390; M.A. Smith 1988:11-15). The evidence indicates that similar changes took place in northern Australia. On the basis of pollen analysis from drill cores taken from the Magela Creek floodplain, Clark et al. (1992) have argued that the climate was drier between 2800 years to 1700 years and wetter from about 1500 years BP. Another indicator of a drier climate is chenier ridges that are formed during periods of
aridity (Lee and Clements 1987; Chappell and Grindrod 1984). On the Adelaide River the last chenier ridges were formed c. 2500 years BP (Woodroffe and Mulrennan 1991:92; Woodroffe et al. 1993:266).

Climatic variations in the mid-late Holocene have been suggested previously as the causal factor for evolutionary changes in the geomorphology of the northern floodplains. However, more recent research has demonstrated that it related more to changing sea levels and sedimentation (Bowman et al. 1999:34; Chappell and Grindrod 1984:199). The geomorphological changes on the Adelaide River are described in detail below.

The Environment 7000-4000 Years BP: 'The Big Swamp Phase'
During the post-Pleistocene sea level rise, down-cut river valleys on the coastal plains of northern Australia were drowned. The deltaic-estuarine plains of northern Australia were embayed behind the new shorelines. They were then subjected to three dominant sedimentation processes; coastal progradation resulting in extensive coastal plains, vertical accretion of floodplains and the development of freshwater wetlands, and channel migration resulting in the formation of lateral-accretion, channel margin deposits and palaeochannels (Woodroffe and Mulrennan 1991:90).

The various river systems of northern Australia responded differently to this event. Some, like Darwin Harbour, became deep-water embayments. Others, through processes of sedimentation, formed vast mangrove swamps and, in the late Holocene, freshwater swamps (Chappell 1988:34; Clark et al. 1992). The rivers of western Arnhem Land are examples of the latter type. When the sea level stabilised, mangroves rapidly invaded leading to what has been described as the 'Big Swamp Phase' from about 7000 to 4500 years BP on the South Alligator River (Woodroffe et al. 1985a, 1985b).

Cores taken from the Adelaide River show that the situation there broadly resembles the sequence of events on the South Alligator River, except that the timing is slightly different. Mangroves were widespread on the Adelaide River floodplains c. 6000
years BP. Dates from two drill cores in close proximity to both North and Middle Points indicate that the Big Swamp Phase persisted on the Adelaide River until c. 4000 years BP, somewhat later than on the South Alligator River (Map 2.2; Woodroffe et al. 1993:266).

A chenier ridge believed to have marked the shoreline at the time of sea level stabilization, towards the end of the ‘Big Swamp Phase’, has been dated to 4990±330 years BP (Woodroffe and Mulrennan 1991:90, Map 2.2). This earliest known Holocene shoreline is the most landward of the chenier ridges and marks the boundary between the estuarine and littoral plains (Williams 1969b:73-75; Woodroffe et al. 1993:270) (Map 3.2). A relict beach ridge (M. Sullivan pers. comm.) lies just to the north of North Point, part of the study area, and is still clearly visible today.

One of the archaeological sites discussed in later chapters has been dated to c. 4000 years BP, the tail end of the Big Swamp Phase on the Adelaide River. The species of mangrove from the pollen cores has not been specified (Woodroffe et al. 1993). At the end of the Big Swamp Phase on the South Alligator River and the Magela Creek, the floodplains were dominated by the mangrove species *Avicennia*, which had overtaken the former *Rhizophora* forests (Woodroffe and Mulrennan 1991:90; Clark and Guppy 1988:681-82). Given the similarities between the evolution of the two floodplains, it seems likely that at 4000 years BP *Avicennia* also dominated Adelaide River floodplains. The archaeological sites were also located much closer to the sea at this time (Map 2.2). Both estuarine and marine resources are likely to have been available. Productivity of the mangrove swamps is likely to have matched that of estuarine wetlands (Figure 2.1).

**The Environment 4000-2000 Years BP ‘The Transition Phase’**

Dating has indicated that coastal progradation on the Adelaide River was rapid between 5000 and 3000 years BP but has been markedly slower since then. By 3700 years BP, sedimentation had begun in earnest. Subsequently tidal channels (including the main river channel) became blocked and the mangroves retreated. Saline mud flats were common on the coastal plains during this period. Between 3500-2300 BP
sedimentation processes were such that the old channel of the Adelaide River into Chambers Bay was infilled and abandoned, and the river had adopted its present course through a narrow rock channel, called 'the Narrows' into Adam Bay (Woodroffe et al. 1993:266-67). The Adelaide River floodplain appears to be more horizontal than that of the South Alligator River which is wedge shaped and tidal amplitude is dampened presumably as an effect of the Narrows (Woodroffe and Mulrennan 1991:93-94). The coastline was close to its present position by 2900 years BP (Map 2.2) and the present day seaward chenier ridge was built between 2100-1600 years BP (Woodroffe et al. 1993:264).

The Transition Phase was indicated by undifferentiated sediments in the river valley profile (Woodroffe et al. 1993:264) and is not unlike that reported for the Transition Phase of the Magela Creek (Clark and Guppy 1988:682). On the Magela floodplain the transition from the Big Swamp to the Freshwater Phases occurred in three stages. The initial stage consisted of the decline of the *Rhizophora* forests that dominated the floodplains in the Big Swamp Phase, accompanied by an increase in colonizing mangrove species. Increasing sedimentation led to a period where the dominant mangrove species was the salt/dry tolerant mangrove species *Avicennia*. This period was succeeded by the third stage when mangroves disappeared altogether and were replaced by grass and sedges of the freshwater floodplains (Clark and Guppy 1988:681-82). Clark and Guppy (1988:682) say that the second stage could be described as a third ecosystem with a mosaic environment of mangroves and freshwater fluctuating between all three stages.

Floodplain resources likely to have been available would include fauna and flora from both habitats. However, it is also likely that, despite high species diversity, the instability of the floodplain environment would have resulted in patchy and unpredictable resource abundance and therefore lower productivity than that of the Big Swamp Phase.
The Environment 2000-150 Years BP: 'The Freshwater Phase'
In the last 4000-1500 years BP large productive freshwater wetlands formed on the floodplains of the major rivers of the north. This sequence has been dated for the South Alligator, Magela Creek and Mary Rivers to the east, and the timing is thought to be similar for the Adelaide River. Between 2900 and 1600 years BP, the slowing of coastal progradation on the Adelaide River and continued sedimentation led to a final cut-off of the tidal influence and the ponding of freshwater behind the seaward chenier resulted in the formation of the freshwater floodplains (Chappell 1988; Woodroffe et al. 1993). Sediments from the top 0.5 to 1.5 m of the estuarine plain, containing organic freshwater floodplain clay, indicated that this was the situation (Woodroffe et al. 1993:266). The coastline was the same as today (Map 2.2).

Unfortunately, the geomorphologists were more interested in the duration and extent of the Big Swamp Phase and did not date the establishment of freshwater conditions on the Adelaide River floodplains. The date of c. 2000 years BP has been suggested by the dating of the archaeological sites because of the appearance of freshwater fauna in the sites after this time. While the Freshwater Phase can be described as stable on larger spatial and temporal scales, it is likely to have varied considerably on a smaller scale (Clark and Guppy 1988:682). Such environmental fluctuations would have affected the local distribution of resources and consequently the settlement strategies of the inhabitants (Rowland 1999). Nevertheless, it is likely that the range and abundance of floodplain species were similar to what is available in comparable floodplain areas today (Table 2.3). Productivity would have been high throughout this phase (Figure 2.1), although on a seasonal basis (Table 2.3).

The Environment 150 Years BP to Present: 'The Contact Phase'
The latter part of the Freshwater Phase has been dominated by environmental changes brought about by European contact. As documented extensively elsewhere, feral animals have had a major impact on the floodplains of the Top End. The buffalo (*Bubalus bubalis*), now mainly destroyed by the Brucellosis and Tuberculosis Eradication Programme (B-TEC), was originally introduced by the British through settlements on the Coburg Peninsula, some 350 km to the east, between 1827 and 1849. In 1864 the South Australian government, by then in charge of the Northern
Territory, established a settlement at Escape Cliffs on the Adelaide River, just to the north of the study area. By the early 1880s extensive areas of the Top End were under pastoral lease. Other exotic species were introduced including cattle (*Bos taurus*), pigs (*Sus scrofa*), horses (*Equus cabullus*), cats (*Felis catus*) and dogs (*Canis familiaris*) (Graham *et al.* 1982; Letts *et al.* 1979; Stocker 1971). Since the elimination of the buffalo, the most destructive species are feral cats and pigs (CCNT 1993:12). There has also been an invasion of exotic flora that have adversely affected the floodplains, including *Mimosa pigra*, *Salvinia molesta* and *Eichornia crassipes*. Invasion of *Mimosa pigra*, an aggressive thorny shrub introduced from South America in the late 19th century, is particularly severe on the lower Adelaide River floodplains where it covers about 8000 hectares (CCNT 1993:12; Finlayson *et al.* 1988:117-19).

The grazing, wallowing and trampling habits of buffalo and the rooting habits of pigs are particularly destructive to wetland areas. Buffaloes also create swim channels that can break down levees and allow salt water to poison fresh water areas. In addition, they tend to return to the same paths and pads, which hastens the drying out of swamps and causes erosion (Ford and Tulloch 1977, Letts *et al.* 1979).

On the lower Adelaide River, the presence of buffaloes was particularly dense up until the B-TEC operation, with over 35 animals per square kilometre adjacent to the study area and up to 11 animals per square kilometre elsewhere on the floodplains. There was also a high presence of cattle, at least until 1982 when the survey was undertaken, while the study area was still part of the pastoral station Koolpinyah and carried over 47 head per square kilometre (Graham *et al.* 1982). Needless to say the presence of both the buffaloes and the cattle have had a significant environmental impact in the study area. Abandoned stockyards are a common feature in the study area and on North Point a large mound (NP21) stands beside abandoned stockyards.

In Kakadu, research has suggested that the introduction of buffalo and modern late dry season fire regimes have led to the retreat of rainforest along the margins of the South Alligator River floodplains. The extent of former rainforest areas was established by locating abandoned nesting mounds of the scrub fowl (*Megapodius reinwardt*) that resides exclusively within monsoon rainforests (Russell-Smith 1985b). Mr Tony
Kenyon, traditional custodian of the study area and a long term resident, reported that in the 1940s the margins of the Adelaide River floodplains were covered in monsoon rainforest that has since been replaced by pandanus scrub (see Chapter 7). The archaeological mounds of the Adelaide River under consideration here may also have been scrub fowl mounds prior to their occupation by humans (see Chapter 1). There is evidence of rainforest retreat in the late Holocene at Leanyer Swamp and Gunn Point, two locations close to the study area. Here it has been linked to the combined impact of tropical cyclones and subsequent severe fires in the storm debris (Bowman and Panton 1994; Bowman et al. 1999; Panton 1993). According to Russell-Smith and Bowman (1992:55-57) the factors most commonly responsible for damage to small rainforest isolates on the savannas of northern Australia are fire, water buffalo and cattle, pigs, exotic weeds, and storm and flood. The most threatening factors are uncontrolled fires and introduced livestock, often in combination (1992:61).

Apart from these changes the region as a whole is highly disturbed. There are numerous rural subdivisions and some pastoral leases. The area is criss-crossed with roads, tracks, fire trails, fences and power lines. Much of the area has been cleared for horticulture and cattle grazing. In addition, there are the Royal Australian Navy's communication base and the Northern Territory Department of Primary Industry and Fisheries Coastal Plains Research Station at Middle Point. Beatrice Hill was once the site of a prison farm and is now the setting for a Parks and Wildlife Commission tourist attraction, 'Window on the Wetlands'. The western floodplains of the Adelaide River were subject to experimental rice farming in the 1950s and 1960s, while the western side of the river houses a car park, kiosk and jetty for cruise boats. Overall the disturbance to the environment in the Contact Phase resulted in a decline in productivity.
2.11 CONCLUSIONS

This chapter has presented information on the environment as it existed on the Adelaide River from the mid-late Holocene (4000 years until present) a time of dynamic change. This period has been divided into four phases according to the environmental and archaeological contexts. The phases are the Big Swamp Phase (c. 4000-3800 years BP), the Transition Phase (c. 3800-2000 years BP), the Freshwater Phase (c. 2000-150 years BP) and the Contact Phase (c. 150 years BP until present).

Each phase was reconstructed from geomorphological data and details of the vegetation, flora and fauna were included. These descriptions of the physical landscape will be used as the framework within which to analyse and discuss the next layer of the landscape, the archaeological landscape. The archaeology provides details of subsistence, technological and settlement strategies, which are all part of the cultural response to change in the physical landscape.
CHAPTER 3: THE ARCHAEOLOGICAL LANDSCAPE

3.1 INTRODUCTION

The aim of this chapter is to develop preliminary archaeological models of settlement patterns and mobility strategies using the physical landscape as the framework. In order to do this I will be examining previous archaeological research in northern Australia to ascertain what issues have been identified, what site types were located, and what systems of landscape use were identified. I will then discuss the survey methodology I used in the Adelaide River study area, what kinds of sites were found and what was the site distribution within each land system. I will detail the rationale for the excavations of the earth mound sites and explain their chronology in relation to landscape evolution.

3.2 PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS

Until recently most archaeological investigations in the Top End of the Northern Territory have centred on Kakadu. Kakadu National Park embraces a broad range of environments including the western edge of the Arnhem Land escarpment, savanna plains and several major rivers and creeks and their floodplains. Consequently the species of fauna and flora that inhabit the landscape are rich and diverse. It has an exceptional archaeological record that may be as old as 50,000 years BP (Roberts et al. 1990), and is home to numerous World Heritage listed rock art sites.

Investigations of rockshelters on Magela Creek in northern Kakadu suggest that appearance of estuarine resources during the Big Swamp Phase led to the establishment of a series of sites along the floodplain margins c. 6000 years BP (Kamminga and Allen 1973; Schrire 1982; Map 3.1). With the decline of the mangroves these sites were abandoned c. 3000 years BP and only reoccupied after the establishment of freshwater conditions post 1500 years BP (Allen and Barton 1989). Schrire (1982) suggested on the basis of a technological dichotomy between the plains sites and those of the nearby
Arnhem Land plateau valleys that there was some relocation of settlement during the wet season when the wetlands were flooded. Investigations on the South Alligator River confirmed that there was a concentration of settlement in the form of large artefact scatters along the freshwater floodplain margins post 1000 years BP (Brockwell 1983, 1989; Jones 1985b; Meehan et al. 1985). Brockwell (1983, 1989) argued that residence at the wetlands was year-round, the inhabitants moving to adjacent earth mound sites on higher ground in the wet season. Later research suggested a more complex settlement pattern with a number of sites located in the woodland adjacent to the floodplains (Guse 1992; Hiscock et al. 1992).

There were also technological changes from the mid-Holocene onwards. Flaked stone points and small scraper adzes appeared in the Kakadu deposits (Jones and Johnson 1985:200-207; Schrire 1982:238-39). There were concentrations of points between 3500 and 1500 years BP in both the Kakadu rockshelters (Allen and Barton 1989; Schrire 1982) and Yarar Shelter in the western Top End (Flood 1970). Extremely good organic preservation at one of the northern Kakadu sites, Paribari, revealed a technology based on wooden spear shafts and bone points (Schrire 1982). Regional comparisons between floodplains settlement patterns in Kakadu and on the Adelaide River will be discussed further in Chapter 8. The following discussion will review the work that has been undertaken in the Darwin hinterland region.

In the Darwin hinterland region to the east of the study area, Baker (1981) conducted research on the lower Mary River along the coast and floodplains at Point Stuart and Sampan and Thrings Creeks on Chambers Bay and recorded a series of open sites (Map 3.1). Most of them were located on chenier ridges close to water, either freshwater or estuarine. Guse (1992) conducted further site surveys along the Mary River freshwater floodplains and in open woodland north of Clarke’s Crossing. This survey was located in an area ecologically and geomorphologically similar to the present study. The sites were all open artefact scatters located along the floodplain margins of the Mary River. These
studies served to confirm that regional settlement patterns along these northern rivers was concentrated on the estuarine and freshwater floodplains.

More recently, regional archaeological surveys to the west and east of the study area have located additional site types. These include shell middens (mostly on the coast), quarried rock outcrops, grinding hollows, rock engravings, stone arrangements, burials, contact and historic sites (Bourke 2000, in press; Brockwell 1993, 1996b, 1996d, 1998; Burns 1994, 1996; Guse 1995; Hiscock 1993a, 1995a; Hiscock and Mitchell 1991; Richardson 1996).

On the Adelaide River itself, sporadic investigations have been carried out in the region since the late 1960s. Correspondence indicates that earth mounds were officially reported in 1965 when a botanist resident at the Middle Point Village wrote reporting them to the South Australian Museum (Smith 1981a). Besides the 'midden debris', one of the things that had attracted his attention was the presence of edible plant species growing on the mounds, some of them up to 10 km from their natural habitat. In 1968, Carmel White (Schrire 1968) undertook a test excavation of one of the mounds (HD1) on Middle Point. Like other mounds in the area it was located in a patch of pandanus scrub adjacent to the freshwater floodplains of the Adelaide River. The excavation yielded stone artefacts, faunal remains, bone tools and shell. Bifacial points and scrapers dominated the stone assemblage. The faunal remains included species of both the floodplains (fish and turtles) and the open savanna (goannas, wallabies and bandicoots). She interpreted the evidence as indicating wet season habitation (land-based indicators - savanna animals, stone points) with some early or late wet season occupation when freshwater floodplain resources were also exploited. The assemblage, not analyzed at the time, was analyzed for this thesis and the results are discussed in Chapters 4, 5 and 6.

In 1980 and 1981 Smith conducted site surveys on the lower Adelaide River (Map 3.2). He recorded a number of sites, including earth mounds, artefact scatters and grinding hollows (Appendix 1; Smith 1981a, 1981b). The presence of large numbers of stone
points at some of these sites and their occurrence in older landforms raised questions about their antiquity. Subsequently Smith conducted a test excavation at a stratified open site at Scotch Creek on the eastern side of the Adelaide River that determined there was a discrete horizon of stone points dated, like other regional sites, between 3500 and 1500 years BP (Smith and Brockwell 1994:87-88). Smith and Brockwell (1994:102) speculated that the increased manufacture of points around this time was linked to conflict between groups in the Transition Phase, which they interpreted as a time of landscape instability and unpredictable resources.

Previous research in the Top End has introduced several themes into the archaeology of mid-late Holocene period in northern Australia. These include an emphasis on floodplains settlement, changes in settlement patterns and subsistence strategies linked to physical transformations on the floodplains, the introduction of new technologies, and seasonal occupation of sites. These themes are common to investigations of wetland archaeology elsewhere in the world. For example, in the north east of the United States there have been intensive studies of individual wetlands in their environmental settings that have provided detailed data on site activities, seasonality and subsistence. There have also been studies of the role of wetlands in a regional context that have produced information on long-term human interaction with the landscape. Within these two broad themes researchers have concentrated on wetlands as a human habitat, site/wetland associations and changing patterns of wetlands use (Nicholas 1992:1-2).

These issues have been well documented in Kakadu but less so elsewhere in the Top End, despite an abundance of floodplain sites. An investigation of the archaeology of the lower Adelaide River provides the opportunity to explore these questions and test previous interpretations in a similar physical environment with a similar geomorphic history. The earth mound sites along the floodplain margins, with their stratified deposits, also provide the opportunity to investigate these topics over time.
3.3 SITE DETECTION

During the investigation sites in the study area were located by several methods. Prior to fieldwork being undertaken, the site registers of the Australian Heritage Commission (AHC) and the Museum and Art Gallery of the Northern Territory (MAGNT), now held by the Heritage Unit, Northern Territory Department of Lands, Planning and Environment were consulted, and recorded sites were visited. People living and working in the area already knew other sites. Several trips were made with the traditional custodians and in the company of staff from the Northern Territory Department of Primary Industry and Fisheries (DPIF) and the Northern Territory Parks and Wildlife Commission to locate these sites in the field. A general reconnaissance of areas where permission for access had been granted (NT Parks and Wildlife Commission and DPIF land) was made by four wheel drive vehicle using existing tracks, tracks along fence lines, survey lines, fire trails and off-road driving along the edge of the floodplains. Subsequently, systematic field surveys were undertaken to locate additional sites.

**Site Types**

Previous archaeological investigations and MAGNT records indicate what site types could be expected in the study area; artefact scatters, earth mounds, pounding hollows, quarried rock outcrops, rock engravings, stone arrangements, burials, wells, contact and historic sites. All these are open sites. As the study area is located well inland it was considered unlikely that shell middens would be found. Likewise as it does not contain suitable rock formations, there are no rockshelters or associated rock art. This information gave me a general idea of what to expect during the survey of the lower Adelaide River.

**Definition of Artefact Scatters**

For the purposes of the survey, artefact scatters were classified according Hiscock's (1993a) definition as areas having:

1. More than ten stone artefacts.
2. An area of $2\text{m}^2$ or more.
3. An average density of artefacts or shell more than five times the average density of the background scatter, which is defined as the continuous but sparsely distributed scatter of stone artefacts which surrounds sites.

**Stone Artefact Definition**
The majority of artefactual remains in Australia are made from stone. Stone artefacts possess distinctive characteristics that allow them to be distinguished from naturally occurring stone:
1. A positive or negative ring crack;
2. A distinct negative or positive bulb of percussion;
3. A definite erraillure scar beneath a striking platform;
4. Definite remnants of flake scars (for example dorsal scars and ridges)

Four main types of artefacts have been recognized in this study. Their morphologies are described below using definitions provided by Hiscock (1984:128-29):

*Flake:* This is the piece of rock struck off a core. It exhibits a set of characteristics that indicate that it has been struck. The most indicative of these are ring cracks which show where the hammer hit the core. The ventral surface may also be deformed in a particular way, for example a bulb or erraillure scar.

*Core:* A piece of stone with one or more negative flake scars but no positive flake scars.

*Retouched Flake:* A flake that has had flakes removed from it, identified by flake scars onto the ventral and/or deriving from the ventral surface.

*Flaked Piece:* This is a chipped artefact which cannot be classified as a flake, core or retouched flake. This category is used only when an artefact was definitely chipped but could not be placed in another group.

By employing a systematic survey strategy, I expected to be able to identify the following range of archaeological sites: earth mounds, artefact scatters with dimensions greater than two metres, quarried rock outcrops, consistent and relatively high density background
scatter, and some isolated stone artefacts. The results of both the general reconnaissance and the systematic surveys are described below.

**Archaeological Visibility**

The success of an archaeological survey depends to a large degree on visibility and the survey methodology employed. There are varying degrees of archaeological visibility in any one place depending on a number of factors. In northern Australia, visibility is usually related to seasonal vegetation cover. As has been pointed out above, access to the study area is dictated by wet season flooding. More areas become accessible as the dry season progresses. Surveys for this study were undertaken throughout the dry season, between April and November 1993.

At the beginning of the dry season long spear grass grows throughout much of the region. It is difficult to penetrate and reduces visibility considerably, making archaeological detection unlikely. As the dry season progresses the grasses wither and die back and there are usually a number of dry season fires, both controlled and uncontrolled. Thus visibility improves throughout the dry season. Where there have been fires, it is excellent with 90-100% of the ground surface being visible on average. Following fires there is some regrowth and leaf litter present but these factors reduce visibility only marginally and it remains relatively high, between 80% and 90%. In areas where there have been no fires the vegetation often remains dense despite grass dieback, especially around areas which remain wet long into the dry season - for example, lagoons, waterholes and the floodplains themselves. Visibility in these places is low. Where cattle and buffalo graze, the grass remains short most of the year. Visibility is 50-60% in these areas. If visibility was poor in an area being surveyed, an adjacent area of good visibility was examined instead.

Another factor affecting visibility is disturbance. The study area is located within the Darwin rural area, which for the most part is built up and highly disturbed by development. There are numerous rural subdivisions and some pastoral leases. The area is criss-crossed with roads, tracks, and fire trails, fences and power lines. Much of the area
has been cleared for horticulture and cattle grazing. In addition, there are the Royal Australian Air Force (RAAF) communications base and the DPIF Coastal Plains Research Station at Middle Point. Beatrice Hill was once the site of a prison farm and is now the setting for the Northern Territory Parks and Wildlife Commission tourist attraction, 'Window on the Wetlands'. The western floodplains of the Adelaide River were subject to experimental rice farming in the 1950s and 1960s, while the western side of the river houses a car park, kiosk and jetty for cruise boats. Areas where there was extensive disturbance, for example clearing, road works, fences and power lines were not examined, as any existing sites are likely to have been destroyed, obscured or highly disturbed.

Visibility of sites on the floodplains is likely to have been affected by the sedimentation that has taken place since the mid-Holocene. In places the build-up is several metres thick and sites older than 3000 years BP, when sedimentation slowed (see Chapter 2), are likely to be obscured. This situation is similar to Victoria where authors have suggested that geomorphological events and higher sea levels have obscured coastal sites older than 3000 (Bird and Frankel 1991:5-6; Head 1987:457).

**Survey Methodology**
The study area was divided according to the environmental zones defined in Chapter 2, ie. hills and ridges, open woodland and floodplains (Map 3.2). For the purposes of the survey, open woodland was further subdivided into areas that occur within it, ie. open woodland, lagoons and creeks and monsoon rainforest. Floodplains were divided into floodplain margins and floodplains. Based on previous archaeological work and experience in similar areas in Kakadu (Meehan et al. 1985; Brockwell 1989) those areas highly likely to contain sites were given priority in the survey, ie. floodplain margins (earth mounds and artefact scatters) and margins of other water sources, eg. lagoons, waterholes and creeks (artefact scatters). Where possible one hundred per cent of these areas were examined. Site detection in open woodland is more difficult as there are no features to concentrate activities, but this does not mean sites (usually artefact scatters) are not present. So this zone was sampled at the rate of 60%. Floodplains themselves are
the least likely areas to contain sites as they are either flooded or swampy for most of the
year and dense vegetation often reduces visibility to nil. However, features on the
floodplains likely to contain sites, eg. islands and beach ridges, were examined.

The initial survey or general reconnaissance was carried out both on foot and in a vehicle.
Areas covered by this survey include DPIF land to the east of Anzac Parade as far as
Beatrice Lagoon, the edges of Harrison Dam, the floodplain margins of eastern Middle
Point, the floodplain margins north of Fogg Dam, around North Point to the western edge
of Black Jungle Swamp, the southern edge of Black Jungle Swamp, and several lagoons
and waterholes, including Lambells Lagoon and Whitestone Lagoon (Map 3.2). During
the early dry season access to the study area poses a problem as a result of wet season
flooding and the boggy nature of the terrain which can take months to dry out. As a result
the surveys were undertaken in stages. Areas on high ground could be investigated earlier
in the dry season from about April, while closer to the floodplains we had to wait till the
surrounding area had dried up sufficiently to allow off-road driving. Access to North
Point was only possible in the late dry season when the tracks were sufficiently dry. The
floodplains themselves could not be investigated till late in the dry season, around
September-October.

During the general reconnaissance we surveyed westwards along the edge of the
floodplains from North Point as far as the second headland (Koolpinyah, see below)
adjacent to the eastern side of Black Jungle Swamp (Map 3.2). Here we were forced
away from the edge of the floodplains by dense vegetation and extremely rough ground.
Visibility was poor throughout the surveyed area, as it was overgrown with grass and
dense stands of Mimosa pigra and Hyptis suaveolens. During this survey we also located
the chenier beach ridge that runs across the floodplains to the east and west of North
Point ridge and marks the former coastline some 5000 years ago (see Chapter 2). Two
small sections were examined for artefacts but none were found. The southern edge of
Black Jungle Swamp was also inspected. Vegetation was similar to that described above.
There was nil visibility and no sites were located.
Based on the initial survey, a purposeful sampling strategy was employed. Two areas were targeted because they contained a concentration of sites; the floodplain margins south of the road on Middle Point and North Point. The methods used in an archaeological survey determine the intensity of the survey. The important factors are the distance between the surveyors and the speed of the survey, that is the closer the space between the surveyors and the slower the speed of the traverse, the more intense the survey. It has been demonstrated that survey intensity is significant as it affects the number of sites located (Hiscock 1995b). The targeted areas were traversed on foot by surveyors at approximately 10 m intervals, until the required area was covered. Surveys were conducted in stages throughout the dry season after fires exposed areas that had been obscured by undergrowth early in the field season. As a result approximately 250,000 m$^2$ was covered on Middle Point and 500,000 m$^2$ at North Point. More sites were located during this survey (Map 3.3).

Beatrice Hill is the only example of the hills and ridges land system in the study area (Map 3.2). However it is highly disturbed having been the site of a prison farm and now a tourist attraction (see Chapter 2) and I decided not to survey it. The area around Olympic Bridge on the floodplains edge adjacent to the bottom end of Beatrice Lagoon is highly disturbed. It has been cleared of trees for pastoral purposes and is currently being used as a holding paddock for cattle by DPIF. However, this disturbance meant that visibility was generally good. At North Point, although some areas were unburnt and overgrown, visibility of the ground surface was generally high (80-90%) as a result of dry season fires. There was a low-density background scatter of approximately one artefact per 10,000 m$^2$.

Subsequently, another survey was conducted in open eucalypt woodland, which covers much of the study area, to determine what concentration of sites exists in this zone. Some areas were unburnt and overgrown, visibility in these areas during the survey (September 1993) was generally high (80%-90%) as a result of dry season fires. During this survey,
which was located west of Lambells Lagoon (Map 3.2), 50 areas of approximately 10,000 m² were examined thoroughly at 500 m intervals in the same manner as described above. When visibility was low in any targeted area, we continued along the track until the nearest clear area was located. Approximately 500,000 m² was covered during this survey.

Within the open woodland zone, several small waterholes occurred. Three that were accessible were examined in detail. When water was available these locations may have acted as a focus for activities in the landscape and they are therefore considered to be likely areas for sites. The edges and surrounding areas of the waterholes were examined thoroughly. At the time of the survey (September 1993) the waterholes we observed were dry and had been invaded by the weed *Hyptis suaveolens*. This weed reduced visibility around the edges and insides of the waterholes. However further up on the banks and surrounding areas where sites are most likely to be found, visibility was generally high (80%-90%) due to dry season fires.

The western margin of Lambells Lagoon was surveyed for sites during September 1993 (Map 3.2). It was dry at this time of year but the presence of paperbarks with high water marks and the topography indicate that it is flooded during the wet season. We thoroughly checked two areas approximately 100 m by 50 m on the northern and southern edges of the western side of the lagoon. Despite relatively good visibility as a result of a recent fire, no sites were found. We then entered Lambells Lagoon Reserve itself where permanent water was present in the middle of the lagoon. This area is a haven for waterbirds. We checked the foreshores adjacent to the track for sites. Three and a half kilometres along the track and about half way around the lagoon our progress was halted by boggy ground. Ground vegetation was prolific and dense. It was possible to examine in detail only three small cleared areas ranging in size from about 2500 m² to 10,000 m². The edges of Whitestone Lagoon and Attar Billabong adjacent to the track, which leads to North Point, were also examined (Map 3.2). Visibility was extremely poor due to a thick cover of grass.
Monsoon rainforest was rare in the study area. However, one earth mound was located in monsoon rainforest about 2.5 km from the eastern side of Black Jungle Swamp (Map 3.2). It was interpreted as being non-archaeological in origin. No artefacts were found on the surface and the mound is not located close to the floodplains in a pandanus fringe like the earth mounds containing archaeological material in adjoining areas. It also appears that modern earth works did not create the mound as it is located some distance from the track and is an isolated occurrence. It is likely that this mound is the remains of a nesting mound of the orange-footed scrub fowl (*Megapodius reinwardt*), which resides exclusively in monsoon rainforest. It conforms in size and shape with other such mounds that I have observed in Kakadu (Brockwell 1989:12,158-62).

Visibility is poor on the floodplains as they are flooded for several months of the year and even when dry have thick vegetation cover. In addition, ploughing during the rice farming experiments of the 1950s and 1960s has disturbed the floodplains on the western side of the river. However there are high ground features, eg. islands and beach ridges, on the floodplains that are likely to contain sites. All of these were checked during the survey.

Several consultancy surveys undertaken since 1993 have added to the knowledge of site distribution in the study area (Brockwell 1996a, 1998, 2000; Hiscock 1995b). Below, site locations are listed according to the land systems identified above.

### 3.4 SITE DISTRIBUTION

**Hills and Ridges**

Although Beatrice Hill was not surveyed, two sites have been reported. An artefact scatter was recorded by MAGNT (Appendix 1; Map 3.2) and a quarried rock outcrop of Gerowie tuff was reported on the northern side of Beatrice Hill (S. Sutton pers. comm.). An amateur collector took a surface collection from this site, which is now housed at MAGNT. There is no information on the size of the site or the density of the stone artefacts.
**Open Woodland**

In open eucalypt woodland, very little archaeological material was found. During the 1993 survey, only one site (LL1) was located in this zone. It consists of a small scatter of artefacts on the side of a track approximately one kilometre east of Black Jungle Swamp (Map 3.2). This site is located on a low laterite ridge 40 m east of the track and consists of a low-density scatter of small quartzite flakes covering an area 30 m by 40 m. The maximum density of items is approximately 0.5/m², giving an estimated total of 60 artefacts for the site as a whole. The surrounding area was checked thoroughly and nothing more was found. There was an extremely low-density background scatter of isolated quartz and quartzite flakes, approximately 3.2 items per km². Other surveys nearby have confirmed the overall lack of sites in this zone (Brockwell 1996a, 1998, 2000; Hiscock 1995b).

**Lagoon and Watercourse Margins**

There was only one site, a large earth mound (AR4) found in this zone. It was located on the edge of a dry lagoon 500 m south of the floodplains in open eucalypt forest during the general reconnaissance near Black Jungle Swamp (Map 3.2).

At two of the three small waterholes, there were scatters of small quartzite flakes and one quartzite core. However, according to the definition of a site provided above, neither of these waterholes can be considered a site as the frequency of archaeological material is less than ten artefacts. Therefore the material is considered to be background scatter, the average density of which is approximately 1/6000 m². Nevertheless, as the artefacts are located adjacent to waterholes they must be considered important.

At Lambells Lagoon, there were only isolated finds. One small quartzite flake and a quartzite core measuring 10 cm by 5 cm were found in a clear patch three kilometres along the track. At Whitestone Lagoon, two large quartzite stones were found one with negative flake scars. They are presumed to be manuports from the white quartzite outcrop one kilometre to the east (see above) as there are no nearer sources.
**Monsoon Rainforest**

There were no sites located in this zone.

**Floodplain Margins**

The high ground adjacent to the floodplain margins had the densest concentration of sites. Thirty-nine out of a total of 55 sites located in the study area occurred in this zone (Map 3.2; Appendix 2). There were 10 artefact scatters, 27 earth mounds, and one well. One of the mounds was associated with pounding hollows and contact material. The quarried quartzite seam also passed along the floodplain margins. The sites occur in four main areas, Beatrice Lagoon, Middle Point, North Point and an unnamed point that I will call Koolpinyah, as it lies adjacent to Koolpinyah Station. All these areas are located adjacent to the high floodplains that dry out early in the dry season, rather than the backwater swamps that hold water well into the dry season. Below the sites have been described according to their locations south to north, Beatrice Lagoon, Middle Point, North Point and Koolpinyah (Map 3.3)

**Beatrice Lagoon**

During the general reconnaissance, we located the nine mounds adjacent to Beatrice Lagoon that had been previously recorded by MAGNT (Smith 1981a, 1981b; Map 3.2, Appendix 1). Two artefact scatters were located on the floodplain margins at the southern end of Harrison Dam (WL1 and WL2) (Map 3.3).

**Middle Point**

There are 10 sites at the top of Middle Point located adjacent to the floodplains in an area of pandanus fringe (Map 3.3). A seasonal lagoon, Reedy Lagoon, is located adjacent to the headland. Eight sites were located there during the survey, seven earth mound sites and one artefact scatter. Two other earth mounds had been located previously (HD1 and HD2) (Map 3.2; Appendix 1). Six earth mounds (MP1-MP3 and MP4-MP6) appear to form two clusters (Map 3.3).
Four of the earth mound sites have been surveyed and mapped; MP2 and the cluster MP4, MP5 and MP6. All heights recorded below are maximum heights. The approximate areas and volumes are listed below in Table 3.1. The mounds are littered with stone artefacts made from quartz, quartzite, chert, Gerowie tuff, sandstone, ochre, haematite and volcanic rock. Surface densities ranged from 30-35 artefacts per m². Stone artefact types observed were mainly flakes: bipolar flakes, retouched flakes, edge rejuvenation flakes, and utilised flakes. Other types included points, ground sandstone pieces, ground ochre pieces, ground volcanic flakes which may be the result of sharpening or using edge-ground axes, and cores including bipolar cores. The well was located at the edge of the floodplains between Middle Point and North Point (Appendix 2).

**North Point**
Eighteen sites have been recorded on the floodplain margins in this area; 11 earth mounds and seven artefact scatters (Map 3.3), as well as a number of isolated finds, including one large quartzite grindstone beside the lagoon adjacent to the headland. Mound NP20 contained contact material and a large rock with pounding hollows. Most of the sites occur in pandanus scrub, which lines the margins of the floodplains and the lagoon.

The artefact scatters range in size from 5 m to 100 m across. They contain flakes of quartz, quartzite, chert, Gerowie tuff and haematite and some recognisable stone artefact types such as points, leilira blades and scrapers. Densities vary from nine artefacts per m² to 61 artefacts per m². Quartzite is the dominant raw material and appears to be derived locally from the seam of white quartzite that runs through the area (see Chapter 2).

Six of the earth mounds at North Point (NP1, NP13, NP14, NP15, NP19 and NP20) have been surveyed and mapped in detail. Their dimensions are listed in Table 3.1. The mounds occur singly and in clusters. NP1 is an isolated mound. NP13, NP14 and NP15 are grouped together, as are NP18, NP19 and NP20. NP13, NP14 and NP15 are exposed and eroded. A vehicle track runs through all three sites and two of them (NP14 and NP15) are also badly affected by goanna burrows. Stone artefacts are littered across the surface of all these mounds. The assemblages contain the same range of stone raw
materials and artefact types as have been described above for the artefact scatters, including a clycon at one mound site. Density varies from between five and 60 artefacts per m².

**Koolpinyah**
We located two mounds on the edge of the floodplains (AR2 and AR3), both located c. 500 m from a perennial lagoon (Map 3.3).

**Floodplains**
Eleven sites were located on the floodplains: five artefact scatters, three earth mounds, one associated with pounding hollows, and two quarries. The quarried quartzite outcrop also passed across the floodplains between Middle Point and North Point. The sites are described below according to their locations at Beatrice Lagoon and North Point (Map3.3).

**Beatrice Lagoon**
Two mounds were located on the edge of the Adelaide River floodplains adjacent to Beatrice Lagoon. They were located previously in a MAGNT survey (Smith 1981a, 1981b; Appendix 1; Map 3.2). The Olympic Bridge mound site at (OB1) is located on the edge of the Adelaide River floodplains at the bottom end of Beatrice Lagoon (Map 3.3). Despite poor visibility due to thick grass, it is possible to see small quartz artefacts on the surface at a density of one item per m². At some stage the mound has been damaged by removal of soil, possibly with a backhoe, which has left a large hole in one side. Its dimensions are listed in Table 3.1.

One artefact scatter and an outcrop of quartzite boulders that have been flaked (OB2) are located on the floodplains on the eastern side of Olympic Bridge at the bottom of Beatrice Lagoon, adjacent to the road (Map 3.3). The site also contains flakes of non-local material including chert. It measures approximately five metres in diameter.

**North Point**
At North Point one artefact scatter (NP12) was located on the floodplains adjacent to higher ground. Another artefact scatter (NP9) was located on the floodplains side of the lagoon adjacent to North Point (Map 3.3). A survey on the floodplains adjacent to North Point located an artefact scatter (NP11) on the remnants of an old beach ridge to the east of North Point. The beach ridge to the west of North Point was also examined but no sites were found. A quartzite quarry site and artefact scatters (AR1) were located on an island in the floodplains also to the east of North Point (Map 3.3; Brockwell 1996e).

3.5 RESULTS OF THE SURVEYS

The surveys located 49 sites in the study area. Sites sometimes included more than one site type (Appendix 1, Appendix 2). MAGNT has recorded 21 sites on the lower Adelaide River, 10 of them in the study area (Smith 1981a, 1981b; Appendix 1; Map 3.2). The surveys for this study located an additional 39 sites (Appendix 2; Map 3.3). The types of sites were as predicted. They included artefact scatters, earth mounds, quarries, one well, pounding hollows and one contact site. The results of the surveys revealed that the majority of sites on the lower Adelaide River are located either close to or on the floodplains, usually associated with perennial or intermittent water bodies (Appendix 2; Map 3.2; Table 3.2). One site, a quarried rock outcrop (WR), could not be classified according to zone as it crosses a number of different landforms from the floodplains edge to high ground (Map 3.3). Of the 55 site types, earth mounds and artefact scatters are the most common (Table 3.2).

The surveys also revealed that the majority of sites in the study area are located on Middle Point and North Point headlands (Map 3.3). They are all situated next to the high black soil plains rather than around the backwater swamps. I decided to target these areas for further investigations. Most of the sites in these two areas are earth mounds and artefact scatters (Appendix 2; Table 3.2). I decided to take sample surface collections from both site types in order to compare the composition of the stone artefact assemblages and investigate such issues as raw material acquisition, mobility, intensity of
occupation etc. I then intended to excavate a sample of earth mounds from both areas to give a temporal context to these issues, particularly in relation to the evolution of the floodplains.

**Adelaide River Mound Dimensions**
In order to characterise the mound sites and compare them with each other, I took a series of measurements. Thirty-one earth mound sites have been recorded in the study area. Because of time constraints and the inaccessibility of some areas, only eleven of them were measured in detail (Table 3.1). The largest mound (OB1) was over 10,000 m³, while the smallest was only 115.5 m³. The mean mound height was 0.69 m (sd=0.31 m) and the mean volume was 1717.7 m³ (sd=2925.8 m³).

3.6 EXCAVATIONS

The earth mounds at North Point and Middle point were all located close to the floodplains. I decided to excavate a series of them from both areas in order to investigate their relationship with the evolution of the floodplains and compare the settlement patterns and mobility strategies of their inhabitants over time.

**Site Selection**
I excavated three earth mounds on Middle Point, MP2, MP5 and MP6, and two at North Point NP19 and NP20. I selected these sites on the basis of their accessibility, visibility, disturbance and excavation potential.

The northern area of Middle Point contains two clusters of mounds that have good excavation potential, although all of them have been damaged to some extent by goanna burrows. MP4, MP5 and MP6 lie along a north-south line, 300 m south of the sealed access road (Map 3.3). These mounds were easily accessible in July 1995 and had been burnt off early in the dry season. MP1, MP2 and MP3 lie in an east-west line 500 m further south. All three of these mounds were still heavily vegetated in July 1995.
I chose MP6, the northernmost mound of the northern cluster on Middle Point, to excavate first as goanna damage was limited to a small section. It is also the largest and highest mound of the cluster and contains a potentially deep deposit. The next site I excavated was MP5, the middle mound of the cluster that lies 25 m south of MP6. I rejected MP4 as a possibility as it is the lowest and smallest of the three mounds and has been severely degraded by goanna burrows. Later in the dry season (August 1995), fire through the area cleared mounds MP1 and MP2. However due to time constraints I excavated only MP2 which is the largest of a cluster of three earth mounds located some 500 m southeast of cluster MP4-MP6.

My first choice for excavation at North Point (Map 3.3) was the isolated mound NP1 as I was looking for a large, undisturbed mound. However after examination this was rejected as it was entirely covered with the weed _Hyptis suaveolens_. We next checked the sites on the track, NP14, NP15 and NP16. NP15 and NP16 were heavily covered with _Hyptis suaveolens_ and disturbed by goanna burrows. NP14 was clear of vegetation and undisturbed by goannas but was rejected as it has been disturbed by vehicle traffic. NP19 is located off the track at the top of North Point, some 100m south of the lagoon, and is one of a cluster of three mounds, NP18, NP19 and NP20. It was selected for excavation, as it was undisturbed by goannas and, unlike NP18, it was almost entirely free from vegetation except for a clump of pandanus in the middle of the mound. NP20 lies some 40m directly south of NP19. It was selected for excavation as its eastern side was free of vegetation and it had suffered only minor goanna damage. It is also the highest of the three mounds.

**Excavation Methods**

Obviously the ideal approach to mound excavation includes long trench excavation from the edge of the mound through to the centre. This method when combined with off-mound sampling is useful for providing information relating to mound origin and formation (Williams 1994). However, given the large size of the mounds on Middle Point and due to logistic reasons of lack of resources and personnel, this approach was not feasible. Under the circumstances, I decided that the best way to obtain a representative
sample from each site was to excavate a metre square from the top of each mound to obtain maximum depth. The relative richness of the Middle Point sites in terms of lithic and faunal assemblages meant that there was adequate data available to answer the range of questions posed by this thesis. However, the relative paucity of data from North Point indicates that the thesis may well have benefited from the long trench excavation method at those sites.

The method of excavation was the same at all sites. A metre square was laid out as near as possible to the top of the mound, taking into consideration the presence of trees and goanna burrows. Heights were measured with a dumpy level. I tried to excavate according to changes in the deposit and spit sizes were thus arbitrary. The excavated material was weighed and sieved through 6 mm and 3 mm sieves. The 6mm sieve residue was sorted in the field and finds were bagged and labelled. Any residue (mainly laterite gravel) from the 6mm sieves was weighed and discarded. The 3mm sieve residue was bagged as it was very fine and covered with dirt making it difficult to sort under field conditions. It was washed and sorted in the laboratory. Soil samples were taken from each spit and from the ground surrounding each mound. At the end of each excavation the site was back-filled and marked with a tent peg and flagging tape.

**Mound MP2**

Mound MP2 is 1.37 m high and some 80 m in diameter. In late August 1995 it was heavily vegetated with the weed *Hyptis suaveolens* on all but its northern side which had been cleared by fire since inspection earlier in the field season. I located the excavation some six metres from the top of the mound as there is a large fig tree growing there and I wished to avoid its roots as well as the extensive goanna burrows surrounding the tree. The deposit was 71 cm deep and appears to contain three layers (Figure 3.1, Table 3.3). I closed the excavation when I reached a rock hard layer containing much laterite and quartzite rubble at the bottom of Layer III. There was no shell present in any of the layers. As the excavation reached base 66 cm short of the height of the mound, I concluded that the occupation deposit was located on a low layer rise in the same way as at mounds MP5 and MP6.
**Mound MP5**
MP5 is 41 m in diameter and 92 cm high. Goanna burrows on its southwestern side extensively disturb it. The top of the mound is quite flat and its centre is covered with trees, both pandanus and *Planchonia careya*. I therefore decided to locate the excavation on the top of the mound towards the eastern undisturbed side that was free from vegetation. A large snake inhabiting one of the burrows on the southwestern side helped reinforce this decision! MP5 was 49 cm deep and appears to contain two layers (Figure 3.2, Table 3.4). At the base of this Layer II, there was a layer of orange soil. As this layer was full of large pieces of laterite gravel and cement-like in consistency, I concluded I had reached the laterite surface lying beneath the excavation and closed the excavation. The deposit ended 43 cm short of the depth of the mound and, as at MP6, I concluded that the mound capped a low level laterite rise.

**Mound MP6**
Mound MP6 is 69 m in diameter and 98 cm high. There are many trees present on this mound, both pandanus and the early wet season fruiting green plum (*Planchonia careya*), also known as 'cocky apples' (Norma Richardson pers. comm.). The deposit appears to contain three layers with a basal depth of 55 cm (Figure 3.3, Table 3.5). I closed the excavation when the soil became extremely hard and compact and no more stone artefacts appeared in the sieves. The presence of increasing amounts of laterite gravel towards the end of the pit and the fact that the bottom was reached at 55 cm when the height of the mound is about one metre seems to indicate that the mound caps a low laterite ridge.

**Mound NP19**
Mound NP19 is approximately 50 m in diameter and 60 cm high. The surface scatter consisted mainly of stone artefacts, including items made from quartz, quartzite and Gerowie tuff. There were also tiny bits of bleached bone, including turtle shell. A one metre by one metre excavation square was located on the high point of the mound, north of the pandanus clump in the middle of the mound. The deposit proved extremely hard and compact and we were forced to reduce the size of the excavation to a 50 cm by 50 cm square. The deposit contained only one stratigraphic layer five centimetres in depth.
The excavation was closed down because of the cement-like consistency of the deposit. It is unclear whether we reached the basal layer of cultural occupation.

**Mound NP20**

Mound NP20 was 44m in diameter and 1.35m high. A large sandpaper fig (*Ficus opposita*) dominates the top of the mound. There is also a large stone with pounding hollows present under the tree on top of the mound. The depth of the deposit was only seven centimetres but can be divided into two layers (Figure 3.5, Table 3.7). NP20 was not excavated further as its base had the consistency of cement. This led me to believe that the base of the cultural layer had been reached. However this may not be the case as there were still artefacts present. The early onset of the wet season in 1995 prevented the completion of investigations at NP20.

### 3.7 CHRONOLOGY

The dates for the geomorphological organic samples were quoted as conventional radiocarbon ages. The shell dates were uncorrected for the ocean reservoir effect because a number of known older samples yielded dates of less than the correction factor of 450 years for marine shells in northern Australia (Woodroffe *et al.* 1993:260). Likewise, a number of regional archaeological studies relevant to this thesis have also used uncorrected and uncalibrated radiocarbon determinations. As the geomorphological dates were crucial to the interpretation of the archaeology and I wished to place the Adelaide River study in a regional perspective, I have used uncorrected and uncalibrated radiocarbon determinations to avoid confusion. The radiocarbon dates from the Middle Point and North Point mounds all fall within the period of the mid-late Holocene period, from c. 4000 years until the recent past (Table 3.8). Twelve radiocarbon determinations have been made. Five dates were determined on samples from MP2, one from MP5, two from MP6, one from NP20 and three from HD1. The dates have been obtained from a number of different materials, bone, charcoal, shell and turtle carapace. Although it would be ideal for comparative purposes to obtain dates on the same material for all sites,
this was not always possible for a number of reasons. The same laboratory, Waikato Radiocarbon Laboratory, was used to process all the samples, thereby hopefully minimizing possible discrepancies caused by dating different materials.

The organic preservation at the sites was variable. Some sites had excellent preservation, eg. MP2 and HD1, others had very poor preservation, eg. MP5, NP19 and NP20. Thus it was easy to obtain dates for some sites and more difficult for others. Only one date each could be obtained from MP5 and NP20 due to lack of suitable samples. NP19 could not be dated at all as all three samples, just about the total of the organic remains for the site, proved to be contaminated. Funding for dates was piecemeal, so I had to prioritise the sites. MP2 and HD1 were selected as they both had the deepest deposits and the most organic material. This also meant they were the easiest sites from which to obtain viable samples. There was no charcoal available for IID1, so shell and bone samples had to be submitted instead. While sorting the material from these sites, it became obvious that there was a change in the faunal content from fish to turtle about halfway through the sites. It was important to obtain dates for this event as it had the potential to pinpoint the change in floodplain conditions from estuarine to freshwater. However, several samples were contaminated and fresh samples had to be re-submitted, which meant that I was not always able to obtain dates from my first choice of spit.

**Mound MP2**
The dates from MP2 were on charcoal from spits 5, 7 and 13, and on a charcoal/turtle carapace pair from spit 10 (Figure 3.1, Table 3.8). MP2/5 from 22-26cm below surface came out at 350±70 years BP (Wk-5581) (Figure 3.6). MP2/7 from 31-35 cm below surface was determined at 460±130 years BP (Wk-8452). MP2/13, 53-59cm below the surface and eight centimetres from the base of the deposit, was 1880±210 years BP (Wk-5582) (Figure 3.7). These three dates are in sequence. The charcoal/turtle carapace pair from spit 10 was chosen to test the reliability of the turtle carapace, as this is not a material used commonly for dating. The pair did not match each other, with the charcoal dated to 360±190 years BP (Wk-6235) and the turtle carapace to 2040±260 years BP (Wk-6374) (Table 3.8; Figure 3.8). The charcoal date seems rather young. It is 42-47cm
below the surface, at least 16cm below spit 5, dated to 350±70 years BP and seven centimetres below the older date of 460±130 years BP from spit 7. Yet the three dates overlap. I prefer the turtle carapace date of 2040±260 years BP for MP2/10. It is only six centimetres above MP2/13, dated to 1880±210 years BP. Although these two dates are not in sequence, they do overlap. In any event, the difficulty of non-sequential dates is partly overcome by the way the data have been divided for analysis according to time frames. As I explain below, MP2 has been divided into three time periods, <460, 460-2000, >2000 years BP. The middle period 460-2000 years BP includes data from both spits 10 and 13, so it is immaterial which of the dates is correct as both are encompassed within this time frame.

**Mound MP5**
Organic preservation at this site was very poor. An AMS date of 630±60 years BP (Wk-7400) was obtained on a small charcoal sample from spit 11, 36-41cm below the surface and eight centimetres above base (Figure 3.2, Table 3.8).

**Mound MP6**
Two dates were obtained on mixed 3mm faunal bone through the AMS technique, as there was generally poor preservation of organic remains at this site and there was no charcoal available (Table 3.8). The upper layer was dated to 434±56 years BP (Wk-6668) (Figure 3.3, Figure 3.9) at spit 5, 10-16cm below the surface. The lower layer was dated to 1432±56 years BP (Wk-6669) (Figure 3.10). These dates are in sequence.

**Mound HD1**
No charcoal samples or stratigraphic information were available for HD1. The two dates from the lower spits are from estuarine shell (Table 3.8). A sample from HD1/9, 49-56cm below surface came out at 3880±60 years BP (Wk-5957) (Figure 3.11). The sample from HD1/11, the bottom spit 62-69cm below the surface came out as 4060±60 years BP (Wk-5796) (Figure 3.12). These dates are in sequence with each other. In the absence of shell in the upper layers, turtle carapace from spit 3 was used to date the top of the site (Table 3.8). This sample came out at 2027±77 years BP (Wk-6373) (Figure 3.13), 10-19cm
below the surface and was obtained through AMS because of the low organic content of the turtle carapace. This date is chronologically in sequence with the other dates.

**Mound NP19**

Organic preservation at this site was poor. Three samples, obtained from the spit 2.3mm fraction three centimetres below the surface, each consisting of weathered shell, bone and turtle carapace, were submitted for radiocarbon dating. In each case it was found that the samples were contaminated, so I was unable to obtain a determination for this site. However, because of the shallow nature of the site and its proximity to NP20, I am assuming for the purposes of the following discussion that NP19 belongs to the Late Freshwater Phase.

**Mound NP20**

No charcoal and very few organic remains were present at NP20. A modern (Wk-5580) date was obtained on one intact estuarine shell, 5cm from the top of the excavation and 2cm from the base (Figure 3.5, Table 3.8). Fragments of glass and ceramics found in the deposit tend to confirm a recent age for this site. On this evidence it has been assumed that the site has been occupied at least 150 years ago.

**Discussion**

When contemplating diversity in archaeological assemblages, two issues that must be considered are spatial and temporal differences. The archaeological surveys on the Adelaide River described above defined the spatial distribution of sites within the landscape. The Middle Point and North Point sites are all located on the same landform on the floodplain margins. However, spatial differences exist in terms of distances from raw material sources and other resources at different times of the year. The implications of such spatial differences will be considered in the following chapter when variability in the archaeological assemblages will be investigated.

The earth mound sites have the potential to address questions of human adaptive strategies to change in the landscape over time. The radiocarbon dates imply that the western floodplain margins of the Adelaide River have been occupied for at least the last
4000 years, a period spanning three environmental phases of the mid to late Holocene period, the Big Swamp Phase, the Transition Phase and the Freshwater Phase. The mound sites thus have the potential to chart cultural responses to this period of rapid environmental change.

For the purposes of comparative analysis I have divided the sites into time frames, according to their radiocarbon dates based mostly on the environmental evolution of the floodplains. These phases are the Big Swamp Phase, the Transition Phase, the Early and Recent Freshwater Phases, and the Contact Phase (see Table 3.9). This division cannot be considered absolute, as the dating of each of the phases is not precise for the Adelaide River (see Chapter 2), but as a convenient aid to the interpretation of cultural data within an environmental framework. The separation of the Freshwater Phase into Early and Late Phases is artificial. It was done because recent dates were available from most of the sites and the division makes it possible to ask more qualified questions of data spanning a 2000-year period. For example, Hiscock (1997, 1999) and Bourke (2000) have suggested an environmental change from open beaches to closed mangroves occurred in the Darwin Harbour region post 1000 years BP. This event may have had consequences for the Adelaide River residents. The division of the Freshwater Phase into Early and Late means that this question can be addressed and it will be explored further in the following chapter. The Contact Phase at the end of the sequence is a cultural construct that may well be encompassed by the Late Freshwater Phase but remains valid because of the obvious impacts on the environment of European contact. This method of analysis is also a useful tool for enabling the comparison of the Adelaide River sites with other regional wetland sites (see Chapter 7). I have had to make arbitrary decisions about the dates and what phases they fit into, based on the radiocarbon determinations that were available.

### 3.8 ARCHAEOLOGICAL MODELS OF SETTLEMENT PATTERNS AND MOBILITY STRATEGIES

According to the geomorphologists (Chappell 1988; Woodroffe and Mulrennan 1991; Woodroffe et al. 1993), the Big Swamp Phase persisted on the Adelaide River until at
least 4000 years BP (see Chapter 2). The chronology and remains of estuarine fauna from HD1 suggest that the site was occupied initially at the end of the Big Swamp Phase c. 4000 years BP and occupation continued through the Transition Phase and into the Freshwater Phase. The dates and faunal remains suggest that MP2 was occupied initially in the Transition Phase and throughout the Freshwater Phase. MP5 and MP6 overlap MP2 early in the Freshwater Phase right through until the recent past. It has been assumed that NP19 also belongs to the Freshwater Phase. NP20 is linked firmly to the recent past by its modern date and the occurrence of European material (glass and ceramic) in the deposit, and it has been relegated to the Contact Phase. However the non-European assemblage also links this site with the Recent Freshwater Phase.

One of the questions that this thesis asks is whether the mounds were occupied contemporaneously and if so what were the implications for intensified settlement of the area? It appears that MP2 is the site that links all the sites. In the Transition Phase it is contemporary with HD1. It is also contemporary through the Freshwater Phase with MP6 from c.1400 years BP and MP5 from c. 600 years BP. It is also probably contemporary with NP19 and NP20 in the Recent Freshwater Phase.

It is necessary to envisage what these different phases would have meant for the people occupying the landscape at those times. Settlement and subsistence patterns should reflect shifting resource availability on the floodplains. Below, I have suggested models of likely settlement patterns and mobility strategies, including considerations of foraging strategies and technology, based on the environmental conditions extant in the mid-late Holocene period. These models are summarized in Tables 4.1 and 6.1. The next question to ask is what is the likely archaeological signature of this changing scenario?

The Big Swamp Phase
As Hiscock (1999) has rightly pointed out in the context of western Arnhem Land, landscapes that existed prior to the Freshwater Phase have no modern day analogues. This is especially true of the Big Swamp Phase when vast Rhizophora mangrove swamps dominated the floodplains of the northern rivers. Clark and Guppy (1988:682) point out
that during the Big Swamp Phase in the Alligator Rivers region, apart from short-scale variability, there was large-scale environmental stability of the *Rhizophora* forests over a period of some 5000 years. However even short-term local variability is likely to have affected the settlement patterns and foraging strategies of hunter-gatherers. Given the geomorphological similarities between the two regions (see Chapter 2), it seems likely that a similar situation persisted for c. 3000 years on the Adelaide River. During the Big Swamp Phase, foraging and settlement would have been concentrated along the landward margins of the *Rhizophora* mangrove swamps. As the study area was also located close to a low-energy coastline at this time (Map 2.2), I would also expect available in-shore marine resources to be utilised. The Big Swamp Phase would have been a period of relatively high productivity (Figure 2.1) and predictability. Given this situation, I would expect low residential mobility and a relatively concentrated population while people exploited the rich and diverse food resources of the mangrove swamps. As Pardoe (1994:185) has said, 'More food resources per unit area coupled with greater predictability over the year and longer will generally mean more people'.

As the foraging focus was water-based, I would expect the technology to reflect this, in the form of fishing equipment, fish spears, fish traps, nets etc. Suitable stone for knapping would be essential for the manufacture of these items. During the wet season when the resources of the swamp and sea were not easily accessible, I would expect the residents to turn their energies to the resources of the open woodland.

While offering advantages in terms of rich and diverse food resources, these swamps also would have presented difficulties. The floodplains would have become virtually impenetrable barriers, up to 30 km wide on the Adelaide River for example. Access to groups of people and resources on one side of the river would have been cut off from the other side, and movement confined to corridors of high ground between the rivers.

Settlement patterns should reflect this scenario. I would expect a concentration of sites on the floodplain margins of the Adelaide River. I expect that low mobility would be
reflected archaeologically by a more intense use of sites and local stone resources (Table 4.1). Faunal remains should reflect estuarine and marine-based exploitation (mainly fish and shellfish). Estuarine resources exploited were probably similar to those found in the rockshelters of western Arnhem Land located on the edge of the floodplains also dated to the Big Swamp Phase. These resources included mangrove shellfish, for example *Geloina, Telescopium, Cassidula, Nerita, Terebralia, Cerithidea* and *Ellobium*, and estuarine fish, such as barramundi (*Lates calcarifer*), catfish (*Arius* sp.) and sleepy cod (*Oxyeleotris lineolatus*), and the crab, *Sesarma* sp., that makes its home on the edge of tidal channels (cf Allen 1996:198; Allen and Barton 1989; Hiscock 1999; Schrire 1982). In these sites *Geloina*, which favours small streams draining mangrove forest, was the dominant species. Marine resources should include shellfish species from sandy and muddy open beach fronts that dominated the mid-Holocene coastline at that time, similar to those found in middens at the mouth of the West Alligator River dated to the same period, eg *Anadara, Marcia* and *Circe* (Hiscock 1999; Mowat 1995). The gathering of marine and estuarine shellfish can take place year-round and is more likely to be affected by tides and than by seasons (Meehan 1982:64-65). Like the western Arnhem Land midden sites dated to the Big Swamp Phase, I would expect that the economy was not totally reliant on the mangrove swamps but mixed to a lesser extent with resources from other habitats away from the floodplains. These resources would include woodland fauna, for example wallabies (*Macropus* sp.), possums (*Trichosurus arnhemensis*) and bandicoots (*Isoodon macrourus*) (Table 2.4), and some freshwater resources from lagoons and streams, such as turtle (*Chelodina* sp.) and freshwater fish (Allen 1996:196; Hiscock 1999; Schrire 1982) (Table 6.1). Mobility, which can be measured in terms of raw material acquisition, is likely to be south-north, rather than east-west because of the impenetrable nature of the mangrove forests on the floodplains (Table 4.1).

**The Transition Phase**

Following the decline of the swamps and the beginning of the Transition Phase c. 3700 years BP, there existed a landscape of great variability made up of a mosaic of freshwater and estuarine ecosystems. Clark and Guppy (1988:682) suggest that this was a period of environmental instability with rapid changes in vegetation, channel migration and
alternating inundations of fresh and salt water on the floodplains. The eventual cut-off of tidial inundation may also have led to the formation of saline and hypersaline mudflats on the landward margins similar to those described by Clark and Guppy (1988:677) for the Magela Creek. Following a period of progradation, the coast reached its present position by c. 3000 years BP and like today the study area was located some 30 km inland (Map 2.2). This phase lasted for approximately 2000 years. During this time, the dynamic nature of the environment would have made the floodplains an unpredictable resource base. For this reason, it is predicted that the productivity of the Transition Phase was low in comparison with the Big Swamp Phase.

In the less certain times of the Transition Phase settlement may have been forced away from the floodplains into the woodland around lagoons and creeks, or continually relocated between the floodplains and the woodland depending on what resources were available. I expect that the population density would be lower and mobility higher as settlement became more widespread. There may have been some conflict at this time as previously resource-rich areas turned into saline mud-flats and groups were forced to reschedule their subsistence round. The economy would still be partially water-based but with more emphasis on land-based resources, given the unpredictability of the floodplain resources. As a result the technology would need to be flexible to adapt to changing situations. Movement across the floodplains may have been restricted but not to the same extent as during the Big Swamp Phase.

I would expect a shift in settlement away from the floodplains and greater mobility during the Transition Phase to be reflected archaeologically by less intense use of floodplains sites and shifts in raw material acquisition (Table 4.1). Faunal remains would consist of a more even mix of both freshwater (Table 2.3) and estuarine species from the floodplains, and land-based species with a greater emphasis on woodland fauna than in the Big Swamp Phase (Table 2.4). The type of estuarine shellfish obtained from the mangroves is likely to have changed with the changing nature of the mangroves themselves. Increased sedimentation in the Transition Phase meant that initially colonizing mangroves and then
the salt/dry tolerant *Avicennia* replaced the *Rhizophora* forests (Clark and Guppy 1988:681-82). The shellfish *Cerethidea* favours this habitat and became the dominant species in the western Arnhem Land midden sites dated to the Transition Phase (Allen and Barton 1989; Hiscock 1999; Schrire 1982). Marine species would no longer be present, as the sea was by then located too far away (Table 6.1). Increased west-east accessibility may also be reflected by raw material acquisition from eastern sources (Table 4.1).

**The Freshwater Phase**

The establishment of the freshwater floodplains post 2000 years BP began another phase of environmental stability in contrast with the Transition Phase, similar to that in Kakadu. However as noted in Chapter 2 and above, this period was not necessarily uniform and there may have been environmental variations that affected settlement strategies (Rowland 1999). The division of the Freshwater Phase into early and late phases (see Chronology above) will allow this issue to be addressed.

During the Freshwater Phase, the floodplains would have provided a predictable, highly productive resource base (Figure 2.1) (Clark and Guppy 1988:682; Head 1987; Finlayson *et al.* 1988). However, this productivity was seasonal (see Chapter 2). There would have been periods of high productivity during the dry season when resources were accessible. In terms of human utility, the wet season, except for the goose egg harvest late in the season, was a period of low productivity as floodplain resources were flooded and dispersed. Settlement strategies would have been adjusted to the regime of wet and dry. Given the highly productive and predictable nature of the resource base, there would be a concentration of settlement on the floodplains during the dry season, with an increased density of population and low residential mobility. There would have been a seasonal shift to alternative resource bases during the wet season, which may also have required a residential shift. Movement across the floodplains would have been unrestricted during the dry season, the remaining barrier to the east being the river itself, though even this could be crossed at low tide at a ford to the east of North Point.
I would expect decreased residential mobility during the Freshwater Phase to be reflected by an increased intensity of site use and reliance on local lithic raw materials. Non-local raw materials may also be more intensely worked. With open accessibility across the Adelaide River to the east, there may also be changes in lithic raw material acquisition (Table 4.1). Seasonal occupation of sites may be apparent in the faunal assemblages of the Freshwater Phase. Faunal remains should be mainly freshwater with some land-based species, though less so than in the Transition Phase (Table 6.1).

During this time the economy would have been mainly water-based, with appropriate technology. Freshwater floodplains provide numerous plant products that are useful in the manufacture of material cultural items (see Chapter 2). However, no plant remains were found in the sites so their use remains speculative, except for what can be gleaned from the ethnography (see Chapter 7).

**The Contact Phase**

During the latter part of the Freshwater Phase, the floodplains once again underwent environmental changes under pressure from exotic species of flora and fauna introduced by Europeans (see Chapter 2). These changes were just one aspect of European contact that profoundly affected the settlement patterns and social and economic strategies of the Aboriginal inhabitants. Exotic species of plants and animals invaded and decreased the productivity of the floodplains. At the same time some of these animals provided a new food source. Sites were abandoned as people died from introduced diseases or gravitated to European and Chinese settlements and enterprises. People increasingly relied on flour and sugar and other rather than traditional carbohydrates. Technology became more efficient as stone was replaced by metal and new technologies such as firearms became available.

At least one of the Adelaide River sites is dated to this phase and I would expect the archaeology to reflect some of these historic trends. The intensity of site use should decrease, along with less emphasis on the acquisition of non-local raw materials Table
4.1). There may be faunal remains of some of the introduced species and European artefacts should be present (Table 6.1).

The settlement patterns and mobility strategies suggested by these models will be tested in Chapters 4, 5 and 6 by addressing questions of raw material acquisition, discard rates, intensity of site use, resource use and seasonality in the analysis of the lithic and faunal assemblages.
CHAPTER 4: LITHIC RAW MATERIAL ANALYSIS

4.1 INTRODUCTION

This chapter and the one following will seek to test the models of settlement patterns and mobility strategies through the mid-late Holocene, as constructed in the previous chapter. I will attempt to do this through an analysis of lithic raw materials, their acquisition and curation, and density and distribution within the earth mounds. This analysis will be linked to the environmental phases by dividing the assemblages from each site according to the time frames outlined in the previous chapter. The phases (ie Big Swamp, Transition, Early, Late and Contact) are based on chronologies established by independent geomorphological and environmental evidence concerning the evolution of the floodplains, as presented in Chapter 2. The assemblages have been assigned to phases according to the chronologies established by the archaeological research, as discussed in Chapter 3.

In a review of stone artefact analysis in Australia, Hiscock (1998:263-65) pointed out that there has been increasing emphasis on issues of access and stone availability as key factors in assemblage variability. For example, Byrne (1980) demonstrated increasing retouch further away from silcrete quarries. Researchers have attempted to see access to stone as related to a range of factors in settlement systems, eg. level and structure of mobility; structure of the environment; familiarity with the environment, and environmental and social barriers to access (Edmonds 1987; Hiscock 1994b, 1998:265; Jeske 1989; Lurie 1989; E.A. Smith 1988; Torrence 1983, 1989). Access to stone and its availability must have influenced movement in the landscape to a certain extent, as well as interactions between groups of people. Thus an examination of raw material acquisition on the Adelaide River is crucial to explanations of settlement patterns and mobility strategies, as part of the subsistence and settlement landscape.
For example, Jeske (1989:34) has argued that natural or cultural restraints on access to raw material sources will result in technological adjustments that can be observed in the archaeological record. He tested the hypothesis that as raw materials became more difficult to access, hunter-gatherers employed economizing strategies in the production of artefacts, including standardization of form, reduction in size and extended usage (1989:34). Hiscock (1994b:267) and Torrence (1989:64) recognized similar forces at work when they argued that the standardization of tool form was a technological response to minimizing environmental risk. Edmonds (1987:175) agreed that the way risk is perceived and coped with will have a direct impact on the nature and structure of lithic assemblages. Lurie (1989) tested the theory that the way in which a group manufactured and used lithic materials could measure their degree of mobility, eg. raw materials that were difficult to obtain would be collected less when mobility decreased. Hiscock (1996), Jeske (1992) and Parry and Kelly (1987) argued that the use of the bipolar technique, which allows for the efficient production of flakes and thereby conserves raw materials, may be an indicator of low residential mobility. This hypothesis is discussed and tested in relation to the Adelaide River sites in the following chapter.

There are two aspects to mobility that I will examine in the raw material assemblages: spatial differences between sites and chronological change, in terms of the availability and accessibility of local and non-local stone materials. The environmental framework outlined in the previous chapter has led to certain expectations about how these aspects are manifested within and between each time frame. In the Big Swamp Phase, it was predicted that there would be a concentration on local stone resources as mobility was low due to the availability of highly productive swamp and beach resources. A dominance of local raw materials, high density and small size of both local and non-local materials should reflect this scenario, as local stone was the main focus and non-local stone was not being procured frequently. Non-local materials would come from either the south or the west as the mangrove forest on the floodplains prevented access to the east. Smaller sizes of raw materials should reflect distance from source (Table 4.1).
The lower productivity of the Transition Phase means that people could move and acquire non-local raw materials more regularly. Lower densities and increased size and richness of raw materials may reflect increased mobility. Raw materials from the east are also expected as the mangrove forests retreated from the floodplains (Table 4.1).

The establishment of the Freshwater Phase on the floodplains signalled a period of even higher resource productivity than that of the Big Swamp Phase. Lower mobility is expected and should be reflected by factors similar to those in the Big Swamp Phase. The eastern side of the river was now accessible and new sources of raw materials were available. Different resource bases may have required new extractive technologies and a different range or emphasis on raw materials (Table 4.1).

The Contact Phase is another period of lower productivity when the environment was adversely affected and Aboriginal people were not using the sites as before. As the sites were used less frequently, the effect on the assemblages may be something like that of increased mobility, i.e. a decrease in density and an increase in the size of raw materials. However, I would also expect lower densities of non-local raw materials and the presence of non-Aboriginal artefacts as the use of stone declined, interactions with European enterprises increased, and traditional alliance networks were broken down. These expectations are summarized in Table 4.1.

Below I will present information on site taphonomy, raw material sources and their distance from the sites. I will then examine the assemblage of each site to test the model of raw material acquisition for each phase. I will summarise the results of the analysis for each environmental phase by comparing the data from the sites in order to highlight the spatial differences between the sites. In the light of these results, I will assess the predictive model outlined above. This summary will emphasize chronological changes in raw material acquisition and their implications for a regional model of settlement and mobility strategies for the Adelaide River through the mid to late Holocene.
4.2 TAPHONOMY
As a result of experimental work Gregory (1998:i) concluded that the biggest taphonomic impact upon sites in the Ord-Victoria River region are fluvial processes and that these processes are likely to have a similar impact on sites elsewhere in northern Australia. Bowen (1996:173) also argued that the greatest taphonomic force in the region was fluvial impact and that artefacts may have been moved or buried by flooding or run-off. Meehan et al. (1985:103) drew attention to taphonomic forces operating at the South Alligator River floodplains sites when they pointed out that sites had been degraded by annual inundation and disturbed by buffaloes.

All of these factors are likely to have affected sites on the Adelaide River, which are exposed to heavy rains and flooding during the wet season. Animals have also had an impact as the sites are located on a former cattle station and, before the Brucellosis and Tuberculosis Eradication Campaign (BTEC) in 1989, buffaloes were present in high numbers. It is highly likely therefore that there has been some movement of stone artefacts within the earth mound deposits.

4.3 RAW MATERIAL SOURCES
The main lithic raw materials on the sites are quartz, quartzite, Gerowie tuff, chert, a fine-grained siliceous material, sandstone, ochre, haematite and volcanic materials. Quartz is a mineral form of silica, massive or crystallizing in hexagonal prisms. Quartzite is a compact granular quartz rock (Sykes 1976). Chert is a member of the chalcedony group of water-bearing silica minerals characterized by its opaqueness. It occurs as strata and also in nodules (Bahn 1992:96). The Gerowie tuff referred to here is a form of chert. It is described variously as glassy black spotted crystal chert, tuffaceous chert, minor tuffaceous greywacke and arenite (Pietsch and Stuart-Smith 1987:8). Chert is a preferred raw material for the manufacture of stone artefacts as it has no pre-determined cleavage planes, is very hard, fractures conchoidally and holds an edge (Cotterell and Kamminga 1992). In the absence of more suitable materials, other forms of siliceous rocks, such as
quartz and quartzite, were used to manufacture stone tools. Quartzite and Gerowie tuff outcrops are a common feature in the Darwin hinterland and were used as raw materials for the manufacture of stone artefacts. Sandstone is a sedimentary rock composed of compressed sand. The term ochre refers to soft varieties of the iron oxide minerals, including those that can be used as pigments. Limonite and goethite ochres produce brown, yellow and black colours. Haematite is red ochre (Bahn 1992:364). Volcanic raw materials refer to coarse basaltic rocks, eg dolerite.

In the study area, the locally occurring raw materials are quartzite, quartz and the fine-grained siliceous material. Quartzite is readily available. The Wildman Siltstone Formation, part of the Mount Partridge Group of the Pine Creek Geosyncline, the major regional geological formation, crops out as a seam of white quartzite (see Chapter 2, Needham and Stuart-Smith 1984). It runs from North Point in the study area to Manton Dam southwest of the study area, a distance of some 70 km. The outcrop is not continuous but occurs regularly and its path is obvious. It has been quarried along its entire length of 12 km in the study area, from North Point to the Arnhem Highway (Map 4.1, Table 4.2). Some places have been more extensively worked than others, presumably because the flaking quality of the quartzite is variable. Quartzite rock outcrops also occur on an island on the floodplains to the east of North Point (AR1) (Map 3.3). Quartz outcrops locally in veins on the Koolpinyah Surface (Crassweller 1996:23). There are no known local sources of the fine-grained siliceous material. However, it is so constant in the sites yet so little modified that it is likely to originate locally.

It appears that other raw materials at the sites come from further afield, as there are no nearby sources. Tuffaceous chert, commonly known as 'Gerowie Tuff' from the geological formation of the same name is part of the South Alligator Group of the Pine Creek Geosyncline. A minor source is located in the study area at Beatrice Hill (BH1) some 12 km south of the Middle Point sites and 17 km south of the North Point sites (Map 3.2, Table 4.2). Another minor source is located 70 km to the south-west near Manton Dam (Map 4.1, Table 4.2). Large sources are available on the eastern side of the
Adelaide River from the high ground in the southern parts of the coastal plains region, c.
20 km south of Scotch Creek and 40 km from the study area (Needham and Stuart-Smith
1984; Pietsch and Stuart-Smith 1987; Roddom 1997; Smith and Brockwell 1994:98)
(Map 4.1, Table 4.2). For the purposes of this thesis, tuff is regarded as a non-local raw
material. Chert occurs in lenses and nodules in the Koolpin Formation of the South
Alligator Group (Needham and Stuart-Smith 1984). No sources of chert have been
reported for Beatrice Hill but it can be found in the strike hills and ridges on the eastern
side of the Adelaide River (Crassweller 1996:23; Roddom 1997; Smith and Brockwell
1994:97). There are also known sources further afield at Mt Bundy Station (Needham and
Stuart-Smith 1984) (Map 4.1, Table 4.2). There are sources of feldspathic sandstone from
the Crater Formation around Batchelor to the southwest. However much more substantial
sources of Mundogie sandstone outcrop to the east between the Mary and Wildman
Rivers, and further to the south-east in Kakadu (Needham and Stuart-Smith 1984; Pietsch
and Stuart-Smith 1987:11, 14) (Map 4.1, Table 4.2). Red ochre is known to have come
from at least one source in the vicinity of Manton Dam, some 70 km to the southwest.
There was a source of white ochre on the eastern side of the Adelaide River (Ritchie and
Baumann 1991:43, 61) (Map 4.1, Table 4.2). The sources of the volcanics and haematite
are unclear, but they are almost certainly not local.

In terms of accessibility over time, quartzite, quartz and the fine-grained siliceous
material were readily available through all the environmental phases, being located on the
western side of the river near the sites. Access to tuff, chert and sandstone would have
been most difficult during the Big Swamp Phase, being located on the eastern side of
floodplains dense with mangrove forest. Access would have improved during the
Transition and Freshwater Phases after the mangroves retreated (Map 2.2).

The presence of non-local raw materials implies that either people moved to the sources
on their annual round, or that some kind of trade network/regional alliance was in place to
enable people access to distant stone sources. One of the issues that this chapter will
examine is the economic pattern of stone acquisition, whether there was change in it over time and whether such change was related to environmental change.

4.4 INTRA-SITE DENSITY AND DISTRIBUTION

A method widely used to calculate abundance of stone artefacts through a deposit in northern Australia is to calculate the number and weight of items per kilo of deposit (cf. Bourke 2000; Flood and Horsfall 1986; Fullagar et al. 1996; Hiscock 1984; Jones and Johnson 1985). As bucket weights were not available for HD1 this was not possible, so I used the formula of 1500 kg per cubic metre of deposit as suggested by Jones and Johnson (1985:183). On this basis I estimated the volume (based on spit depth) and approximate weight of each spit. I was then able to calculate the number of artefacts per kilo so that HD1 could be compared with the other sites. When these calculations are linked to the dates of the sites we can calculate discard rates and track chronological changes in the abundance of raw materials through the environmental phases.

When considering density and distribution, especially if the data are used to construct arguments concerning intensity of occupation, a number of factors must be taken into account, including sampling strategies, taphonomy and changes in lithic technology (cf Bourke 2000; Dortch and Smith 2001; Gregory 1998; Hiscock 1981, 1985; Spriggs 1999). Hiscock (1984:133-36; 1986:47) suggests that stone discard rates within sites in the mid-late Holocene are not necessarily related to increased intensity of site use but may be explained in terms of shifts in settlement, technology or resource procurement and use. Before such conclusions can be drawn other evidence must be taken into account including the variability in the discard rates of other archaeological remains, including fauna, and regional evidence from a diverse range of sites (Hiscock 1986:48; Dortch and Smith 2001:41). The faunal evidence will be presented in Chapter 6 and the regional archaeology will be considered in Chapter 8.

There is also the issue of distinguishing between the intensity versus the frequency of site use. It has been argued that they are virtually impossible to differentiate because of the
large number of unknown factors involved, including group size, on-site and off-site activities and taphonomy (Dortch and Smith 2001; Cribb 1986:148). Below I have considered not only the discard rate of artefacts but also their discard weight in this context. If the discard rate remains the same but the total weight of artefacts being discarded increases, this may be one indicator of more frequent rather than more intensive use of sites. Of course, this result will have to be considered together with the faunal and other regional archaeological evidence before conclusions can be suggested.

**Site MP2**

MP2 had an abundance of stone artefacts. There were a total of 9718 artefacts through the deposit, in an area of only 0.7 m$^3$. Overall there is a pattern of decreasing density over time, although there are fluctuations within this pattern (Table 4.3, Figure 4.1). There appears to be no discernible pattern with average weight.

The 3mm samples from the MP2 excavation were dense with stone and bone. It took approximately six weeks in the laboratory to sort the first three spits. In order to reduce sorting time, the remaining 3mm fraction from each spit was sampled. Spits 1-3, 10 and 13 were sorted completely because samples for dating had been taken from them. Twenty-five per cent of spits 7 and 16 were sampled. Ten per cent of spits 4, 5, 6, 8, 9, 11, 12 and 14-15 were sampled. The number of artefacts present in each spit was projected from the sample size.

For the purposes of the intra-site comparison, data from MP2 spits 1-4 and MP2 spits 5-7 have been presented, although both are assigned to the Late Freshwater Phase. When the data were divided into phases according to the dates and the discard rates calculated (Table 4.4, Figure 4.2), artefact numbers increased dramatically in the early part of the Late Freshwater Phase (350-460 years BP), then declined in the upper levels post 350 years BP. Weight of artefacts followed a similar pattern. Figures cannot be supplied for the Transition Phase because the number of years involved is unknown. The dramatic increase in discard rate between 350 and 460 years BP and subsequent decline indicates that there was some shift in site use in the Late Freshwater Phase.
Site MP5
There was a total of 1496 artefacts in the MP5. The distribution was relatively even throughout, except for a peak in spit 8 (Table 4.5, Figure 4.3). The calculation of artefacts discarded per kg of deposit per 100 years does not offer additional information as the number of years involved was not available for the Early Freshwater Phase (Table 4.6).

Site MP6
There were abundant artefacts in MP6, totalling 10,199, in an area of 0.6 m³ (Table 4.7, Figure 4.4). The dates allowed the data to be divided into two phases, the Late Freshwater Phase dated to less than c. 430 years BP, and the upper and lower Early Freshwater Phase from c. 430-1430 years BP. Although spits 5-11 and spit 12 are both assigned to the Early Freshwater Phase, they have not been combined in the intra-site comparison because spit 12 is not defined by a lower date. There was a trend of increasing density of artefacts over time that indicates a change in site use post 430 years BP. The lower Early Freshwater Phase was not included in the calculation of discard rates as the number of years involved is unknown (Table 4.8, Figure 4.5).

Site HD1
Schrire's (1968) report does not specify what size sieve was used when HD1 was excavated. However from the comparatively large size of the artefacts, it is assumed that it was equivalent to a 6mm sieve as the smallest measured artefact had dimensions of 9x8x3 mm. There were 1088 artefacts in HD1. The density of artefacts peaked in the middle of the deposit and declined subsequently (Table 4.9, Figure 4.6).

When the artefact densities are divided according to phases, there is a decrease in the discard rate from the Big Swamp Phase to Transition Phase and a subsequent increase in the Freshwater Phase (Table 4.10, Figure 4.7). Thus it appears that there is a change in site use between phases. The weight of artefacts per 100 years decreased over time.
Site NP19
Artefacts were distributed densely at NP19. There were 894 artefacts in an area of 0.04 m³. Density decreased from base to surface. The average density was 19.3 artefacts per kg deposit (Table 4.11, Figure 4.8).

NP19 was unable to be dated (see Chapter 3). However, it has been assumed from the shallow depth of the site, its close proximity to site NP20 that has been dated as modern, lack of contact material, and the presence of freshwater turtle carapace throughout the deposit, that NP19 belongs to the Freshwater Phase, most probably the Late Freshwater Phase. Because no dates were available, no calculation could be made on the discard rate.

Site NP20
There was a low density of lithic material at NP20. Altogether there were only 215 stone artefacts recovered from the excavation in an area 0.1 m³. The average density was 1.7 artefacts per kg deposit. It has been assumed from the presence of nineteenth century contact material in NP20, that the site was occupied over a period of at least 100 years. On this basis, the rate of artefact discard per kg deposit per 100 years has been calculated as 1.7 items (Table 4.12).

NP20 was also the only site that contained contact material, namely two green glass pieces and a blue and white ceramic fragment recovered from the excavation, and the broken top of a green glass bottle and a metal nail lying on the surface of the site (Table 4.13). The bottle glass has been identified as belonging to the nineteenth century as the lip is an applied sand paste mould commonly used then, rather than a two piece machine mould used in the twentieth century. It is assumed that the glass pieces found in the excavation are from the same bottle as they are the same colour. Likewise the metal nail has been linked to the nineteenth-century as it is hand cut with a rose head common to the earlier part of that century. The blue and white ceramic piece may be a fragment of Chinese pottery (S. Mitchell pers. comm.).

Discussion
None of the sites span all five phases of the environmental model and there is considerable variation in discard rates and weight of artefacts per 100 years between the sites over the various environmental phases. However, of the two sites that span the Early and Late Freshwater Phases, MP2 and MP6, both showed increases in discard rate in the Late Freshwater Phase, accompanied by an increase in total weight per 100 years (Table 4.14; Figure 4.9). This quantitative change in artefact abundance suggests that there was either more activity or a change in activity at the sites between the Early and Late Freshwater Phases.

The data from all the sites were then combined according to each environmental phase to obtain an overall picture of what happened to discard rates and artefact weights over time (Figure 4.10). Data from MP2 spits 1-4 and MP2 spits 5-7 have both been assigned to the Late Freshwater Phase. However when the inter-site comparisons are made, they have been combined into one block of MP2 spits 1-7 in order to make their presentation less complicated. NP19 and HD1 are not represented in Table 4.14 as NP19 has not been dated and there is only a 6mm fraction available from IID1. HD1 has been included in Table 4.15 that compares the 6mm fraction for all sites.

The combined data for total artefacts show that there is only a slight increase in discard rates from the Early Freshwater Phases to the Contact Phase (Table 4.14, Figure 4.10). However, the total weight of artefacts per 100 years increased three-fold in the Late Freshwater Phase and subsequently declined to one sixth of that figure in the Contact Phase (Table 4.14). So although artefact discard rates did not change significantly, the amount of stone at the sites varied. This result suggests that the sites were being used more frequently, rather than more intensively, in the Late Freshwater Phase. Whether this shift was due to changes in settlement patterns or resource procurement will be further explored when the assemblages are analyzed according to individual raw materials.

The chronological comparison of the combined 6mm artefact distributions indicates that, in the Transition Phase, the discard rate was halved compared with the discard rate for the
Big Swamp Phase. It then trebled in the Early Freshwater Phase, and subsequently increased only slightly in the Late Freshwater and Contact Phases (Table 4.15; Figure 4.11). This pattern is consistent with that predicted by the model outlined in Table 4.1, based on decreased productivity of the floodplains in the Transition Phase and increased productivity in the Freshwater Phases. The overall weight of artefacts decreased slightly from the Big Swamp to the Transition Phase, then increased five-fold in the Early Freshwater Phase. It increased three-fold in the Late Freshwater Phase and then declined to one sixth of that figure in the Contact Phase (Table 4.15). This scenario would appear to agree with the model of more frequent use of the sites during the phases of highest resource productivity, ie. during the Big Swamp and Freshwater Phases. It also confirms what was observed in Table 4.14, ie that there appears to be some shift in site use between the Early Freshwater and Late Freshwater Phases, post 630 years BP. Below, the figures are broken down into individual raw material categories so that we can examine artefact densities and size distributions of local and non-local materials. This analysis will test whether the settlement strategies suggested by the above data are valid.

4.5 RAW MATERIALS

A more fruitful way to examine the role of raw materials is to look at their proportions relative to each other within sites. This approach enables us to look at the changing emphasis on different raw materials through time without reference to taphonomic effects. The changing emphasis on raw materials can provide information regarding mobility strategies within sites.

It has been assumed that the flaked raw materials (ie those raw materials that potentially can be used to produce chipped stone artefacts) and ground raw materials (those raw materials that potentially can be ground) are the basis of different technologies and have been used for different purposes. The sandstone is also assumed to have originally been in larger pieces that have since broken down. The inclusion of numbers of sandstone in the overall artefact count may skew the distribution results, although it may be a guide to
taphonomic forces at work in the site. For these reasons the flaked and ground components of the site have been separated in the following analyses. Each site has been presented separately, and the number, weight, number per kilogram of deposit, and average weight of each raw material for each site is tabled. Following the individual site presentations, the distributions and weights of the raw materials are combined according to the environmental framework so that variations in patterns through the different phases can be tracked.

**MP2 Flaked Raw Materials**
The most frequently occurring flaked raw materials at MP2 were quartz and quartzite, which probably reflects their local availability. Chert and Gerowie tuff (non-local) were comparatively infrequent. The fine-grained siliceous material (FGS) was the least frequently occurring flaked raw material. The distributions of the flaked raw materials at MP2 are listed in Table 4.16 and illustrated in Figure 4.12.

It is easier to define trends in raw material distribution if the data are divided into environmental phases according to the dates. The discard rate (the number of artefacts discarded per kilogram of deposit per 100 years) increased early in the Late Freshwater Phase and decreased subsequently (Table 4.16, Figure 4.12). When the distribution of individual flaked raw materials is examined by phase, a more detailed picture emerges. The raw materials all tend to decrease over time. However, when the discard rate is examined all raw materials peak early in the Late Freshwater Phase, between 350 and 460 years BP (Table 4.16, Figure 4.10).

Expressed as percentages, it can be seen that the proportional discard rate of flaked raw materials changes little between the Early and the beginning of the Late Freshwater phases, apart from an increase in tuff. After 350 years BP, quartz increased and chert and tuff declined (Table 4.17).

Quartzite and FGS had the highest average weights of the flaked raw materials while quartz, chert and tuff had the lowest (Table 4.18). These trends probably reflect
accessibility, distance from source, and the size of the source, suitability for knapping, or a combination of these factors. The average weight of total artefacts decreased slightly over time. The average weights of quartz and quartzite decreased from the Transition Phase into the Early Freshwater Phase and then remained steady. Chert and FGS remained relatively steady over time, while tuff increased in size over time (Figure 4.13). Although FGS is a locally available raw material, it forms only two percent of the assemblage and is little reduced, based on high average weight. The explanation lies, I believe, in the properties of the stone that make it an unattractive option for regular use.

An analysis of total weight of flaked stone per 100 years shows that there was an increase early in the Late Freshwater Phase, 350-460 years BP. This trend was the same for all the individual flaked raw materials, except for tuff, which increased in the Late Freshwater Phase post 350 years BP. When the proportions of raw materials were examined in relation to each other, it can be seen that discard weight of quartz and tuff increased in the Late Freshwater Phase, quartzite decreased slightly, and that of chert and FGS remained relatively steady (Table 4.19, Figure 4.14).

**MP2 Ground Raw Materials**
Sandstone and then ochre dominated the ground raw material component of MP2. Haematite and the volcanic material were present in only very small quantities. The discard weight of ground raw materials increased in the Late Freshwater Phase, mainly due to sandstone, which dominated the assemblage (Table 4.20, Figure 4.15).

Overall and individually the average weight of the ground component increased over time (Table 4.21, Figure 4.16). It must be pointed out, however that the sample size for haematite and the volcanics was small.

**Discussion**
MP2 covers three phases, the Transition and the Early and Late Freshwater Phases. The presence of chert indicates that there is contact with the eastern side of the river through all three phases. The increase in discard rate of all raw materials and raw material weights
early in the Late Freshwater Phase and subsequent decline suggest changes in site use. It may be an indicator of increased use of the site between 350 and 460 years BP. As the Late Freshwater Phase may also encompass the Contact Phase, the decline in discard rates and weights post 350 years BP may be related to contact and decreased use of the site.

Overall, the average weight of flaked raw materials declined after the Transition Phase, which is consistent with lower mobility as outlined in the model above. When raw materials are examined individually, this is true of quartz and FGS both regarded as local. However other raw materials, both local and non-local, increased their average weights, which is not consistent with the model of increased use of the sites post-Transition.

The discard rates of the ground raw materials may have more to do with breakage of sandstone than the actual numbers of artefacts discarded, which may have been originally much larger. However, the overall discard and average weights of ground raw materials increased over time.

**MP5 Flaked Raw Materials**
At MP5 quartz and quartzite were the dominant flaked raw materials, followed by tuff, chert and FGS (Table 4.22, Figure 4.17). Gerowie tuff was present in only low numbers. Chert, a non-local material, was also present in low numbers. The discard rate of flaked raw materials per 100 years could only be calculated for the Late Freshwater Phase (Table 4.22), as no dates were available for the Early Freshwater Phase.

In terms of average weight, quartzite is the dominant raw material followed by FGS, tuff, quartz and chert. The raw materials in this site seemed to be the most variable of all, though overall chert and tuff were the smallest, which is consistent with them being non-local in origin. Quartzite and FGS were the largest, reflecting their local origins (Table 4.23, Figure 4.18).

When divided according to the environmental phases, there was an overall increase of the average weight of flaked raw materials in the Late Freshwater Phase, post 630 years BP.
The average weights of quartz, quartzite and tuff all increased, while chert decreased by one-third and FGS remained relatively steady.

**MP5 Ground Raw Materials**
Sandstone was the dominant raw material in the ground category at MP5. Ochre occurred sporadically through the deposit. Volcanic material was present only in the upper levels and haematite was absent altogether from the deposit. Sandstone tended to increase in density over time (Table 4.24, Figure 4.19). The discard weight of ground raw materials could only be calculated for the Late Freshwater Phase, as no dates were available for the Early Freshwater Phase (Table 4.24, Figure 4.19).

Overall, the average weight of ground raw materials decreased in the Late Freshwater Phase, due to the decrease in the average weight of sandstone. The sample size for the other ground raw materials was too small to comment (Table 4.25, Figure 4.20).

**Discussion**
The fact that there was only one date from MP5 means that discard rates could not be examined over time. However, the average weight of flaked raw materials indicates that there was a size increase in the Late Freshwater Phase for all raw materials but chert, which decreased in size. As chert comes from a considerable distance away, its smaller size may indicate less accessibility. At the same time there was a decrease in the average weight of sandstone. These factors may indicate changes in site use between the Early and Late Freshwater Phases.

**MP6 Flaked Raw Materials**
Quartzite was the dominant raw material at MP6, followed by tuff, quartz, chert and FGS. The overall density of flaked raw materials peaked around the middle of the deposit, and then declined towards the top. Proportions of quartz and Gerowie tuff increased over time, while chert increased from base and declined post 434±56 years BP (NZA-9700). Quartz increased substantially in the upper levels post 434±56 years BP (Table 4.26, Figure 4.21).
When the discard rates of all flaked raw materials are examined according to the environmental phases, they doubled in the Late Freshwater Phase, post 430 years BP. No figure is available for spit 12, which is undated. Expressed as percentages, it can be seen that the proportions of raw materials change little in relation to one another between phases (Table 4.27, Figure 4.22).

Quartzite had the highest average weight of the flaked raw materials, followed by FGS, quartz, chert and tuff. Overall the flaked raw materials tended to increase in size towards the top of the deposit. There does not appear to be any particular period when all materials are heavily reduced, except for at the top of the site (<430 years BP). The average weight of all the flaked raw materials increased in the Late Freshwater Phase post 430 years BP (Table 4.28, Figure 4.23).

**MP6 Ground Raw Materials**
Sandstone was the dominant ground raw material at MP6, followed by ochre. Haematite was rare, only present in the Early Freshwater Phase and the sample size was very small for the volcanic material (Table 4.29, Figure 4.24).

When the discard weight was examined according to the environmental phases, the ground artefacts showed an overall increase in density in the Late Freshwater Phase. When examined individually, sandstone was mainly responsible for this increase. Ochre decreased in the same period. Volcanic material was absent from the basal layer.

Haematite had the highest average weight of the ground raw materials in MP6, but there was only one example. Sandstone was the next largest followed the volcanic material and then by ochre (Table 4.30, Figure 4.25).

When they are divided according to the environmental phases, it can be seen that overall average weights remain relatively constant over time (Table 4.30, Figure 4.25). Haematite occurs only once in the Early Freshwater Phase and has been left out of Figure 4.25 as it skews the results. The sample size for the volcanic material is also very small.
Discussion
At MP6, the discard rate of flaked raw materials and discard weight of ground raw materials increased in the Late Freshwater Phase. The size of the flaked artefacts increased, while that of the ground remained the same. This suggests that more flaked stone was coming onto the site during this phase, which could be an indicator of higher mobility.

**HD1 Flaked Raw Materials**
Only the 6mm fraction was available for HD1. The most frequently occurring flaked raw material was quartzite, followed by quartz, FGS, tuff and chert. Overall, the discard rate was reduced in the Transition Phase to about half of that in the Big Swamp Phase, and then increased again in the Early Freshwater Phase. The discard rate of both quartz and tuff remained steady through the Big Swamp and Transition Phases and then doubled in the Early Freshwater Phase. Quartzite decreased by about a third in the Transition Phase and then increased slightly in the Early Freshwater Phase. Both chert and FGS remained steady throughout the phases (Table 4.31, Figure 4.26). When the proportions of raw materials were examined in relation to one another, local materials quartz and FGS, and non-local materials tuff and chert, all increased over time while local material quartzite decreased (Table 4.32, Figure 4.27).

FGS and quartzite had the highest average weight of the flaked raw materials throughout the deposit, perhaps reflecting their local origins. Conversely the average weight of quartz was comparatively low. The average weight of chert was also low as expected for an imported material. The overall average weight indicated a general diminution in the size of flaked materials between the Big Swamp and the Transition Phases. However the huge drop in the weight of tuff affected this figure and other raw materials either increased in size or remained steady for the same period (Table 4.33, Figure 4.28). It must be pointed out that the sample size for the Big Swamp Phase is very small.

When the data are examined according to the environmental phases, the average weight of flaked raw materials decreased over time. Individually, the average weight of quartz
and tuff decreased in the Transition Phase (c. 3900-2000 years BP), and then increased again in the Early Freshwater Phase (<2000 years BP). Quartzite on the other hand increased its average weight in the Transition Phase and then decreased in the Early Freshwater Phase. The average weight of both chert and FGS increased over time (Table 4.33, Figures 4.28).

**HD1 Ground Raw Materials**
At HD1 sandstone was the most common ground raw material, followed by ochre, volcanics, and haematite. Overall density of raw material decreased in the Transition Phase and then increased in the Early Freshwater Phase. This distribution was due mainly to the effect of the density of sandstone. Ochre was not present in the basal layers. Haematite was only present in the Big Swamp Phase, while the volcanics only occurred in the Transition and Early Freshwater Phases (Table 4.34, Figure 4.29).

The overall average weight of ground raw materials also declined in the Transition Phase and then increased in the Early Freshwater Phase, again mainly due to effects of the density of sandstone. The sample size was small for ochre and haematite and the volcanic material occurred only sporadically (Table 4.35, Figure 4.30).

**Discussion**
The discard rate of quartzite, the most frequently occurring of the local flaked raw materials, declined in the Transition Phase and then increased in the Early Freshwater Phase. Such a result is consistent with the model of decreased site use during the Transition Phase, and increased use with the arrival of freshwater conditions on the floodplains. Interestingly, the discard rate of chert remained steady through all three phases. When the average weight of flaked raw materials were examined individually, quartzite (local) increased in size in the Transition Phase and then decreased in the Early Freshwater Phase. This situation is consistent with the model of a heavier reliance on local raw materials during times of resource abundance when populations were less mobile. Meanwhile chert increased in size over time, substantially between the Big Swamp and the Transition Phases. Again this situation agrees with the model as it
suggests greater accessibility to sources on the eastern side of the river with the passing of the mangroves. The density of ground raw materials decreased in the Transition Phase and then increased in the Freshwater Phase, mainly due to the effect of sandstone (non-local) the most abundant ground raw material. This situation is consistent with the model. However, average weight of ground raw materials followed the same pattern, which is not consistent.

**NP19 Flaked Raw Materials**
The most common flaked raw material at NP19 was quartz, followed by quartzite, tuff, chert and FGS (Table 4.36). Although the site was only shallow, there was a marked discontinuity in the distribution of artefacts. Numbers per kilogram overall and for individual flaked raw materials were much lower in the top spit. No dates are available for this site so the discard rate could not be estimated. FGS had the highest average weight of flaked raw materials at NP19, followed by quartzite, tuff, and quartz and chert (Table 4.37).

**NP19 Ground Raw Materials**
Overall, the most common ground raw material at NP19 was sandstone, followed by haematite and ochre. Volcanic material was not present in the sample (Table 4.38). Haematite had the highest average weight of ground raw materials at NP19, but this was only one specimen, followed by sandstone and ochre. Ochre also had a small sample size (Table 4.39).

**NP20 Flaked Raw Materials**
Overall quartz was the most common flaked raw material. Quartzite was the next most common, followed by tuff. Chert was rare and FGS does not occur at all (Table 4.40). Chert had the highest overall average weight of the flaked raw materials, but it was represented by only one example in the 6mm fraction. Quartzite, quartz and tuff followed (Table 4.41).
NP20 Ground Raw Materials
The most common ground raw material was sandstone followed by ochre. Haematite and volcanic material were not present in the sample (Table 4.42). Sandstone had the highest average weight of the ground raw materials (Table 4.43).

4.6 RAW MATERIALS: INTER-SITE COMPARISONS

Flaked Raw Materials
In all sites either quartz or quartzite is the most common raw material, reflecting their local availability. MP2 and MP6 have the highest density of flaked raw materials, which increased at both sites in the Late Freshwater Phase. MP5 has a noticeably lower density of artefacts than the other sites. Compared with all the Middle Point sites, tuff and chert form only a very small proportion of the flaked assemblages at the North Point sites (Table 4.44, Figure 4.31). FGS, classified as a local raw material, is low in numbers and does not occur at all at NP20. However, as pointed out in the discussion of the MP2 assemblages, the lack of FGS has been attributed to its unsuitability for use. When the 6mm fraction was examined the pattern remained the same. HD1 had a very low discard rate, which remained steady over time. In the Early Freshwater Phase the discard rate for MP2 and MP6 was also low (Table 4.45, Figure 4.32).

The average weights of flaked raw materials again demonstrated inter-site differences. MP2 and MP6 had the highest average weights of raw materials, and MP5 the lowest. The size of artefacts decreased at MP2 over time, while they increased at MP6. MP5 remained steady (Table 4.46, Figure 4.33). The 6mm fraction for average weight of flaked raw materials again showed inter-site differences (Table 4.47, Figure 4.34). Overall average weight at HD1 decreased in the Transition Phase and then remained steady over time, while it increased at MP2 in the Freshwater Phases. MP2 and MP5 had the highest average weights of flaked raw materials in the Freshwater Phases.
Ground Raw Materials

Numbers per kilogram of deposit may be a misleading figure to use for ground raw materials as it is likely that any item originally belonged to a larger block. Therefore I have analyzed the ground raw materials according to grams of raw material per kilogram of deposit per 100 years.

The highest density of ground raw materials belongs to sandstone for the sites listed in Table 4.48 (Figure 4.35). MP2 has the highest density of ground raw materials overall, which increases in the Late Freshwater Phase. The density at MP6 also increases over time. MP5 has the lowest density.

When the 6mm fraction is examined the pattern remains the same, except that HD1 has the lowest density overall (Table 4.49, Figure 4.36). The density of ground raw materials at HD1 decreased in the Transition Phase and then increased in the Early Freshwater Phase. HD1 is the oldest of the Middle Point sites. The most notable difference between HD1 and the other Middle Point sites is the lower percentage of sandstone. So there appears to be an increased use of sandstone over time at Middle Point.

Again sandstone, with a couple of exceptions, had the highest average weight, which influenced overall average weight (Table 4.50, Figure 4.37). MP5 had the highest overall average weight in the Early Freshwater Phase and both MP2 and MP5 were high in the Late Freshwater Phase. At HD1 average weight decreased in the Transition Phase and then increased in the Early Freshwater Phase. At the other sites, overall 6mm average weight decreased over time, unlike the pattern of total overall average weight (Table 4.51, Figure 4.38).

Discussion

The main inter-site differences were the higher discard rates of flaked raw materials and discard weights of ground raw materials at MP2 and MP6 compared with the other sites. These results suggest that MP2 and MP6 may have been used more frequently or for longer periods of time. The discard rates and weights at both sites increased significantly
in the Late Freshwater Phase, indicating a shift in the use of the sites post 460 years BP. MP5, on the other hand, had a lower discard rate but a higher average weight of flaked raw materials. This result suggests that it may not have been used as frequently or for as long, but used intensively at those times. The small proportion of tuff and chert at North Point reflects the fact that these sites are located further away from the raw material sources. The occupants relied more heavily on the local quartz and quartzite.

4.7 RAW MATERIALS: CHRONOLOGICAL COMPARISONS

**Flaked Raw Materials**
Although discerning patterns in the above data may seem difficult, it is made clearer if the sites are considered in chronological order, and in terms of local versus non-local materials. The latter can provide information on mobility strategies at sites. The discard rate for total flaked raw materials remained constant, both overall and for individual raw materials during the Freshwater Phases and then all but quartz (local) decreased in the Contact Phase. This result agrees with the model where a decrease in discard rate was predicted for the Contact Phase (Table 4.53, Figure 4.39). Figure 4.40 shows the discard rate for local and non-local materials.

Because only a large sized sieve was used for HD1, the distribution of the 6mm flaked raw materials are listed below to make it comparative. The 6mm discard rate of quartzite decreased in the Transition Phase, while the other raw materials remained steady. The 6mm discard rate of all flaked raw materials increased in the Early Freshwater Phase, further increased in the Late Freshwater Phase and then all but quartz and tuff decreased in the Contact Phase (Table 4.53, Figure 4.41). Overall, discard rates show a decline of local raw materials between the Big Swamp and Transition Phases and then a steady increase over time. On the other hand, discard rates of non-local raw materials decline between the Big Swamp and the Transition Phases, then increase over time after that. Discard rates of non-local raw materials are always lower than those of local raw materials for all phases (Figure 4.42).
The average weight of total and 6mm flaked artefacts decreased in the Early Freshwater Phase as predicted by the model, but then increased in the Late Freshwater Phase, which was not (Table 4.54, Figure 4.43; Table 4.55, Figure 4.44). This pattern was true for individual raw materials, local and non-local. In the Contact Phase, the overall weight of raw materials decreased slightly but individually, quartzite (local) and chert (non-local) had a much higher average weight than any other phase. This situation also fits the model. The overall average weight of 6mm artefacts decreased in the Transition Phase. However this result is skewed by tuff, which is the only raw material to decrease in average weight. All the other raw materials actually increased, which also fits the model (Table 4.55, Figure 4.44).

Ground Raw Materials
In all sites sandstone, the dominant ground raw material, accounted for almost all of the discard weight of total ground raw materials (Table 4.56, Figure 4.45). The frequency of discarded sandstone increased in the Late Freshwater Phase and then remained steady into Contact Phase. This pattern was not as expected as the model predicted that the discard rate would decrease in the Contact Phase.

I have presented the discard weight of the 6mm fraction separately so as to make HD1 comparable with the other sites. The discard weight was again mainly influenced by sandstone for all phases and at all sites (Table 4.57, Figure 4.46). It decreased in the Transition Phase, increased in the Early Freshwater Phase, increased further in the Late Freshwater Phase and then remained steady into the Contact Phase, echoing the pattern of discard weights for total raw materials. This pattern was as predicted by the model, apart from the Contact Phase, as discussed above. The increase in the discard rate in the Late Freshwater Phase indicates suggests that there was increased activity at the sites post 630 years BP.

The average weight of ground raw materials can give some indication of the amount of breakage at the sites. Total average weights are influenced mainly by sandstone (Table 4.58, Figure 4.47). The average weight of ground raw materials increases over time until
the Contact Phase when it decreases. It is interesting that the highest average weights belong to the Late Freshwater Phase. If there was more activity at the sites during this time as suggested by the high discard weights, one would expect more breakage due to increased trampling and therefore lower average weights.

The pattern of average weights of ground raw materials in the 6mm fraction from all sites followed that of the total average weights, with the added information that average weight decreased from the Big Swamp into the Transition Phase (Table 4.59, Figure 4.48).

**Discussion**
Apart from the Late Freshwater Phase, raw material distributions followed the chronological patterns predicted at the beginning of this chapter. Overall, discard rates of flaked raw materials and discard weights of ground raw materials declined in all sites from the Big Swamp Phase into the Transition Phase and subsequently increased in the Freshwater Phases. The increase in discard flake rates and ground weights in the Late Freshwater Phase was picked up by the individual site and 6mm fraction analyses, but was obscured by the overall analyses. This trend is due to results from MP2 and MP6, post 460 years BP. The high discard rate in the Contact Phase is due to the dramatic increase in discard of the local material quartz.

The model is also confirmed by the analysis of individual local and non-local raw materials. The discard rate of the local raw materials quartz, quartzite and FGS increased in the Freshwater Phases as predicted. At the same time, the average weight of quartz, quartzite and FGS decreased in the Early Freshwater Phase, indicating that, as expected, they were being more intensively used during that time. However, this pattern changed in the Late Freshwater Phase when the average weight of all flaked artefacts increased. Tuff was the exception and its average weight increased in both Freshwater Phases. These trends were not as predicted but may have been the result of increased access to sources on the eastern side of the Adelaide River following the Transition Phase. In the Contact Phase, the discard rate of quartzite and tuff decreased and the average weight of quartzite increased as predicted. Tuff decreased in weight but this is likely due to a small sample
size and distance from source. There was a dramatic increase in the discard rate of quartz in the Contact Phase while its average weight remained constant, which is consistent with the model.

The discard rate of chert was predictably low in the Big Swamp Phase, when mangrove forests on the floodplains limited access to sources. As expected, its discard rate increased in the Transition Phase when access was easier, and increased further in the Freshwater Phases when the floodplain sites became the focus of exploitation. However its average weight increased in the Late Freshwater Phase, which was not predicted. The discard rate of chert decreased in the Contact Phase, which is as predicted. At the same time its average weight increased but this is because of small sample size.

The ground raw materials were all non-local. Ochre, haematite and the volcanics were relatively rare at the sites through all phases, which emphasizes their lack of availability. Because most sandstone was found in the 6mm fraction, it is possible to use the 6mm analysis to describe its distribution at all sites. It had a higher than expected discard weight in the Big Swamp Phase, given that those sources on the eastern side of the Adelaide River were inaccessible at that time. Therefore, it must be concluded that sandstone at the sites then was obtained from sources to the south-west. Discard weights declined in the Transition Phase as expected then increased in the Early Freshwater Phase. There was a substantial increase in the Late Freshwater Phase, which was maintained into the Contact Phase. These results, especially the high discard weight of sandstone were not expected.

**4.8 CONCLUSION**

The analysis of the raw materials has demonstrated that there are both spatial differences between the sites and chronological changes in raw material acquisition. The model presented at the beginning of the chapter predicted that availability, accessibility and mobility (distance to source) all affect acquisition of raw materials and therefore
influence distribution of raw materials within sites. Of the raw materials, quartz, quartzite and FGS were available locally and were accessible through all the environmental phases. This was demonstrated by these raw materials, especially quartz and quartzite, being generally the most common at the sites through all phases. Tuff, chert, sandstone, ochre, haematite and the volcanics came from elsewhere. Although there was a minor source of tuff available from Beatrice Hill in the south of the study area, more substantial tuff and chert sources are located on the eastern side of the Adelaide River. There are some restricted sources of sandstone located some 70 km south west of the sites, but more substantial sources are located to the east. During the Big Swamp Phase these sources were not easily accessible, as the mangrove forests prevented eastward movement across the floodplains. It is expected that during this phase movement and economic networks and alliances would have been north to south west, rather than east. This situation changed with the retreat of the mangroves and the establishment of the freshwater floodplains, allowing access to the eastern side of the river and its resources.

Mobility was affected by the distribution of resources in the landscape. The Big Swamp and Freshwater Phases were periods of high productivity on the floodplains and were the major focus of the subsistence effort. It is expected that during these phases residential mobility of the population was reduced. In contrast, the Transition and Contact Phases were periods of reduced productivity. Resources were more dispersed, which would have encouraged increased residential mobility. Raw material acquisition was affected by all these factors. The expectation that the archaeology reflects these factors through the raw material distributions within the sites led to the construction of the predictive model presented at the beginning of the chapter. I will now assess the predictive model using the results from the sites for each environmental phase.

Patterns of settlement were as predicted for the Early and Late Freshwater Phases (Table 4.60). The other phases only partially conformed to the model (Table 4.61). Procurement and targeting of raw materials reflect the mobility of populations, the extent of their territory and economic circumstances. In the following chapter I will examine which raw
materials were targeted for modification over time as a way to further explore these issues and seek explanations for the differences between the predictive model and the outcome.
CHAPTER 5: MODIFIED SPECIMENS

5.1 INTRODUCTION

Allen and Barton (1989:78) conclude that in western Arnhem Land, raw materials rather than implement types are a more accurate guide to technological change, '... the analysis of raw materials, rather than any formal analysis of tool types is the most powerful gauge of industrial change in western Arnhem Land. ...' Likewise, as this analysis concerns itself more with raw material acquisition and changes rather than typology, I will be looking at modification primarily in those terms. Some of the questions that will be explored are: what was the nature of the lithic technology used to exploit the environment? Were there differences between the sites? Were there changes over time? And if so, do these changes relate to the shifting resource base, technological change or something else?

Modification here is taken to mean mechanical alteration to a lithic raw material after its initial acquisition. For the purposes of this analysis, modification of raw materials includes four forms of technology: knapping cores, or original pieces of stone, to produce primary flakes; retouch or secondary flaking of primary flakes, usually by removing small fragments of stone to produce an implement (Bahn 1992); the use of a primary flake for some purpose, eg scraping that produces a residue, in this case the silica polish on the edge of 'polished' flakes; and grinding suitable raw materials, eg. ochre to produce pigments, sandstone to produce grindstones, volcanic material to produce axes. The Adelaide River sites contained points, 'leilira’ blades and retouched flakes.

I will now consider the proportion of modified and unmodified artefacts within each raw material class to indicate the extent of modification in each phase and identify which raw materials were more intensively worked over time. These data, with Chapter Four’s data on proportions of raw material can provide information about mobility. If populations are mobile, there should be a greater range of lithic raw materials with a lower level of
modification. If populations are less mobile, a greater concentration on local raw materials is expected (as opposed to non-local raw materials) and non-local materials will be more heavily reworked (Byrne 1980; Jeske 1989; Lurie 1989; Torrence 1983). There may also be a reliance on the bipolar technique as a means of economical flake production (Hiscock 1996).

The model outlined in the previous chapter predicts that, during the Big Swamp and Freshwater Phases, highly productive resources made the floodplains of the Adelaide River the primary focus of regional exploitation and influenced settlement patterns accordingly. Longer use of sites is expected during these phases. In other words residential mobility is low and raw material acquisition is affected. Low residential mobility means there is less opportunity to procure quality non-local raw materials for tool manufacture: chert and Gerowie tuff in the case of the Adelaide River. Therefore there is pressure on both local raw materials and those acquired from elsewhere. Inferior materials may have to be used more frequently and quality materials will be used more economically (Lurie 1989:47-48). The archaeological corollary of this is an increase in modification of both local and non-local lithics. Specialised techniques that conserve raw materials may be employed, eg. bipolar core reduction.

Conversely, the Transition and Contact Phases have been defined as periods of lower productivity on the floodplains, which were therefore no longer a primary focus of exploitation. Populations are expected to be more residentially mobile with more frequent opportunities to access non-local raw material sources. The pressure on both local and non-local raw material sources is reduced and levels of modification declines. Specialised techniques of reduction are no longer required. These expectations are summarised in Table 5.1.
5.2 MODIFIED ARTEFACTS

**MP2 Modified Artefacts**

At MP2, the percentages of modified artefacts have been calculated on the sample number of artefacts analyzed rather than the projected numbers of artefacts that were used in Chapter 4. The Transition, Early and Late Freshwater Phases were represented. The number of raw materials that were modified in some way between the phases varied by only two percent. However, the amount of modification within the Early and Late Freshwater Phases varied considerably (Table 5.2, Figure 5.1).

When the modified component of the assemblage is broken down, it can be seen that there was a four-fold increase in modification of all non-local materials (chert, tuff, sandstone, haematite and the volcanics) between the Transition and the Freshwater Phases, although the sample size for haematite and the volcanics was very small. Modification of quartzite increased in the Late Freshwater Phase. These results are consistent with the model. Modification of local raw materials quartz, quartzite and FGS remained the same between the Transition and Early Freshwater Phases and, in the case of quartz and FGS, actually decreased to 0% in the late Freshwater Phase (Table 5.3, Figure 5.2). These results are not consistent with the model.

**MP5 Modified Artefacts**

At MP5, data were available only for the Early and Late Freshwater Phases. The rate of modification changed little between these phases. However, there was considerable variation within the phases (Table 5.4, Figure 5.3).

Rates of modification of individual raw materials decreased between the Early and Late Freshwater Phases except for the appearance of modified ochre in the Late Freshwater Phase. However, the sample size for ochre was small (Table 5.5, Figure 5.4).
**MP6 Modified Artefacts**

At MP6, data were available only for the Early and Late Freshwater Phases. There was no change in the rate of modification between phases at MP6. However, there was some variation within the phases (Table 5.6, Figure 5.5).

The rate of modification of quartz (local) increased while that of tuff (non-local) decreased between the Early and Late Freshwater Phases. The rate for all ground raw materials (non-local), apart from haematite increased in the Late Freshwater Phase (Table 5.7, Figure 5.6).

**HD1 Modified Artefacts**

The Big Swamp, Transition and Early Freshwater Phases were represented at HD1. There was little change in the rate of modification between phases, although again there was variation between phases (Table 5.8, Figure 5.7).

The sample of modified artefacts from the Big Swamp Phase is too small to be meaningful, as is the volcanic sample from the Transition Phase. However, there are several differences that can be noted between the Transition and Early Freshwater Phases for the other raw materials. In the Early Freshwater Phase, there is a drop in the rate of modification of quartzite (local) and chert and volcanic (non-local), while that of quartz (local) and tuff and sandstone (non-local) increased (Table 5.9, Figure 5.8). This result indicates a change in the use of raw materials at HD1 between the Transition and the Early Freshwater Phases.

**NP19 Modified Artefacts**

As the assemblage from NP19 has been assigned to the Freshwater Phase only, change in the rate of modification over time could not be assessed. However there was variation within this phase (Table 5.10, Figure 5.9).
The sample of modified raw materials from NP19 was small. Quartzite (local), tuff and sandstone (non-local) were most frequently modified. Chert was not modified at all (Table 5.11, Figure 5.10).

**NP20 Modified Artefacts**

As the assemblage from NP20 has been assigned to the Contact Phase only, change in the rate of modification over time could not be assessed. Likewise, as there was only one spit excavated from this site, variation within the phase also could not be assessed (Table 5.12).

The sample of modified raw materials from NP20 was small. Tuff, sandstone and ochre (all non-local) were most frequently modified. Chert was not modified at all (Table 5.13, Figure 5.11).

### 5.3 INTER-SITE COMPARISONS OF MODIFIED RAW MATERIALS

**Rates of Modification**

The model predicts that there will be a high rate of modification in periods of low residential mobility (the Big Swamp and Freshwater Phases) and low rate of modification in periods of high residential mobility (the Transition and Contact Phases). All the Middle Point sites, MP2, MP5, MP6 and HD1 showed little change in the overall rate of modification of raw materials between phases, though there was a slight increase in modification at MP2 following the Transition Phase (Table 5.14, Figure 5.12). This result accords with the model of increased modification accompanying low residential mobility. The assemblages of both North Point sites, NP19 and NP20, belong to only one phase so cannot be assessed over time. There is inter-site variation within the phases (Table 5.14, Figure 5.12).

At HD1, the rate of modification is unnaturally high because only the 6mm fraction is represented. It was therefore compared with the 6mm fraction from the other sites (Table
5.15, Figure 5.13). It can be seen that again there is inter-site variation within phases. As with the modification of total artefacts MP2 demonstrates an increase between the Transition and Early Freshwater Phases, which agrees with the model. However, HD1 shows an increase in modification between the Big Swamp and Transition Phases and there is no change into the Early Freshwater Phase. Neither of these results accords with the model as a decrease between the Big Swamp and Transition Phases and an increase in the Freshwater Phase were predicted.

**Modified Raw Materials**

There is little change in the range of modified raw materials at the sites apart from ochre, haematite and the volcanics, which do vary. However there is inter-site variation. The North Point sites are notable for their lack of modified chert and NP20 for its high proportion of modified tuff, though the sample size is very small. Sandstone has a high proportion of modification in all phases (Table 5.16).

The total modified raw materials were then divided into local and non-local materials to test the theory that low residential mobility is accompanied by increased conservation of raw materials. There is inter-site variation in the modification of local and non-local raw materials both within and between phases. However some general trends do emerge. Although there were a range of non-local raw materials present, there is 0% modification of non-local material, apart from haematite, in the Big Swamp Phase. This result could be due to the small sample size. In the Transition Phase at MP2 the modification of local and non-local materials is almost the same. In the Early Freshwater Phase, there is a three-fold increase in modification of non-local raw materials, which agrees with the model of low residential mobility in this phase. Modification of non-local raw materials decreases slightly for the Middle Point sites, MP2, MP5 and MP6, in the Late Freshwater Phase but remains higher than the modification of local raw materials. At the North Point sites, NP19 and NP20, modification of non-local materials is almost double that of the other sites. This result is consistent with these sites being located further from the sources of non-local raw materials. The modification of local raw materials is low through all the
phases compared with non-local raw materials. It is highest at MP2 in the Transition Phase, which is not consistent with the model that predicts it will be lower in periods of high residential mobility (Table 5.17, Figure 5.14).

The 6mm fraction for all sites was then examined in order to include HD1 and compare the sites across all phases. There was considerable inter-site variation both within and between phases (Table 5.18). To simplify the data and to test the theory that low residential mobility is accompanied by increased conservation of non-local materials, the information was divided into local and non-local raw materials (Table 5.19, Figure 5.15). The results for the Big Swamp Phase are skewed both by the small sample size from HD1 and the fact that haematite was the only modified raw material. There was an increase in modification of raw materials for HD1 and MP2 in the Early Freshwater Phase, which agrees with the model. Non-local modification decreased slightly for the Middle Point sites, MP2, MP5 and MP6, in the Late Freshwater Phase. Again the North Point sites, NP19 and NP20, had the highest rates of non-local modification again reflecting their distance from source. The rate of modification for the local raw materials remained low (less than five percent) comparative to non-local modification through all the phases. This result is not consistent with the model, which predicted that local modification would increase with low residential mobility. The exception was at MP2 where local modification nearly doubled in the Late Freshwater Phase.

**Discussion**

The inter-site comparison demonstrated that there was inter-site variation in rates of modification within phases. This result suggests that the sites may have been used differently, whether some were used more frequently or for different activities is unclear. The model predicted that there will be a high rate of modification in periods of low residential mobility (the Big Swamp and Freshwater Phases) and low rate of modification in periods of high residential mobility (the Transition and Contact Phases). This did not hold true for HD1 in the Big Swamp and the Transition Phases where the reverse was true and the rate of modification did not increase in the Freshwater Phase. However it was
consistent with results from MP2. The rates of modification decrease slightly for the Middle Point sites in the Late Freshwater Phase indicating that there may be a change in site use perhaps related to an increase in residential mobility. If such was the case it may reflect environmental fluctuation in the Freshwater Phase. This possibility will be discussed later. The rates of modification were high for the North Point sites, NP19 and NP20, compared with the other sites. As flagged above this result is probably due to increased distance from source for these two sites.

There was also inter-site variation in the distribution of modified raw materials, both local and non-local, again suggesting differences in the use of sites. At all sites both within and between phases, the modification of local raw materials was lower than that of non-local raw materials. This is not surprising as the local materials, quartz, quartzite and FGS, are not the first choice for knapping. At HD1 the rate of modification of local materials did not decrease between the Big Swamp and Transition, nor did it increase between the Transition and Freshwater Phases as predicted by the model. In fact the opposite was true in both cases. Similarly at MP2 the rate of modification of local materials did not increase between the Transition and Freshwater Phase but also decreased. It then remained steady at the Middle Point sites, MP2, MP5 and MP6, through the Early and Late Freshwater Phases. It was also low at NP19 and NP20.

It was a different story for the non-local raw materials. The exception was at HD1 where modification of non-local raw materials increased in the Transition Phase, a result not predicted by the model. However non-local modification increased at both HD1 and MP2 between the Transition and the Freshwater Phases, which is consistent with the model. At MP6 non-local modification remained steady between the Early and Late Freshwater Phases, while it dropped at MP2 and MP5, again suggesting a difference between the two phases at these sites. Non-local modification was high at both North Point sites compared with the Middle Point sites. These results will be discussed below where the data have been combined to show overall chronological changes in modification through the phases.
5.4 CHRONOLOGICAL CHANGES IN RAW MATERIAL MODIFICATION

The model of high rates of modification of raw materials associated with low residential mobility (Big Swamp and Freshwater Phases) and low rates of modification associated with high residential mobility (Transition and Contact Phases) was tested against the combined modified raw material data, organised according to phase. Total modified raw materials cover the Transition through to Contact Phases and there was data available for the 6mm modified raw materials from the Big Swamp Phase through to the Contact Phase. The data for total modified materials did not agree with the model at all as there was no change in rates of modification between the Transition and Freshwater Phases and then an increase in the Contact Phase (Table 5.20, Figures 5.16, 5.17). The model also did not hold completely for 6mm materials, as the rate of modification increased in the Transition Phase and in the Contact Phase (Table 5.20, Figure 5.16, 5.17). However it did increase in the Freshwater Phase, which was as predicted.

To obtain a more accurate picture of the distribution of modified materials they were broken down into their individual components. The breakdown of modification within raw material classes over time also does not follow the model exactly as predicted. An increase in modification of both local and non-local raw materials, associated with lower levels of mobility, was expected in the Freshwater Phases. This is true of the imported materials (chert, tuff, sandstone, ochre, haematite and the volcanics). However the modification of quartz remains steady through the Transition and Freshwater Phases, while that of quartzite and FGS actually decreases. Contrary to expectations, modification of raw materials increased in the Contact Phase (apart from chert, FGS, haematite and the volcanics) when it was predicted that it would decrease with increased mobility (Table 5.21, Figure 5.18, Table 5.22, Figure 5.19).
I will deal with local modified raw materials first. The results demonstrated that the model did not hold true for total local materials, which followed the opposite pattern and decreased between the Transition and Freshwater Phases and then increased, in the Contact Phase. The 6mm local materials were not consistent with the model either as rates of modification increased in the Transition Phase or did not decrease in the Contact Phase as predicted. However they did increase between the Transition and Freshwater Phases, which does follow the model (Table 5.23, Figure 5.20, 5.21).

The model is more consistent with the distribution patterns of non-local modified raw materials, although they do not fit exactly. Modification of total non-local materials increased as predicted in the Freshwater Phase, but then unexpectedly increased again in the Contact Phase. Modification rates of 6mm non-local materials did not decrease in the Transition Phase as predicted. They did increase in the Early Freshwater Phase, in accordance with the model, and decreased in the Late Freshwater Phase. There was a subsequent unpredicted increase in the Contact Phase (Table 5.23, Figures 5.20, 5.21).

The fact that in most cases the modification of local raw materials did not increase as predicted during periods of low residential mobility and decrease in periods of high mobility means that the model needs revision. It seems that low residential mobility did affect the modification rates of local raw materials. It seems that they were simply procured more frequently (see Chapter 4) rather than used more intensively.

The model proved correct for non-local raw materials in the Freshwater Phase when the rate of modification more than doubled that for the Transition Phase. The data for the Big Swamp Phase did not agree with the model. However, this does not necessarily prove the model incorrect, as it may be a result of the small sample of artefacts obtained from HD1 the only site dated to this phase. Likewise, the high proportion of modified non-local materials in the Contact Phase is unexpected as the model predicts that local raw materials will be less intensively used in periods of increased mobility. Again a sampling issue may be the explanation as NP20, the only site that represents this phase, is located
further north than the other sites. The high rate of modification for this phase may be due to distance to source.

5.5 CORES

One way of assessing the level of residential mobility is to measure the amount of bipolar working in a site (Hiscock 1996; Jeske 1992; Parry and Kelly 1987:300). Bipolar working is an economical way of producing flakes and as such is useful when residential mobility is low. According to Hiscock's (1996:153-54) criteria, a low frequency of bipolar cores is consistent with relatively high residential mobility. Therefore the comparative abundance of bipolar working in a site may be one indicator of reduced mobility. Hiscock (1996) examined one site, Kunkundurnku, on the freshwater floodplain margins of the South Alligator River in order to address this issue. He counted the ratio of bipolar to non-bipolar cores at the floodplain site and compared the result with figures from four sites located nearby in open woodland. He found that the ratio of bipolar to non-bipolar cores at the floodplains sites was on average four times greater than the ratio at the woodland sites (1996:153-54). He then measured the ratio against distance to raw material source and found that there was no relationship. In other words, despite proximity to source, there was still a high level of bipolar working at the floodplains. He concluded that intensive stone working at Kunkundurnku related to intensive occupation of the site (1996:154).

At the Adelaide River sites, there were 40 cores altogether, 18 of which were bipolar. Cores were found only in the Transition and the Freshwater Phases. As can be seen from Table 5.24 the ratio of bipolar to non-bipolar cores at the Adelaide River was relatively even and did not approach that of 6.7:1 for the South Alligator River floodplain site described by Hiscock (1996:153). However, although the sample size is small, it can be seen that the ratio of bipolar to non-bipolar cores did increase in the Early Freshwater Phase and again in the Late Freshwater Phase.
Another way to assess intensity of stone use is by measuring the size of the artefacts. The size of both bipolar and non-bipolar cores became smaller in the Early Freshwater Phase. Bipolar cores continued to decrease in size into the Late Freshwater Phase, while non-bipolar cores remain about the same (Table 5.24).

The cores were then analyzed according to raw materials to determine whether there were differences between local (quartz, quartzite, FGS) and non-local raw materials (chert and tuff). There were so few cores altogether at the Adelaide River sites that the data have been combined (Table 5.25, Figure 5.22). Quartz, FGS (local) and chert and tuff (non-local) become smaller in the Freshwater Phases. However quartzite cores increase in size over time, which is unexpected.

**Discussion**

The model presented at the beginning of this chapter predicted that in periods of low residential mobility (Big Swamp and Freshwater Phases) there would be an emphasis on bipolar working as a means of conserving lithic raw materials. Conversely during periods of high residential mobility this technique would not be necessary, as access to raw materials would not be as limited.

Bipolar cores were found only in the Transition and Early and Late Freshwater Phases. The lack of cores in the Big Swamp and Contact Phases is probably the result of sampling. Compared with the floodplain site of Kunkundurnku on the South Alligator River (Hiscock 1996), bipolar cores were not abundant at the Adelaide River sites. Their low ratios compared with the non-bipolar cores were more like those of the open woodland sites described by Hiscock (1996:153). This result accords with the model for the Transition Phase but not for the Freshwater Phases. The reduction in the size of all cores is consistent with more intensive/regular site use in the Early Freshwater Phase, as is the decrease in size of bipolar cores in the Late Freshwater Phase.
5.6 STONE IMPLEMENT TYPES

In the north Australian context there are a number of stone implements that are easily recognizable as types. They have been separated and compared on that basis, for example, points, (c.f. Allen and Barton 1989; Davidson 1935; Flood 1970; Hiscock 1993b, 1994a; Jones and Johnson 1985; MacIntosh 1951; Smith and Brockwell 1994; Smith and Cundy 1985; Thorley et al. 1994), leiliras (Allen 1997; Brockwell 1989; Jones and Johnson 1985; Kamminga and Allen 1973; McCarthy and Setzler 1960; Schrire 1982) and polished flakes (Brockwell 1989:87; Kamminga 1982; Schrire 1982:70, 131-32). Although these types are also present at the Adelaide River sites, they are notable mostly on account of their absence. So I will deal with them only briefly here.

Points
There are only three samples of points altogether, only one of them whole. Their dimensions are listed in Table 5.26. The lack of points at the Adelaide River sites is remarkable given the proximity of Scotch Creek, a site located only some 12 km to the south west. It has a dense horizon of chert points dated to between 3500 and 1500 years BP (Crassweller 1996; Smith 1995; Smith and Brockwell 1994).

Leilira Blades
Leiliras are large blade flakes that have been described variously as trigonal points, 'leilira' blades, end-struck blades, large blades, rectangular retouched blades and rectilinear scrapers (Allen 1997; Brockwell 1989; Jones and Johnson 1985; Kamminga and Allen 1973; McCarthy and Setzler 1960; Schrire 1982). They are believed to be a relatively recent introduction/innovation (Allen 1997; Clarkson and David 1995). Although they have been dated back as far as 3000 years BP in western Arnhem Land, they are found mainly in the upper levels dated to less then 1000 years BP and on the surface of Top End sites (Allen 1997: Brockwell 1989:74).
There were only three leilira specimens in all from the Adelaide River, two from MP2 and one from HD1. There are two whole pieces and one butt, one each made from tuff, quartzite and chert. Their dimensions are described in the Table 5.27. They were present from the Transition through the Freshwater Phases.

**Polished Flakes**

Polished flakes are often also retouched. As they are a type of implement associated with freshwater wetlands sites, I will discuss them briefly here. Polished flakes are distinctive implements with a high silica gloss polish along the edge of the implements. They do not have any definitive shape. Up till now they have only been found at wetlands sites located in western Arnhem Land. Use wear studies have suggested that these implements were used to harvest and process silica-rich plants (Akerman 1986; Kamminga 1978:303-308, 1982:93-95). Polished flakes from sites in western Arnhem Land have come mainly from the surface and upper levels of sites (Brockwell 1989:87; Kamminga 1978; Schrire 1982:70, 131-32). As these sites are associated with freshwater wetlands and post-date the establishment freshwater conditions on the floodplains, the polished flakes are presumed to be associated with silica-rich freshwater plants. Experiments indicate that the plant in question may be the spike rush (*Eleocharis dulcis*) and the polish caused by stripping the spines (Akerman 1986). One specimen from western Arnhem Land was found mounted on a handle (McCarthy and Setzler 1960:269). Traces of resin found on several other specimens from western Arnhem Land and the small size of the implements suggest that they must have been hafted for use (Brockwell 1989:87; Kamminga 1978:95).

In the Adelaide River sites only two specimens of polished flakes were found, both from the Transition Phase. One was made from chert and the other from quartzite. Their dimensions are listed in Table 5.28.
Discussion

In relation to sites in western Arnhem Land, Allen and Barton (1989:118) have suggested that ‘[t]he location of manufacturing activities and the presence of points in any quantity probably reflects the proximity of quarries or the availability of high quality quartzite. Apart from this, the frequency of points, adzes, polished flakes and axes could indicate different site functions or local environmental zones’ (Allen and Barton 1989:118). I think that the lack of points, leiliras and polished flakes at the Adelaide River sites is attributable partially to both explanations. The Scotch Creek assemblages indicate that it was a manufacturing site for points located close to a number of high quality chert sources (Crassweller 1996; Roddom 1997; Smith and Brockwell 1994). The Adelaide River sites, on the other hand, were located far from chert sources on the other side of the river. The quartzite outcrop near the Adelaide River sites was not of sufficient high quality for the manufacture of leilira blades. The silica rich plants that were being processed in western Arnhem Land in the late Holocene, although also available at the Adelaide River, were not being processed on a regular basis there.

5.7 RETOUCHED FLAKES

The majority of retouched flakes are made from tuff and chert reflecting a preference for using these materials and also conserving them (Table 5.29). A chronological comparison of the raw material weights of retouched flakes demonstrates that in the Transition and Freshwater Phases, retouched quartzite flakes (local) are mostly larger than the non-local retouched chert and tuff flakes, reflecting its local origins (Tables 5.30). Retouched tuff flakes decrease in size in the Early Freshwater Phase, which is consistent with the model of reduced mobility in the Freshwater Phase. However, retouched chert flakes increase in size in the Early Freshwater Phase and retouched tuff flakes decrease in size in the Transition Phase. Neither result is consistent with the model. However, the result from the Contact Phase is probably due to small sample size. Retouched quartzite, chert and tuff flakes all increase in size in the Late Freshwater Phase, again indicating a change in
site use at this time. Retouched quartz flakes reduce in size at this time but again the sample is small. There are no retouched flakes from the Big Swamp Phase.

5.8 GROUND IMPLEMENTS

The analysis identified four categories of ground implements; grinding slabs, pestles, haematite and ochre, and ground pieces (Table 5.31). As numbers may be misleading, especially in the category of ground pieces where all the artefacts are broken pieces from a larger whole, their weight has also been used to describe their distribution in the sites. Both calculations show that these ground artefacts increased in the Freshwater Phases.

There are five grinding slabs, one from the Early Freshwater Phase and four from the Late Freshwater Phase. They are flat and smooth on the surface and mostly made from sandstone, a non-local raw material. All of them are broken. As implied by their name, these implements were used as a base for grinding. Several similar specimens from western Arnhem Land showed microscopic traces of red and yellow haematite, starch grains, phytoliths and plant fibre indicating that they were used for grinding pigments and in preparation of plants (Brockwell 1989:106). Their dimensions of the Adelaide River specimens are listed in Table 5.32.

There were four broken pestles in the excavations from three different sites, all on Middle Point. These pestles are rounded cobbles with ground surfaces, two from sandstone and two from quartzite. They are usually associated with mortars and used for pounding/grinding activities. One large mortar stone was found on the surface of NP20 at North Point. All the pestles date from the Early and Late Freshwater Phases. Their dimensions are listed in Table 5.33.

Ground haematite and ochre pieces were present in all sites from the Big Swamp Phase up into the recent past in the Late Freshwater Phase. These pieces had ground facets.
Their presence indicates the use of ground pigments. Their dimensions are listed in Table 5.34.

There were numerous ground pieces at all the sites. These pieces were broken and had at least a small amount of grinding on their surface. They were made from sandstone, quartzite, quartz, FGS and volcanic material. Sandstone and quartzite were the most common. Their chronology and weight are listed in Tables 5.35 and 5.36 (Figure 5.23). Quartz, FGS and volcanic material were rare (Table 5.31). It appears that the non-local sandstone pieces are smallest in the lower levels of MP2, MP6 and HD1 in the Transition Phase. The trend is the same at MP5 where the sandstone pieces are smallest in the Early Freshwater Phase (Table 5.35).

At MP2 and HD1, there is an increase in use of sandstone for ground implements in the Early Freshwater Phase and a corresponding decrease in the use of quartzite (Table 5.38). From the Early Freshwater Phase onwards sandstone is targeted for modification at all the sites, except for MP5. This site stands out as having a high percentage of ground quartzite in the Freshwater Phases (Table 5.37).

Inter-site comparisons demonstrate clearly that sandstone and quartzite were the raw materials most used for grinding. Sandstone is a non-local material. Volcanic material and quartz were used only rarely. The ground volcanic flakes may have been from axes or mortars, both of which were commonly made from volcanic material in western Arnhem Land (Brockwell 1989:93,101).

The shift in emphasis in the use of sandstone and quartzite for ground implements is quite clear when looked at phase by phase (Tables 5.39, Figure 5.24). Overall there is a switch from a reliance on quartzite for grinding in the Big Swamp and Transition Phases to greater use of the non-local sandstone in the Early and Late Freshwater Phases (Tables 5.35, 5.36, Figure 5.23). This scenario fits the model of decreased mobility in the
Freshwater Phases, in terms of increased modification of non-local raw materials, but increased modification of local raw materials was also predicted.

It is obvious from Table 5.38, that both grinding technology and haematite and ochre have been employed at the Adelaide River sites for at least 4000 years. This implies firstly that there was some sort of food being ground and pounded. Secondly haematite and ochre were being used for pigment, either for decorating items of material culture/bodies perhaps for ceremonial activities. The volcanic material may indicate that axes were being used and resharpened on the sites. However, if this was so they were not used commonly.

5.9 DISCUSSION

In Chapter 4, it was suggested that residential mobility on the Adelaide River changed over time according to variations in productivity levels on the floodplains. One way of testing this theory is to examine the modification of lithic raw materials at the sites. It has been assumed that low residential mobility places stress on raw material acquisition and therefore stone is used more conservatively. The model presented at the beginning of the chapter stated that low residential mobility is associated with high levels of modification of local and non-local raw materials and bipolar production of flakes. Conversely high residential mobility is equated with low levels of modification of local and non-local raw materials and and bipolar production. Therefore this chapter has asked the questions, what raw materials were targeted for modification? What elements constituted the modified stone assemblage of the Adelaide River floodplain sites? And were there differences between the sites and changes in levels of mobility over time in response to changes on the floodplains?

There appears to be spatial differences between the sites in terms of the raw materials that were being targeted for modification. The Middle Point sites (MP2, MP5, MP6 and HD1) have a greater range of modified raw materials than the North Point sites. Modified chert
was entirely absent from the North Point sites, while tuff was modified at a much higher rate. This situation may reflect distance from sources as the North Point sites were located some 12 km north of the Middle Point sites and furthest from sources of the targeted non-local raw materials chert, tuff and sandstone. Of the Middle Point sites, MP5 stands out as being different from the other sites. Tuff was modified at a higher rate and quartzite rather than sandstone was targeted for grinding. This suggests that MP5 was used differently from the other sites with which it was contemporaneous. It may indicate a different activity area within the cluster of mounds, MP4, MP5 and MP6.

The modified stone assemblages found at the Adelaide River sites consisted mainly of cores, retouched flakes, grinding slabs, pestles, ground haematite and ochre, and ground pieces. There were very few cores, either bipolar or non-bipolar, at the sites, which suggests that very little primary production of flakes was taking place at the floodplains sites. This situation was in contrast to the floodplain site of Kunkundurnku on the South Alligator River, discussed at the beginning of the chapter, where large numbers of bipolar cores were present (Hiscock 1996). Thus the model of increased bipolar production during periods of low residential mobility and vice versa was not proved for the Adelaide River sites. The ratio of bipolar to non-bipolar cores at the Adelaide River was more like that found in open woodland sites of the South Alligator River by Hiscock (1996). As a high level presence of bipolar cores can be used as an indicator of reduced mobility, it would appear that the inhabitants of the Adelaide River were more mobile than those at the South Alligator River.

At the Adelaide River sites there was a distinct lack of points, leiliras or polished flakes, formal tool types that are common in other northern Australian contexts. Brockwell (1989:215-22) argued that points and leiliras were rare on the South Alligator River floodplain sites compared with their distribution in the rockshelters and outliers of the Arnhem Land escarpment. This relative deficiency was attributed to distance from source of suitable raw materials to manufacture points and leiliras (Brockwell 1989:223). At the Adelaide River floodplain sites, points and leiliras can be described as being virtually
absent altogether compared with the South Alligator sites. I would suggest that this lack is due to the same reason, ie distance from suitable raw material sources. In the case of unifacial and bifacial points, it may also be that their manufacture had ceased prior to the Freshwater Phases on the Adelaide River. A point horizon from Scotch Creek, located some 20 km to the south-east of the study area on the eastern side of the river, was dated to c. 3500 years BP and points did not occur in the upper levels of the site (Crassweller 1996; Smith 1995; Smith and Brockwell 1994). Scotch Creek is located close to suitable raw material sources that would have been inaccessible from the western side of the river during the Big Swamp Phase. Polished flakes were also a common item found at floodplain sites in western Arnhem Land (Brockwell 1989:222, 226). The lack of polished flakes at the Adelaide River suggests that processing silica rich plants from freshwater swamps was either not an important activity at the sites or it was carried out at other locations. The absence of polished flakes may be related also to seasonal occupation of the sites, in the sense that the plants in question are only available seasonally from the mid-dry season to the early wet season (Russell-Smith 1985A:252). This may mean that the Adelaide River sites have been occupied at other times of the year.

There were really only two categories of modified artefacts where there were sufficient numbers of implements to look at changes in raw material acquisition over time. These were retouched flakes and ground implements. Retouched and use wear flakes were present from the Transition through the Freshwater Phases and most of these flakes were made from either tuff or chert. However, there was a marked drop off in the targeting of chert for retouch modification through time, while reliance on local raw materials, quartz, quartzite and tuff increased over time. This perhaps suggests a decrease in mobility over time.

There was an increase in ground implements in the Freshwater Phases. This result indicates that there was an increase in the demand for ground technology, which may be related to the establishment of freshwater resources on the floodplains. At the same time
sandstone, a non-local raw material, was targeted for modification as opposed to the local material quartzite.

The next question to ask is whether these temporal changes in raw material acquisition are related to changes in technology? I do not believe that this is so in the case of retouched flakes, as these types of implements remain constant through time. However the raw materials targeted for their manufacture do change over time. I think that what is changing is mobility strategies and these changes are cultural responses to changing environmental conditions on the floodplains.

I will now revisit the model of settlement patterns in the various phases as predicted at the beginning of this chapter. The Big Swamp and Freshwater Phases were periods of high biomass productivity on the floodplains. This situation would result in regional populations focussing the majority of their subsistence efforts on the swamps. It was expected that this would lead to reduced mobility, expressed archaeologically as increased modification of local (quartz, quartzite, FGS) and non-local (chert, tuff, sandstone, ochre, haematite, volcanic material) raw materials and a high rate of bipolar flake production. Conversely during the Transition and Contact Phases, periods of reduced productivity on the floodplains, it was expected that the swamps would no longer be the major focus of exploitation. Therefore mobility would increase. This scenario would be expressed archaeologically as a decreased rate of modification of local and non-raw materials and a low rate of bipolar production.

In the Big Swamp Phase, it is difficult to assess the situation, as the sample size of modified artefacts is so small. In the Transition and Freshwater Phases, overall rates of modification remained steady through the phases. Of the local raw materials the rate of modification of quartz remained steady through the Transition and Freshwater Phases. Quartzite modification initially decreased in the Early Freshwater Phase, then increased in the Late Freshwater Phase. Modification of FGS decreased over time. These results do not comply with the model. However modification of the non-local materials (chert, tuff,
sandstone, ochre, haematite and volcanics) all increased in the Freshwater Phases. These results are consistent with the model. The results from the Contact Phase do not agree with the model as rates of modification of local and non-local materials all increased. This result is as predicted for periods of low residential mobility. Bipolar production was low for all periods, which is consistent with the model for periods of high residential mobility, but not for periods of low mobility. These results are summarised in Table 5.39.

In light of the results, the model of settlement patterns for the Adelaide River sites during the Freshwater and Contact Phases needs to be revised. The fact that there is no increase in modification of local raw materials during the Freshwater Phases suggests that periods of low residential mobility lead only to the conservation of targeted non-local raw materials and do not intensify the use of local stone. Alternatively, there were no periods of low residential mobility and residential mobility remained high throughout the Freshwater Phase. The low-level of bipolar production also suggests greater mobility at the Adelaide River floodplain sites than appears to exist at the South Alligator River sites. However, increased modification of all the non-local raw materials during the Freshwater Phases suggests that there were at least some periods of reduced mobility. This result may be due to the fact that the sites were seasonally occupied rather than on a year-round basis. I will examine the question of seasonality when I discuss faunal remains in the following chapter. The results from the Contact Phase are no doubt due to the impact of contact on settlement patterns. I will seek explanations for the nature of this influence when I examine the ethnographic information in Chapter 7.
CHAPTER 6: FAUNA

6.1 INTRODUCTION

Faunal analysis can supply information about both the local environment and foraging strategies (cf. Bowdler 1984:52; Foley 1985; Lyman 1994:5-8; Schrire 1982). The sites under consideration here span a period of 4000 years during which the floodplains were subject to profound environmental changes. It is expected that the sites' faunal record will reflect these changes. Secondly, assuming that the faunal remains were human introductions, their analysis can provide information about the foraging strategies of the inhabitants. The faunal distribution will also add dimension to the body of data describing the intensity of site occupation provided by the stone analysis. In addition, as some fauna are seasonally abundant, faunal analysis may provide information on seasonal occupation of the sites.

Chapter 3 discusses expected faunal exploitation and the intensity of site use over time, based on the nature and productivity of the northern environmental phases. During the Big Swamp Phase from c. 7000 to 4000 years BP, Rhizophora mangrove forests dominated the floodplains. It is expected that the focus of exploitation would be on estuarine resources located along the margins of the floodplains. Fish and shellfish would probably be the dominant species to be taken from these areas, including estuarine fish such as barramundi (Lates calcarifer), catfish (Arius sp.) and sleepy cod (Oxyeleotris lineolatus), and mangrove shellfish, for example Geloina, Telescopium, Cassidula, Nerita, Terebria, Cerithidea and Ellobium. It is likely there would also have been some exploitation of the littoral resources of the (then) nearby low energy coastline, including the shellfish species, Anadara, Marcia and Circe. Birds, reptiles and crustacea are likely to have been taken from both zones. Woodlands species, such as macropods, possums, birds and reptiles, are also likely to be exploited but at a lower rate than the estuarine floodplains species. Seasonality would not have been a large factor as the resources of the mangrove swamps, sea and woodland were available year-round. The high biomass productivity of the floodplains during the Big Swamp Phase meant that there was no need for inhabitants to relocate frequently to satisfy subsistence requirements, therefore relatively high accumulation
rates of faunal remains at the sites are expected. It is also expected that the productivity of the floodplains during this phase would attract a large number of people to the region. The archaeological expression of this situation would be a number of sites with basal dates of between 7000 and 4000 years BP. However, the Big Swamp Phase is represented by only one site (HD1) on the Adelaide River, which is dated to c. 4100 years BP, at the tail end of the phase. The reason for the lack of sites from the Big Swamp Phase may be taphonomic. As there are no nearby rockshelters to preserve remains, as there are in western Arnhem Land, all the sites in the study area are open and therefore either may not have survived or if located on the edge of the floodplain may now be obscured by estuarine infill.

During the Transition Phase from c. 3900 to 2000 years BP, the Rhizophora mangrove forests declined and were replaced by a mosaic of estuarine and freshwater zones on the floodplains. Estuarine faunal remains, similar to those from the Big Swamp Phase are predicted, although the shellfish taxa are likely to have changed with the change in environment and the resulting switch to Avicennia dominated mangrove swamps. It is expected that there would be an increasing number of freshwater species, such as turtle and fish, as freshwater swamps became part of the mosaic environment on the floodplains. Littoral resources are expected to drop out in the Transition Phase, as the sites were by then located further from the sea due to coastal progradation (Map 2.2). As this phase was one of environmental variability it is expected that floodplain resources, although highly diverse, were less predictable than in the Big Swamp Phase and therefore the inhabitants would rely more on woodland and rainforest species than previously. It is expected that faunal remains should reflect this situation with a more even balance of woodland and rainforest species, as opposed to estuarine and freshwater floodplains species. As a result of variability in floodplain resources and an increased reliance on woodland and rainforest resources, it is predicted that the residents will be more mobile. Consequently it is expected that during the Transition Phase there would be less intense occupation and a lower rate of accumulation of faunal remains in the floodplain sites. With the appearance of some freshwater resources on the floodplains, seasonality would become a factor influencing settlement patterns.
Two sites, HD1 and MP2, represent the Transition Phase on the Adelaide River. It appears that MP2 was established during this period, which does not fit with the model of less intense occupation of the floodplain sites during this phase. However, its establishment may be due to the appearance of freshwater resources within the mosaic environment of the floodplains.

The dates from the sites fell into two clusters indicating that the Freshwater Phase divided into an Early Freshwater Phase, from c. 2000 to c. 630 years BP, and a Late Freshwater Phase from c. 630 to 150 years BP. With the establishment of widespread freshwater conditions on the floodplains in the Early Freshwater Phase, the productivity of the associated resource base exploded. Estuarine resources are expected to drop out in this phase and a corresponding dominance of freshwater faunal remains is expected in the sites. The marked seasonality of the climate and flooding regimes meant that some floodplains species were seasonally unavailable, thus some woodland species are expected in the faunal remains, though at a lower density than in the Transition Phase. The high productivity of the floodplains during the Freshwater Phases attracted settlement along the floodplain margins, reflected in the number of sites occupied. In the Early Freshwater Phase, HD1 and MP2 continued to be occupied and MP5 and MP6 were established. In the Late Freshwater Phase MP2, MP5 and MP6 continued to be occupied and it has been assumed that NP19 was established. The increase of the discard rate of stone artefacts in the Freshwater Phases (see Chapters 4 and 5) suggested that residential mobility was lower and an accompanying increase in the accumulation rate of faunal remains is predicted. The Late Freshwater Phase is expected to have a distribution of fauna similar to the Early Phase. However, the increase in the stone artefact discard rate during this phase (see Chapter 4) leads to the expectation that accumulation rates of faunal remains, especially those of freshwater species, may also increase.

In the Contact Phase, the invasion of feral fauna and flora adversely affected the productivity of the floodplains. Disruption to traditional social and economic systems, depopulation and access to new technology irrevocably altered settlement patterns and subsistence strategies. Lack of contact material suggests that the Middle Point sites, MP2, MP5 and MP6, and the North Point site, NP1, may have been abandoned in this
phase. NP20 is the only site representative of this phase. It is expected that in the Contact Phase, the freshwater floodplains were still the main focus of foraging strategies, with some seasonal woodland exploitation. However a reduced range of faunal remains is expected at the sites, with perhaps the addition of some feral species that favour floodplain habitats, such as buffaloes and pigs. A reduced accumulation rate of faunal remains is also predicted as a result of lower floodplains productivity and declining use of the sites. Seasonality of freshwater floodplain resources would remain a factor that influenced settlement patterns, though less so than in the past with the year-round availability of feral fauna and as alternative European carbohydrates increasingly replaced traditional plant sources. The model of foraging patterns and accumulation rates is summarised in Table 6.1.

Below I discuss the methodology I used to analyze the faunal remains, the taphonomic influences on site formation, the data on faunal distribution and density from each of the sites, species abundance and distribution. Spatial differences between the sites are considered in a discussion on inter-site comparisons. The data have been summarised by phase and chronological comparisons made of foraging strategies over time. The seasonal abundance of species is examined to elicit seasonal patterns of site use.

**6.2 METHODOLOGY**

Firstly I calculated the weight of all faunal remains per kilogram of deposit to give an indication of the distribution and density in the sites. The results were used to test the model that there was an increase in use of sites in the Freshwater Phases. Most of the faunal remains from the Adelaide River sites came from the 3mm fraction and were very fragmented. For example, MP2 yielded an estimated 12.4 kg of faunal remains from the 3mm sieve, most of it unidentifiable. Consequently MNI (minimum number of individual species) analysis was not used because the skeletal elements available did not allow a calculation of minimum numbers. There were, for example, no fish otoliths present. NISP (number of individual specimens) analysis also seemed inappropriate because of the fragmented nature of the remains. Given this situation, I decided the best method available was to calculate the weight of each taxon per kilogram of deposit. Weight analysis may imply that I am attempting calculations of
meat weight. This is not my intention. Rather the faunal analysis was designed to answer broad rather than specific questions asked of the data, and define overall patterns of subsistence rather than quantify minimum numbers and calorific intake. For example, 'What are the proportions of fauna in any given time phase?' The answer, taken together with the other archaeological and environmental data available, will provide an indication of exploitation strategies rather than the amount of food being harvested (Amorosi et al. 1996:143-44). Therefore the emphasis will be on relative habitat foraging rather than relative contribution of taxa and species to diet.

The value of taking and analysing 3mm samples was proven as without it, little would be known of the fauna at MP5, MP6 or NP20, and a great deal of detail would have been lost from the other sites. Colley (1990: 208-9) advocates processing through even smaller sieve sizes to recover all fish remains from a site. Experimental studies have demonstrated that use of a smaller sized sieve vastly improves recovery of skeletal elements of mammals weighing over 9 g with femurs in excess of 9.3 mm (Shaffer and Sanchez 1994). As Shaffer and Sanchez (1994:528) point out the identification of smaller animals is a key element in palaeo-environmental and dietary reconstructions. Small animals are restricted in their movements and therefore can be diagnostic of specific microhabitats, while larger animals tend to move across a wide variety of ecozones.

I made preliminary identifications of the other faunal material based on broad categories such as mammal, bird, reptile, fish etc. Categories such as large and small mammals, most likely macropods, possums and rodents, and birds were identified by long bones. Species identifications of mammals, birds and reptiles were made mainly on teeth, jaws and vertebrae. Those identified to species level include agile wallaby (*Macropus agilis*), northern brushtail possum (*Trichosurus arnhemensis*), brown bandicoot (*Isoodon macrorus*), the dusky rat (*Rattus colletti*) and the Northern blue tongue lizard (*Tiliqua scincoides*). Other identifications were to taxon only. The most common macropod in the area is the agile wallaby (*Macropus agilis*). It is likely that the larger mammals and birds were introduced into the sites through human agency.
Species identifications of rodents were made on teeth and jaws. There were several possible interpretations as to the identity of the remains, including the dusky rat (*Rattus colletti*) that inhabits the freshwater floodplains, the water rat (*Hydromys chrysogaster*), the black-footed tree rat (*Mesembriomys gouldii*), a woodland dwelling species, and the European rat (*Rattus rattus*). It is probable that the rodent teeth and jaws were the remains of *R. colletti*, because of their small size and the proximity of the sites to the freshwater floodplains. Both *H. chrysogaster* and *M. gouldii* have bigger jaws and teeth (P. Horner pers. comm.). *R. colletti* is known ethnographically to have been part of the Aboriginal diet in northern Australia (Russell-Smith *et al.* 1997:190). However, the fact that *R. colletti* seek higher ground adjacent to the floodplains during the wet season (Madsen and Shine 1999) suggests that the remains that appear in the lower levels of the sites may not have been humanly introduced.

Reptiles, mostly goannas and snakes, were identified mainly on vertebrae. The most likely species of goanna are two species of sand monitors (*Varanus gouldii* and *V. panoptes*) that both inhabit floodplains and woodlands, and/or the mangrove monitor (*V. indicus*) found in riverine locations. Goannas inhabit burrows in the earth mound sites. Therefore it could not be assumed that they were humanly introduced. It was not clear whether the snakes were of the Boidiae or Agamidae families. If they were targeted as a food item, they are likely to be either Arafuran file snakes (*Acrochordus arafurae*) that inhabit freshwater floodplains and lagoons, or from the python family, species of which inhabit both the floodplains and the woodland. Snakes, especially the water python (*Liasis fuscus*), are common to the study area and likely to have formed part of the diet. However as water pythons are known to nest in goanna burrows (Madsen and Shine 1998), it could not be assumed that they had been humanly introduced to the sites.

Turtles were identified almost wholly from carapace, although there was one vertebra present also. The ornamentation on the carapace suggests that they are the remains of either the long-necked turtle (*Chelodina rugosa*) which inhabits the floodplains, or less likely *Emydura australis* that has similar ornamentation but inhabits deep waterholes. *Chelodina rugosa* dwells in freshwater environments such as swamps and billabongs, water holes and slow flowing rivers across the Top End of northern
Australia. It feeds on other reptiles and amphibians, aquatic crustaceans, tadpoles, frogs and small fish (P. Horner pers. comm.). As turtles dwell solely on the freshwater floodplains and in lagoons, it was assumed that they had been introduced into the sites through human agency.

Fish species were identified on skeletal elements, such as vomer, dentary, premaxilla, articular, maxilla, quadrate, hyomandibular, opercular, preopercular, urohyal, cleithrum, post-temporal, pterygiophores, supra-cleithrum, spines and vertebrae (Barnett 1978:37; Colley 1990:213). Interestingly, otoliths were missing entirely from the assemblages, although they are a common feature of the faunal collections from excavated shell middens in the Darwin Harbour region (Bourke 2000). It seems that because they are made of aragonite, a crystalline form of calcium carbonate, they are prone to decay in acidic conditions even though the cranial bones surrounding them may survive (Colley 1990:214). The earth mounds I excavated had a pH reading of between 6 and 7.5. The presence of otoliths in the Darwin Harbour shell mounds is therefore due to favourable alkaline preservation conditions created by estuarine shell. Fish identified to species level included barramundi (*Lates calcarifer*), catfish (*Arius* sp.), both of which can survive in fresh and salt water, and the pikey bream *Acanthropagus* sp., which is an estuarine species. Those identified to family level included grouper (Serranidae) and threadfin salmon (Polynemidae), both of which live in estuarine conditions. The fork-tailed catfish (*Arius* sp.) in most cases could not be identified further. The remains are quite likely those of *Arius graeffi*, a very common freshwater/estuarine catfish that is of sufficient size to make good eating. The remains could also be of the golden catfish, a very large estuarine species that is yet to be described (H. Larson pers. comm.). As fish live only in water it was assumed that humans had transported them to the sites.

Shell species identified in the sites were *Anadara, Cassidula, Crassostrea, Ellobium, Geloina, Terebralia*, all estuarine species, and *Xanthomelon* (land snail) that inhabits woodlands and rainforest. The estuarine species are all assumed to be introduced by humans to the sites. *Xanthomelon* are known to be exploited by Aboriginal people in northern Australia but as they are a rainforest and woodland species they may not have been brought by humans to the sites.
The fragmented nature of the faunal remains means that much of it remains unidentified. As the analysis examines the distribution of fauna by weight through the deposits, it must be borne in mind that the results can be regarded only as gross indicators of foraging strategies. The fragmented state of the faunal remains and the amount that could not be identified, as well as the taphonomic forces in operation at the sites (see 6.3 below), mean that species are probably under-represented or entirely undetected. Consistent with the aims of the faunal analysis, fish, turtle and shellfish can be used as an indicator of environmental change on the floodplains. The two possible species of turtle present are exclusively freshwater species. The two main species of fish found in the sites, barramundi (*Lates calcarifer*) and the fork-tailed catfish (*Arius* sp.), can live in estuarine as well as freshwater conditions, while the identified shellfish are all estuarine species.

**6.3 TAPHONOMY**

What forces are at work on the sites? The sites are open and subject to annual inundation, including the occasional cyclone (Bowman and Panton 1994), which leads to the rapid decay and displacement of organic materials. Faunal preservation would have been influenced also by scavengers and fire, both bushfires and the habit of discarding bones into camp fires (Colley 1990:215; Schrire 1968; Walters 1988). However, it was not possible to assess the extent of burning as the remains were calcified and covered with dirt. Preservation of faunal remains was differential depending on the degree of robustness (see discussion of fish below). All the sites have been affected to some extent by burrowing goannas.

There was very little charcoal at any of the sites and no other archaeo-botanical remains. Shell formed only a minor part of the assemblages, mainly from one site, HD1. Faunal remains were present at all the sites but were more fragmented at some sites than others. At two sites HD1 and MP2, many items in the 6mm fraction were identifiable to species level. There was no 3mm fraction available from HD1. MP2 had a large quantity of bone. A projected 13.9 kg was recovered from the excavation of 0.7 cubic metres. However, it was in a very fragmented state. At the other Middle
Point sites, there were very few faunal remains at MP5 in either sieve fraction. Most of what was there was unidentifiable. At MP6 there were only a few mostly unidentifiable remains in the 6mm fraction, but a greater quantity that was identifiable in the 3mm fraction. There was very little fauna preserved at both North Point sites NP19 and NP20, and most was unidentifiable.

Many of the remains were of fish that are notorious for their differential preservation (Colley 1990:215-16). This became obvious while I was using the reference collection at MAGNT. The majority of fish species present in the sites were the fork-tailed catfish (Arius sp.) and barramundi (Lates calcarifer), both of which survive happily in estuarine and freshwater conditions. However, there are many more species available from both habitats that were undoubtedly exploited in pre-contact times. Examination of the skeletal material explains why they have not been preserved. Many species, especially the freshwater ones, have extremely delicate bone structure, which bears no relationship to the size of the fish. Therefore it is probable that the fork-tailed catfish and barramundi are over-represented at the sites, simply because of the robustness of their skeletons. A checklist of species likely to have been exploited in the rivers, estuaries and floodplains of the Top End is found in Table 2.2.

It must also be considered how the faunal material made its way onto the sites, ie was it humanly introduced or did it arrive in some other way? It seems reasonable to assume that the floodplain species, shellfish, fish and turtle were humanly introduced as the sites are all located on high ground above the floodplains. Macropods, possums and bandicoots inhabit the open woodland and may have made their own way onto the sites. The dusky rat (Rattus colletti) retreats to higher ground in the wet season, so it may not have been humanly introduced. As the birds and reptiles could not be identified to species level, they could be inhabitants of either the floodplains or the woodlands. Snakes, particularly pythons, and goannas are known to inhabit the mounds themselves so may have died there naturally.

6.4 DISTRIBUTION AND DENSITY OF FAUNAL REMAINS
In the same way as for the analysis of stone artefact density through the sites, I have used the weight of faunal remains per kilo of deposit per 100 years to estimate density and distribution of faunal remains over time.

The projected total weight of faunal remains from MP2 was 13940.1 g. All of the 6mm fraction (1585.1 g) was analyzed. The 3mm fraction (an estimated 12355.0 g) was exceedingly time-consuming to sort, so it was sampled for analysis, as described in Chapter 4. A sample of 4375.9 g, approximately one third of the total weight of faunal remains in the 3mm fraction, was analyzed. Projected total figures for identified and unidentified fauna from the 3mm fraction were subsequently estimated based on the size of the sample from each spit. There was an increase in the discard rate of faunal remains in the Late Freshwater Phase (Table 6.2). This could not be estimated for the Transition Phase because there was no basal date.

At MP5, there were very few organic remains, most of which were recovered from the 3mm sieve. The total weight of faunal remains was 8.9 g, all of which was analyzed. A discard rate could only be calculated for the upper level of the site, as there was only one date available (Table 6.3).

The total weight of faunal remains from MP6 was 1839.1 g, all of which was analyzed. The discard rate of fauna remained about the same between the Early and Late Freshwater Phases (Table 6.4).

Only the 6mm sieve residue was available from HD1. The total weight of faunal remains was 1598.9 g, all of which was analyzed. The discard rate of fauna decreased over time at HD1 (Table 6.5).

The total weight of faunal remains from NP19 was 136.3 g, all of which was analyzed (Table 6.6). There were no dates from NP19 so discard rates could not calculated. All fauna from NP20 came from the 3mm fraction. The total faunal weight was 37.9 g, all of which was analyzed (Table 6.7).
**Inter-Site Comparisons of Faunal Distribution and Density**

There are clearly inter-site differences in faunal distribution and density within phases. Only those sites for which discard rates could be calculated have been included (Table 6.8, Figure 6.1). MP2 had the highest discard rate of fauna in both Freshwater Phases, while MP5 had the lowest.

**Chronological Comparisons of Density and Distribution**

The distribution of fauna over the environmental phases is exactly as predicted by the model. The discard rate decreased in the Transition Phase, increased in the Freshwater Phases, then decreased in the Contact Phase (Table 6.9, Figure 6.2). It is noted that there was an increase in the discard rate of fauna in the Late Freshwater Phase post 630 years BP, coincident with the increase in the discard rate of lithic raw materials for the same phase. This increase is mainly due to the density of fauna at MP2 post 460 years BP.

**6.5 TAXA ABUNDANCE**

A sample of 5961.0 g of faunal remains was examined from MP2, of which 1593.5 g was identifiable. The range of fauna included the remains of both floodplains and woodland taxa. There were large and small mammals, macropods, possums, rodents, birds, snakes, goannas, fish and shellfish (Table 6.10). Fauna identified to species level included the remains of the northern brushtail possum (*Trichosurus arnhemensis*), dusky rat (*Rattus colletti*), barramundi (*Lates calcarifer*), the fork-tailed catfish (*Arius* sp.), threadfin salmon (family Polynemidae), estuarine shellfish (*Geloina*) and land snail (*Xanthomelon* sp.). Mammals, birds, reptiles, turtles and fish were present in all three phases. Shell was present in minor quantities only in the Freshwater Phases. The highest taxa and species abundance was in the Freshwater Phases. When the discard rates are calculated, it can be seen that turtle is the dominant taxon represented in the Freshwater Phases, which was predicted by the model. The discard rate of mammal and turtle increases in the Late Freshwater Phase while that of fish decreases (Table 6.11).
There was 8.9 g of faunal remains in MP5, of which 3.1 g could be identified. There were a limited number of taxa represented at this site, only three in the Early Freshwater Phase and four in the Late Freshwater Phase. These included goanna, turtle and fish, with some the fork-tailed catfish (Arius sp.) and land snail (Xanthomelon) (Table 6.12). Turtle and fish, including Arius sp. were present in both the Early and Late Freshwater Phases. Goanna was only present in the Late Freshwater Phase. When the discard rates are calculated, it can be seen that turtle is the dominant faunal taxon in the Late Freshwater Phase, which was predicted by the model (Table 6.13).

The total weight of faunal remains in MP6 was 1839.1 g, of which 290.7 g was identifiable. A similar range of faunal remains was present as at MP2, consisting of mammal, macropod, rodent, bird, reptile, snake, goanna, freshwater turtle, fish and shell. The only fauna identified to species level were barramundi (L. calcarifer), catfish (Arius sp.) and land snail (Xanthomelon sp.). There were 12 taxa present in the Early Freshwater Phase and only seven in the Late Freshwater Phase, a result probably due to sample size effect (Table 6.14). When the discard rates are calculated, it can be seen that turtle is the dominant faunal taxon in both the Freshwater Phases, which was predicted by the model. Mammal remains the same over time, while reptile and fish decrease. Bird is present only in the Early Freshwater Phase (Table 6.15).

HD1 had a total faunal weight of 1598.6 g, of which 1167.2 g could be identified. The high identification rate is due to the fact that only 6mm sieve remains were available. The species identified were from both freshwater and estuarine floodplains and woodland habitats (Table 6.16). They included the remains of the northern brushtail possum (Trichosurus arnhemensis), brown bandicoot (Isoodon macrurus), dusky rat (Rattus colletti), Northern blue tongue lizard (Tiliqua scincoides), barramundi (Lates calcarifer), the fork-tailed catfish (Arius sp.), pikey bream (Acanthropagrus berda), threadfin salmon (family Polynemidae), estuarine shellfish (Cassidula, Ellobium, Geloina and Terebralia) and the land snail (Xanthomelon sp.). Taxa present were small and large mammals, as well as macropod, bird, reptile, freshwater turtle, fish and estuarine shellfish. The Transition Phase had the highest abundance of taxa (Table 6.16). Rattus colletti, the freshwater dusty rat, is present during the Big Swamp
Phase. As it is unlikely that *R. colletti* inhabited the Adelaide River floodplains in the Big Swamp Phase, its presence suggests that the rodents were using burrows in the mounds during the wet season, and were not humanly introduced. Reptiles were present only during the Transition and Late Freshwater Phases. When the discard rates are calculated (Table 6.17), it can be seen that estuarine shellfish are dominant faunal taxa in the Big Swamp Phase, fish are the dominant in the Transition Phase, while turtle dominates in the Early Freshwater Phase. This scenario is consistent with the model. Turtle, a freshwater species, is insignificant in the Big Swamp Phase but increases between the Transition and Early Freshwater Phases. Mammal increases in the Transition Phase, which was predicted, and increases again in the Early Freshwater Phase, which was not. Bird declines over time, which is a surprising result as more bird remains were expected in the Early Freshwater Phase.

NP19 had a total faunal weight of 136.3 g, of which 11.4 g could be identified. There were eight identified taxa and species, including mammal, macropod, turtle, unidentified fish, catfish (*Arius* sp.), grouper (Serranidae), unidentified shell and *Anadara* (Table 6.18). As there was no date for NP19, the discard rate could not be calculated. However when the weight of fauna per kilogram of deposit was quantified, it can be seen that once again fish and turtle are the dominant taxa, which was predicted, with a small amount of mammal (Table 6.19).

NP20 had a total of 37.9 g of bone, of which 12.1 g was identifiable. There were eight identified taxa and species, including *R. colletti*, reptile, turtle, unidentified fish, *Arius* sp., *Anadara* and *Crassostrea* (Table 6.20). At NP20, estuarine shellfish was the dominant fauna, which was an unexpected result. However the sample size was small (Table 6.21).

**Inter-Site Comparisons of Taxa Distribution and Abundance**

There are both similarities and differences between the sites in terms of taxa distribution (Tables 6.22). MP2, MP6 and HD1 all have high taxa diversity in the Early Freshwater Phase. However, only MP2 maintains this into the Late Freshwater Phase. Turtle, fish and shell (mainly estuarine), all floodplain taxa, are the dominant fauna at all sites. Fish and shellfish dominate at HD1 in the Big Swamp and Transition
Phases, while turtle is dominant at all sites in the Freshwater Phases. Estuarine shellfish and turtle are the dominant taxa at NP20 in the Contact Phase. MP2 has the highest discard rate of both turtle and fish in both Freshwater Phases. An increase in the discard rate of mammal also occurs at MP2 in the Late Freshwater Phase. MP5 has the lowest taxa densities and diversity of all the sites in the Late Freshwater Phase.

**Chronological Comparisons of Taxa Distribution and Abundance**

Overall, the Big Swamp Phase had the highest discard rate of fauna, though the heavy weight of fish bone and shell in the sample from HD1 may have skewed this figure. The discard rate of fauna decreased in the Transition Phase, due to the decline in shellfish, and then increased in the Freshwater Phases and decreased once more in the Contact Phase (Table 6.23, Figure 6.3). This pattern is consistent with the model. The phases of highest faunal diversity were the Transition and Freshwater Phases. The dominance of floodplain taxa in all phases emphasises the importance of the floodplains to the regional economy (Table 6.23, Figure 6.3). In the Big Swamp Phase, fish and shellfish dominated the faunal assemblage then declined in the Transition Phase. Turtle increased in the Transition Phase and became the dominant taxon in the Early Freshwater Phase. The model predicted these distributions. Mammal and bird increased in the Transition Phase, which was predicted by the model. Reptile remained the same. The increase in diversity of taxa during this phase agrees with expectations, as the Transition Phase had the most diverse environment. The increase in the discard rate of fauna (mainly turtle) in the Late Freshwater Phase, taken with the coincident increased discard rate of stone, suggests that there was an increase in activity at the sites during this time. Perhaps more people were using the sites. The number and discard rate of taxa declined in the Contact Phase, which is consistent with the model. Although the model anticipated a high percentage of turtle remains in the Contact Phase, the result for estuarine shellfish was unexpected. It is most likely the result of small sample size.

**6.6 TAXA**

**Mammals**

There were six taxa of mammal at the Adelaide River floodplain sites. The highest taxa and species abundance occurred in the Transition and Freshwater Phases (Table
The number of large and small mammals and macropods increased in the Transition Phase, which is consistent with the model. However, the decline in the numbers of possums, bandicoots and rodents is not. It is highly likely that the rodents made their own way into burrows in the mounds, especially as there was a high density of the dusky rat (*R. colletti*), a freshwater floodplains dweller, in the Big Swamp Phase. Numbers of large and small mammals then decreased in the Early Freshwater Phase, which is also consistent with the model. However macropods increased which is not. The overall discard rate for mammals increased in the Late Freshwater Phase, which emphasises the change in site use already observed for this phase. There were no mammals recorded in the Contact Phase, except for *R. colletti*, which was probably not humanly introduced.

All the mammal remains belong to species that dwell in the open woodlands, whereas most of the rodent remains in the sites are likely to be those of *R. colletti* (P. Horner pers. comm.), a freshwater floodplains species. This rodent retreats to high ground in the wet season and may have used goanna burrows in the mounds for shelter. This behaviour would explain the high density of *R. colletti* in the Big Swamp Phase. Therefore I calculated mammal distribution minus rodents in order to gain a picture of woodlands exploitation over time (Table 6.25, Figure 6.4). This calculation demonstrated an increase of woodland taxa in the Transition Phase, a decrease in the Freshwater Phases and absence in the Contact Phase. This result is consistent with the model. An increase in the discard rate of mammals in the Late Freshwater Phase reinforces an increase in the intensity of site use for this phase.

**Birds**

Bird remains were present through all phases of occupation, except the Contact Phase (Table 6.26, Figure 6.5). However, none of the remains in the assemblages could be identified to species level, so it is uncertain whether they represent floodplain or woodland taxa. Nevertheless, it is probable that birds were an important part of the hunter-gatherer diet, especially in the Freshwater Phases. The freshwater wetlands of northern Australia host an abundant and diverse bird life (see Chapter 2). The lack of bird remains in the site may reflect taphonomic processes at the sites and the fragile nature of bird bone.
It was expected that the highest density of bird remains would occur in the Freshwater Phases as water birds are prolific on the freshwater floodplains of the Top End today and several species, especially the magpie goose (*Anseranus semipalmata*), are targeted for food. However, the distribution of bird remains did not confirm this expectation (Table 6.26). In fact the highest density of bird remains occurred in the Big Swamp Phase. This result argues against taphonomic factors being responsible for the lack of bird bone in the sites, as preservation is less likely in older levels. The density of bird bone decreased subsequently in the Transition Phase, which is as predicted by the model, but it declined even further in the Early Freshwater Phase, which is contrary to the model. However, it increased in the Early Freshwater Phase, consistent with an increase in the intensity of site use during this phase, but not to Big Swamp levels.

The most prominent bird species that inhabits the freshwater floodplains of the Van Diemen Gulf in vast numbers is the magpie goose *Anseranus semipalmata*. The distribution and abundance of this species is seasonal. Magpie geese are highly mobile and relocate themselves constantly throughout the year according to the availability of food and water during the dry season and suitable nesting sites in the wet season. Their favoured food is the corms of semi-aquatic spike rushes (*Eleocharis* spp.) that grow in water up to 1.5 m in depth, and the seeds of the wild rice *Oryza* sp. The geese harvest from wet areas as their beaks cannot penetrate the black soil once it has dried out (Finlayson *et al.* 1988:112; Morton *et al.* 1990; Tulloch 1985:289). Water depth is very important in the selection of nesting sites by magpie geese as the goslings rely on it in the early dry season. For nesting the geese favour dense mixed stands of *Eleocharis* sp. and wild rice *Oryza* sp. that flourish in the perennial backwater swamps of the floodplains (Bowman and Wilson 1986:77). Different flooding regimes and floodplain conditions mean that magpie geese are distributed differently on each river system. In the early dry season the greatest densities of geese occur where *Oryza* sp. is abundant. On the South Alligator system (Nourlangie Creek and Boggy Swamp) the magpie goose population peaks in the mid-dry season when the birds feed on the vast *Eleocharis* sp. swamps. In the late dry season the geese move onto the Magela Creek floodplains where they see out the dry season on perennial swamps.
During the wet season magpie goose numbers are substantially lower on both systems when they transfer to the floodplains on the East Alligator River to nest (Morton et al. 1990:307, 318; Morton and Brennan 1991:143). The floodplains of the Mary and Adelaide Rivers are wet season habitats for magpie geese and contain the most important breeding grounds in the Northern Territory (CCNT 1993:6-7; Guse 1992:47-8; Whitehead 1998:22). However, there are microenvironments involved here too. The two major components of the freshwater floodplains are the high black soil plains that avoid prolonged flooding and the backwater swamps that retain water till late in the dry season (Frith and Davies 1961:100-102; Whitehead 1988:6). The floodplains in the study area are classified as high black soil grasslands. In the early dry season, these areas are important feeding grounds when the water depth is favourable for the growth of the sedge, *Eleocharis* sp., the corms of which are favoured by the geese. These areas dry out rapidly and by April or May there are deep cracks in the black soil (Madsen and Shine 1999:81; Whitehead 1988:7, 9). Backwater swamps located elsewhere on the floodplains, for example Fogg Dam and Black Jungle Swamp, are the breeding grounds in the wet season. Such areas produce a crop of wild rice (*Oryza* sp.) at the end of the wet season. In some areas hatching appears to coincide with the ripening of the rice, which provides the major food source for the goslings and their parents at this time (Bowman and Wilson 1986:75-76; CCNT 1993:7; Frith and Davies 1961:95, 101, 116; Whitehead 1988:8, 10).

If the indications of the data are real and not a result of taphonomic processes and methodological problems, it must be concluded that there was only low level processing of birds at the Adelaide River floodplain sites during the Freshwater Phases. This situation could be the result of several scenarios. Water birds were not a target of foraging strategies, which seems unlikely. Water birds were being butchered and eaten elsewhere at sites used concurrently with the mound sites. This scenario suggests that foraging strategies were more complex than is represented by the sites. It also implies the existence of processing sites that were not revealed by the survey. It is possible that such sites exist around the backwater swamps or lagoons, for example Fogg Dam, Lambells Lagoon and Black Jungle Swamp, where thick vegetation obscured visibility (see Chapter 3). Or they may have been located on the floodplains.
themselves where water birds gather in large numbers around diminishing pools of water in the late dry season. If such were the case, it is highly likely that prolonged seasonal flooding would have dispersed and encouraged rapid decay of the remains. The third scenario is that the floodplain sites were occupied seasonally at a time when water birds were not readily accessible, for example in the early to mid-dry season before floodwaters had retreated and water birds were dispersed widely over the floodplains. This explanation also implies the existence of processing sites, probably in the same locations as described above. However in this scenario they would have been used at a different time of the year from the mound sites. The question of seasonality will be explored further below.

**Reptiles**

Although it cannot be assumed that all reptile faunal remains were humanly introduced into the sites for the reasons outlined above (see 6.2), it is highly likely that they formed part of the Aboriginal diet. There were four classes of reptile remains, those that could not be identified, snake, goanna and lizard (*Tiliqua scincoides*). Snakes remain were more common than varanids over time. The discard rate of reptiles overall increased in the Transition Phase, and again in the Early Freshwater Phase. That figure remained steady through the Late Freshwater Phase and then decreased in the Contact Phase. These patterns are in general agreement with the model. There was only one example of blue tongue lizard (*Tiliqua scincoides*) in the Early Freshwater Phase (Table 6.27, Figure 6.6).

The water python (*Liasis fuscus*) is the most common python on the Adelaide River floodplains. The dusky rat (*R. colletti*) forms the major proportion of the diet for the water python. Together these animals are responsible for the Adelaide River floodplains having the highest faunal biomass in the world (see Chapter 2). Given their abundance, it seems likely that water pythons would have been a major food resource for hunters at the Adelaide River. Madsen and Shine (1998; Shine and Madsen 1997) conducted a 10-year intensive study on *L. fuscus* at Middle Point. This python is known to use varanid burrows seasonally as breeding sites, including the ones associated with the earth mounds under discussion. It turns out that there are
actually three separate breeding populations of *L. fuscus* in the Middle Point area, the Fogg Dam pythons, the paperbark pythons and the varanid burrow pythons.

These populations show a high level of breeding ground philopatry. During the breeding season (July to September), the pythons remained in their breeding grounds. During the late dry season-wet season (October-April), the separate populations intermingled and moved up to 12 km away throughout the floodplains as far as the river levee banks and past North Point in search of the dusky rat. As flooding recedes (May-June), the pythons return to their home ranges around Middle Point (Madsen and Shine 1998:344-46; CCNT 1993:8).

The faunal analysis identified the presence of remains of *Rattus colletti* through all the environmental phases of the sites. The remains identified only as rodent are also probably those of *R. colletti* (P. Horner pers. comm.). It might be expected that as the number of *R. colletti*, a freshwater floodplains species, increased in the Freshwater Phases, so might the proportion of snakes. However, when the distribution of rodent and snake remains are compared, there is no definite relationship established between the two (Table 6.28, Figure 6.7). The high proportion of rodent in the Big Swamp Phase is probably due to *R. colletti*, a freshwater creature, sheltering in burrows at the base of the mounds during the wet season. Both increased between the Transition and Early Freshwater Phases. However, when rodent increased in the Late Freshwater Phase, snake did not.

**Turtles**

Turtles were definitely introduced into the sites by humans, as there was no other way that they could get there. The turtle remains are mainly carapace. They most probably belong to the long-necked turtle (*Chelodina rugosa*). This is a freshwater species that typically inhabits swamps, billabongs and waterholes across northern Australia. Today they occur commonly on the floodplains of the Adelaide River. Long-necked turtles are omnivorous, subsisting on a diet of aquatic crustaceans, tadpoles, frogs and fishes (Cogger 1992; Goodfellow 1993; P. Horner pers. comm.). They aestivate during the dry season making them easy prey (Goodfellow 1993:48). The discard rate of turtle remains increased ten-fold between the Big Swamp and Transition Phases. It
increased by the same amount in the Freshwater Phases and then declined in the Contact Phase (Table 6.29, Figure 6.8). This scenario is consistent with the model. The increase in the Late Freshwater Phase coincides with the increase in the discard rate of lithic raw materials at the same time and reinforces the proposal for increased intensity of site use for this phase.

**Fish**

Fish were also humanly introduced. Of the fish species, the fork-tailed catfish (*Arius* sp.) and barramundi (*Lates calcarifer*) are overwhelmingly dominant in the sites (Table 6.30, Figure 6.9). Both species are present through all the phases, except that barramundi are absent from the Contact Phase. I think the dominance of these species in the sites is definitely the result of differential preservation. While examining the fish reference collection at MAGNT, it became obvious that these two species have extremely robust skeletons. Other fish, especially freshwater fish from floodplain habitats, have fragile skeletons that would not survive for long in an archaeological context. It is highly likely that the fork-tailed catfish and barramundi would not have been the only fish species targeted by the Aboriginal inhabitants. There were isolated remains of some other estuarine fish identified to family or species level at HD1 and MP2. These are the threadfin salmon (family Polynemidae) in the Early Freshwater and Transition Phases, grouper (family Serranidae) in the Early Freshwater Phase, and the pikey bream (*Acanthropagus* sp.) in the Transition Phase. Other freshwater and estuarine fish species likely to have been exploited are listed in Table 2.2.

Table 6.30 (Figure 6.10) demonstrates the distribution of *Arius* sp. and *Lates calcarifer* over time. It can be seen that *L. calcarifer* remains were dominant in the Big Swamp Phase, *Lates* and *Arius* remains were evenly distributed in the Transition Phase, while those of *Arius* sp. dominated increasingly in the Freshwater Phases. This distribution suggests a number of possible explanations. There may have been differential preservation of each species. However, preservation may not have been a factor as, apart from NP20, the sample sizes are large, the identification rate of species is between 30% and 40% for each phase and both species are present in all phases except the Contact Phase. The lack of remains from the Contact Phase may be due to the premature drying-up of lagoons following the impact of exotic species.
Environmental conditions in the Big Swamp Phase may have favoured barramundi, while catfish flourished in freshwater conditions. This reason would explain the relatively even distribution of both species in the Transition Phase. As seasonality became a factor in the Freshwater Phases, catfish may have been more available in the season when the sites were occupied.

Both species are seasonally abundant. Although there is not much data available, there are some reports of Arius sp. migrating either upstream or into deeper water during the spawning season. Tropical Arius species spawn annually for several months at the beginning of the wet season. A. leptaspis, a species known to inhabit the waterways of northern Australia, begins spawning when water temperatures exceed 26° C, which occurs between October and December (Rimmer and Merrick 1982:43-44).

Barramundi (Lates calcarifer) are the only Lates species in Australia. The barramundi is an ambush predator fish, which lurks and then ambushes its prey. It is the largest of the freshwater predator fishes and grows much larger than saratoga. It lives in estuaries and also in freshwater billabongs and lagoons in the floodplains in northern Australia, from where they retreat as the dry season progresses. However they prefer estuaries where they spawn and live in large numbers. (H. Larson pers.comm.). As barramundi require a saline environment to spawn, they must migrate to areas with a salinity of at least 28-31. In northern Australia this means most rivers with a tidal influence are suitable and the fish can spawn a long way upstream as long as the salinity is sufficiently high. Young larvae have been recorded 77 km upstream on the South Alligator River (Davis 1985:189; Finlayson et al. 1988:112). Observations on the small tidal creek-swamp system of Buffalo Creek and Leanyer Swamp near Darwin demonstrated that L. calcarifer spawn from September to February. Resident tidal L. calcarifer begin spawning first. The land-locked L. calcarifer, such as those that inhabit lagoons and billabongs on the Adelaide River floodplains, begin spawning later after the first floods allow them to gain access to the river. The juvenile fish return via feeder streams on spring tides and disperse widely into the swamps while they are still in flood. The floodplain and billabong systems of the van Diemen Gulf become important nurseries during the wet season providing the juvenile barramundi
with an ideal, food-rich, almost predator-free habitat in which they flourish (Davis 1985:186-89; Finlayson et al. 1988:112).

In the Big Swamp Phase, the floodplains of the Adelaide River were tidally inundated and the mound sites were located much closer to the sea (Map 2.2). During the Transition Phase, saltwater areas were still common on the floodplains. Barramundi breeding behaviour was probably similar to that of resident tidal fish that spawn over a long period. These fish have their nurseries in coastal swamp systems, tidal pools and gutters (Davis 1985:188). For these reasons it is likely that widespread swamp conditions in the Big Swamp Phase and the mosaic environment of the Transition Phase meant that barramundi were more plentiful during these phases than in the Freshwater Phases.

Shell

The species identified were Anadara, Cassidula, Crassotrea, Ellobium, Geloina, Terebralia, and Xanthomelon (land snail), a woodland and rainforest dwelling species. Anadara can be obtained from intertidal mudflats of rivers and creeks. Cassidula, Crassostrea (oyster), Geloina, Ellobium and Terebralia are all mangrove species (Allen 1996:196; Meehan 1982:64; Russell-Smith et al. 1997:185). The estuarine species of shellfish were humanly introduced to the sites. The land snail Xanthomelon sp. may have been part of the diet, but as it inhabits woodland and rainforest it may have been introduced naturally. The distribution of shell species is presented in Table 6.31. Cassidula, Crassostrea, Ellobium and Terebralia were present in such small numbers that they have all been subsumed under the category 'Estuarine'. It can be seen that the highest discard rate for shell, mostly estuarine, was in the Big Swamp Phase. In the Transition Phase, the discard rate decreased to only four percent of the Big Swamp Phase, but was still mostly made up of estuarine species. The discard rate was very low for the Freshwater Phases. These results are consistent with the model. However, the discard rate, again mostly of estuarine shell, increased in the Contact Phase which was unexpected. Although the sample size was small it may be an indicator that, with the environmental degradation of the freshwater floodplains during this phase, the inhabitants of the mounds travelled to the mudflats of the Adelaide River four kilometres to the east, to gather shellfish. It was expected also that there
might have been some change in the species of shellfish in the Transition Phase that reflected the environmental changes on the floodplains, as there was in western Arnhem Land. However this was not the case. Although the discard rate of shell was much lower in the Transition Phase than the Big Swamp Phase, Geloina remained dominant and increased its proportion by six percent (Table 6.31, Figure 6.11). This result may be due to the fact that Geloina inhabit salt flats populated with Avicennia mangroves (Meehan 1982:64), as well as the Rhizophora forests that were extant in the Big Swamp Phase.

6.7 CONCLUSION

The Environment
At the beginning of this chapter it was stated that the analysis of faunal remains could provide information about environment and foraging strategies. Today there are two major environmental zones in the study area, the floodplains and the open woodlands, with some minor patches of monsoon rainforest. It is probable that rainforest was more widespread in the past. In the Big Swamp Phase, the study area was located close to the sea. The faunal assemblages from the Adelaide River floodplain sites included taxa mainly from the floodplains and woodlands. There were small amounts of bat and land snail (Xanthomelon) present, which may have come from rainforest. However, land snail also resides in woodland. There were no marine species present at all. The floodplain taxa include the remains of fish, turtle, R. colletti, estuarine shellfish, and possibly water species of snake and goanna. The woodland taxa include wallaby, possum, bandicoot and possibly land species of snake and goanna and the land snail, Xanthomelon.

The geomorphological evidence provides independent evidence of the changes in the floodplains environment in the mid- to late Holocene period (see Chapter 2). The distribution of floodplains fauna in the earth mound sites clearly reflect the different stages in the evolution of the floodplains, from estuarine through a mosaic of both estuarine and freshwater, until freshwater conditions dominate (Table 6.32, Figure 6.12). The dominance of estuarine fish and shellfish in the Big Swamp Phase indicate that estuarine conditions were extant when the sites were first occupied c. 4000 years BP. A decline in fish and shellfish remains and an increase in turtle in the Transition
Phase between 3900 and 2000 years BP signal the period when a mosaic of freshwater and estuarine conditions existed on the floodplains. The dominance of turtle remains in the Freshwater Phases indicates that freshwater conditions dominated the floodplains by c. 2000 years BP. The decline of freshwater fauna in the Contact Phase probably reflects the adverse impact of exotic species on the freshwater floodplains following contact.

**Faunal Distributions and Foraging Strategies**

The archaeological evidence provides information on how the Aboriginal inhabitants were exploiting the environment over time. Mammals, birds, turtle, fish and estuarine shellfish are all attributed to human introduction into the Adelaide River earth mound sites. Rodents, reptiles, snakes and land snail were excluded from the analysis of foraging strategies because, although it is highly likely that they formed part of the Aboriginal diet, they may have been introduced naturally into the sites. The fact that turtle, fish and shellfish dominate the other faunal remains attests to the fact that foraging strategies at the earth mound sites were focussed on the floodplains throughout all the environmental phases (Table 6.32, Figure 6.13).

Table 6.33 summarises the predictions of faunal distributions by phase from the beginning of this chapter and compares them with the results of the faunal analysis. Because faunal remains of rainforest species were negligible and marine species non-existent, these two habitats have not been included in the final comparison. In the Big Swamp Phase it was predicted that the emphasis of exploitation would be on the floodplains. This was confirmed by the dominance of estuarine taxa in the faunal assemblages. There was some minor exploitation of mammals from the woodlands and birds, although whether these were floodplain or woodland species is unknown. It was predicted that there would be some freshwater fauna from transitory lagoons located in the open woodlands and some rainforest fauna. However, the proportion of both was so low that they did not register in the percentage calculation. It was also predicted that there would be some exploitation of the littoral zone, as the sea was located close to the sites during this phase. However there was no evidence of marine species in the faunal assemblages (Table 6.34, Figure 6.13). Perhaps the inhabitants did not exploit the sea on a regular basis because it lay outside their territory, or the
sites are located elsewhere possibly obscured by the build-up of mud on the floodplains. Overall, the faunal discard rate for humanly introduced species was substantially higher for the Big Swamp Phase than other phases (Table 6.34). This result may be due to the weight of estuarine shell as opposed to the weight of other faunal taxa. However, it can be seen that even if estuarine shell is excluded from the sample, the discard rate of fauna is as high as in the Late Freshwater Phase (Table 6.34). The high faunal discard rate in the big Swamp Phase may be due to the fact that estuarine resources were available all year round. A high faunal discard rate is consistent with predictions that, as there was high biomass productivity on the floodplains during this phase, the floodplain sites were used intensively (Table 6.33).

In the Transition Phase, it was predicted that foraging strategies would diversify and woodland resources would become more important as floodplain resources became unpredictable. It was expected that freshwater, woodland and rainforest species would increase, while estuarine species would decrease and littoral remains would drop out as the coast prograded northwards (Table 6.33). There was an increase in the discard rate of mammal but the floodplains remained the focus of foraging strategies at the sites. The introduction of turtle, and the continuing though decreased presence of fish and shellfish, reflect foraging in the mosaic environment of freshwater and estuarine zones extant on the floodplains during this phase (Table 6.33, 6.34, Figure 6.13). Littoral remains were absent as expected. Overall faunal discard rates dropped to only 20% of the Big Swamp rate (Table 6.34). This pattern is consistent with predictions that, although there was high species diversity on the floodplains during this phase, resource unpredictability meant that the floodplain sites were no longer used as intensively.

In both the Early and Late Freshwater Phases, it was predicted that the emphasis of foraging strategies would be on the floodplains (Table 6.33). The large amount of turtle and fish and the small amount of woodland fauna present in the sites during these phases confirmed that this was the case. The absence of bird remains was puzzling as it was expected that with the establishment of freshwater wetlands, waterbirds would become an important resource. A possible explanation for this absence is seasonal occupation of the sites, which is discussed below.
In the Early Freshwater Phase, the discard rate of turtle increased, woodland mammal decreased and estuarine shellfish dropped out. Littoral species were absent and the overall discard rate increased (Table 6.34, Figure 6.13). These patterns are consistent with the model (Table 6.33). Rainforest species were absent. Estuarine fish were still present but in lower numbers. This is not entirely inconsistent with the model as the species involved are mainly catfish and barramundi, which also survive in freshwater conditions. An unexpected result was that, although the overall discard rate of fauna increased, it was not as high as that of the Big Swamp Phase and only slightly higher than that of the Transition Phase (Table 6.34). This may be due to the heavy weight of estuarine shell compared with other faunal remains. However, it may also be due to the fact that, because of the nature of the resource base, year-round rather than seasonal residence could be maintained in the Big Swamp Phase.

In the Late Freshwater Phase, the proportion of woodland fauna was low, and estuarine shellfish and marine species remained absent (Table 6.34, Figure 6.13). These results are consistent with predictions (Table 6.33). The proportion of turtle increased, while that of estuarine fish decreased. These results suggest that there was a change in foraging strategies in the Late Freshwater Phase, as distinct from patterns in the Early Freshwater Phase. This may be due to environmental change or more intensive exploitation of freshwater wetlands. The overall discard rate of faunal remains increased, which does suggest an increase in the intensity of site use. However discard rates in the Late Freshwater Phase were still not as high as in the Big Swamp Phase. This outcome may be for the same reasons as for the Early Freshwater Phase.

In the Contact Phase, foraging was still floodplains-based. However the proportion of freshwater turtle decreased and marine taxa were absent as was predicted (Tables 6.1, 6.34, Figure 6.13). The overall discard rate of fauna decreased as expected, as the sites were no longer used as intensively as in the past (Table 6.34). Woodland taxa were absent, which was not predicted as a change in foraging strategies was expected with the degradation of the freshwater floodplains following contact. However, the unexpectedly high proportion of estuarine shellfish may signal such a change in
foraging strategies. On the other hand, this result may be due to the small sample size from the Contact Phase (Table 6.34).

**Seasonality**

It was assumed that seasonality was not a major factor affecting foraging strategies and settlement patterns in the Big Swamp Phase, as estuarine resources are available year-round. Seasonality would have been more of a factor in the Transition Phase when freshwater resources began to appear on the floodplains. In the Freshwater Phases the seasonality of freshwater resources on the floodplains would have become a major consideration in terms of foraging and settlement strategies, as the behavioural patterns of freshwater floodplain species are strongly regulated by the annual cycle of wet and dry. The magpie goose (*Anseranus semipalmata*) feeds on grasses on the high floodplains during the early dry season, then moves to see out the late dry season at permanent lagoons and backwater swamps where it nests in the wet season. The dusky rat (*R. colletti*) hides in cracks in the high floodplain in the early to mid-dry season and then moves to the backwater swamps in the late dry and onto high ground in the wet season. The water python (*Liasis fuscus*) that hunts the dusky rat follows its prey in its seasonal movements. It returns to its breeding grounds located near to the sites in the middle of the dry season but disperses widely across the floodplains in the wet. The barramundi (*Lates calcarifer*) and the catfish (*Arius* sp.) return to the river to spawn in the wet season.

Some tentative conclusions can be drawn about possible seasonal site occupation from the annual cycle and the faunal remains in the Freshwater Phases. The earth mound sites on the Adelaide River are located adjacent to the high floodplains, which are dried out by mid-dry season. Wet season occupation seems unlikely as there was no strategic advantage in occupying the earth mound sites while the resources of the floodplains were widely dispersed. Nesting magpie geese and their eggs, which were available in the late wet season, occupied the backwater swamps rather than the high floodplains adjacent to the sites. The lack of bird remains or eggshell confirms that geese did not form part of the foraging strategies employed at the sites. Late dry season occupation of the sites also seems unlikely, as by this time the high floodplains and transitory lagoons had dried up and floodplains fauna would have retreated to
permanent water elsewhere on the floodplains. For the same reason, the availability of fresh drinking water would also have affected settlement patterns at this time. From the middle of the dry season onwards, people would have been forced to seek water away from the floodplains. This leaves the early to mid-dry season for occupation of the sites. Turtle, catfish and barramundi would have been widely available at this time when there was still water on the high floodplains and the transitory lagoons were full. The evidence supports this conclusion as most of the remains from the sites in the Freshwater Phases are of turtle and fish. Although geese would have occupied the floodplains adjacent to the sites in the early dry season, they would have been widely dispersed while the floodplains were still inundated and may not have been easy to capture. Again the lack of bird remains from the Freshwater Phases indicates that the earth mound sites were not used as processing sites for waterbirds and that such sites must have been located elsewhere.

6.8 A REVISED MODEL OF SETTLEMENT PATTERNS AND MOBILITY STRATEGIES

The distribution of sites, together with stone and faunal analyses, allow a revised model of settlement patterns and mobility strategies to be constructed for the lower Adelaide River from 4000 years until the recent past. Site distribution and the dates suggest that the floodplains were the focus of settlement in the region from the Big Swamp Phase onwards. The analysis of stone raw materials allowed conclusions to be drawn regarding mobility strategies, while the faunal analysis provided information on foraging strategies. The discard rates of both allowed comments to be made on the intensity of site use. The nature and distribution of the faunal remains confirm that foraging strategies at the earth mounds were based on exploitation of the floodplains throughout the history of the sites. The abundance and diversity of lithic raw materials and faunal remains in the earth mound sites suggest that they were base camps. However mobility strategies and intensity of occupation varied over time according to floodplain conditions.
In the Big Swamp Phase foraging strategies were based on procurement of resources from the highly productive estuarine floodplains, supplemented on a minor scale with some woodland resources. These resources were available year-round. Stone raw materials were locally available. As people did not need to move far to satisfy subsistence requirements, residential mobility was low. Resources on the eastern side of the river were inaccessible, which implies that movement and alliance networks must have extended to the south and west.

In the Transition Phase, a mosaic of estuarine and freshwater resources on the floodplains meant that there was high species diversity on the floodplains. However, because of the fluctuating nature of the environment during this phase, these resources were unpredictable. In addition the freshwater resources were available only seasonally. Consequently, although the earth mound sites were still occupied through this phase, they were not used as frequently and populations became more residentially mobile. The foraging focus remained on the floodplains but there was an increase in the use of woodland resources. At the same time, the decline of the mangrove forests opened up access to the eastern side of the river. Movement in that direction was possible and it has been assumed that alliance networks were extended to take advantage of newly accessible stone resources.

With the establishment of widespread freshwater conditions in the Early Freshwater Phase, foraging was focussed on the floodplains and new sites were established along the floodplain margins. The resource base was predictable and highly productive, but only on a seasonal basis. As a result, settlement patterns became more diverse in the Freshwater Phases. Sites for the processing of specific resources may have existed around the backwater swamps. Although overall mobility at the earth mound sites decreased in response to the availability of the highly productive resources on the floodplains, this effect was seasonally linked to the annual availability of resources. On the basis of the faunal evidence it was argued that, during the Freshwater Phases, the earth mound sites were occupied in the early to mid-dry season. Movement and alliance networks to the east, south and west would have been maintained during these phases.
In the Late Freshwater Phase, the discard rate of stone and faunal remains increased indicating that residence at the earth mound sites was either more prolonged, more frequent or more people were using them. The seasonal nature of the resource base argues against more prolonged use of the sites. Therefore the evidence suggests that the sites were either being used more frequently or by more people than in the Early Freshwater Phase. At the same time the evidence implies that there is diversity in the use of contemporaneous sites. An increase in the number of people using the sites in the Late Freshwater Phase implies that several mounds may have been occupied simultaneously and used for different activities to accommodate this increase. Possible reasons for an increase in the numbers of people using the sites will be discussed in Chapter 8, where comparisons are made with regional archaeology.

With the impact of exotic species in the Contact Phase, productivity of the floodplains declined. In addition the sites were used less often due to the breakdown of traditional social and economic networks, a decline in population as a result of introduced diseases, and increasing reliance on European foods.

It can be argued that, as freshwater conditions were established c. 2000 years BP, the ethnography of the Adelaide River might be able to supply further insights into pre-Contact settlement patterns and mobility strategies. The models of settlement and subsistence proposed for the Freshwater and Contact phases will therefore be tested against the ethnography in the following chapter.
CHAPTER 7: ABORIGINAL USE OF THE ADELAIDE RIVER FLOODPLAINS

7.1 INTRODUCTION

I will now turn to the ethnographic record to see what it can reveal about settlement patterns and mobility strategies on the Adelaide River in the pre- and post-contact periods. The ethnographic data, both oral and historic, can be compared with the archaeological data to determine patterns of pre- and post-contact continuity and change. I will address themes that have emerged from the archaeology including the nature of floodplains settlement, changes in settlement patterns and subsistence strategies linked to physical transformations on the floodplains, the introduction of new technologies, and seasonal occupation of sites. Only the archaeology of the Freshwater and Contact Phases over the last 2000 years will be examined in this context. As Hiscock has commented in regard to ethnographic analogy with earlier periods:

'This depiction of significant economic, demographic and technological change in response to continuing environmental and cultural change implies that recent observations of Aboriginal activities in the contemporary landscape may make poor analogues for the economic strategies that were in place at earlier times. Recent systems centred on strategies of low mobility and a demographic concentration on freshwater resources in the sub-coastal zone may have an antiquity of no more than 500-1000 years. Economic systems reflected in the early or mid-Holocene archaeological record were adjusted to landscapes for which there is no counterpart in the region today, and it seems likely that the subsistence and technological strategies may have no local counterpart today. Certainly the repertoire of economic behaviour displayed in western Arnhem Land since the marine transgression was more diverse than that observable in the recent past' (1999:101-102).

The statement above that the environment has remained similar throughout the last 2000 years needs to be qualified. There has been extensive alteration to the environment of the Adelaide River floodplains since contact. Some of these are recorded in Chapter 2 and include the impact of feral animals, especially buffaloes, weed invasion, rice-farming etc. The custodians also report other changes (see below). However, I do not believe that these changes alter the essential argument that there are insights to be gained into the recent archaeology through examination of the ethnographic record. This is because there are
still some essential elements of the system that have remained unchanged, ie the seasons and the freshwater nature of the floodplains. Although the details are now different, I think insights can be gained into the bigger picture. The contact period can be viewed as the latest phase in the archaeological record and this is where the ethnography is invaluable.

Firstly, I will provide a brief history of contact in the region, and some background on the ethnographic sources that I have used. Then I will present the ethnographic information from the Adelaide River, organised chronologically around the themes mentioned above. Lastly I will compare it with the archaeological information and assess its relevance.

7.2 A HISTORY OF CONTACT

The first outside contact for the Adelaide River Aborigines within the last 1000 years may have been with the Macassan trepang fishermen sailing from the present day islands of Indonesia. There have been no Macassan sites recorded on Chambers Bay. It may be that the mudflats common on the coast of this area were not suitable for trepang colonies. However Macassan sites are common elsewhere on the northern coast of Australia (Clarke 1994; MacKnight 1976, 1986; Mitchell 1994, 1996; Schrire 1972). Even if there was no direct contact with Macassans, it is likely that there was some indirect influence. Although Macassan visits were not recorded, they had a definite impact on Aboriginal culture, especially language (Urry and Walsh 1981), technology (Mitchell 1994) and possibly trade and ceremonial life (Allen 1997; Berndt 1951; Evans and Jones 1997; Thomson 1949).

The Dutch made explorations in the 17th and 18th centuries and the British in the 19th century. However their visits were fleeting and did not record any particular information about the Adelaide River Aborigines. The first British settlements on the north coast of Australia were at Fort Dundas on Melville Island (1824-29), and later on the Coburg Peninsula at Raffles Bay (1829-30) and Port Essington (1838-49). They also lasted only briefly and were abandoned as being unviable. Although they did not have any direct influence on the study area, their indirect influence was profound in the form of introduced diseases, feral animals and new technology. It has been reported that buffalo
were established on the Adelaide River by time of settlement at Escape Cliffs (Ritchie 1998:1-2; Ritchie and Baumann 1991; Young 1866:8).

In 1862, the explorer John McDouall Stuart passed through the area en route to Point Stuart at the mouth of the Mary River on Chambers Bay (Stuart 1863). Following his encouraging reports of good pasture lands, the South Australian government set up a settlement at Escape Cliffs on Cape Hotham at the mouth of the Adelaide River in 1864 (Ritchie and Baumann 1991:16-18). In the wet season of 1865-66 John McKinlay led a disastrous expedition from Escape Cliffs to explore the country to the east as far as the Alligator Rivers region (Edmunds 1865-66; McKinlay 1866) (Map 7.1).

In 1871, gold was discovered at Pine Creek, south west of the study area and as a result a railway was built from Port Darwin the following year. This led to a new influx of both Europeans and Chinese into the region. Many Wulna drifted to the goldfields where they provided labour, sexual services and bush foods to the miners, in exchange for the exotic products they desired especially tobacco, opium (which was legally imported) and alcohol (Ritchie 1998:15-16). With the opening up of new areas, the pastoralists moved in and by 1882 the whole of the Northern Territory was under leasehold (Keen 1980:23). Buffalo shooting became an established industry on the Adelaide River by 1885. By the late 1890s the mining industry was in decline and a lot of Aboriginal groups returned to their own lands (Ritchie 1998:36). By 1909 buffalo shooting was the main economic focus for the Marrakai, Koolpinyah and Humpty Doo stations (Ritchie and Bauman 1991:23) (Map 7.1).

The presence of the mining industry with thousands of miners in the hills south of the coastal plains and the consequent environmental degradation severely disrupted those Aborigines who traditionally owned the land and caused serious conflicts with other incoming Aborigines in their competition for access to resources (Ritchie 1998:16,36).

The buffalo and pastoral industries depended on Aboriginal labour and the stations became a central focus for the local communities. As time went on they were viewed as the ‘heartland’ of Wulna and Limilngan country (Map 7.2). The lifestyle suited the Aboriginal people. Most activities took place in the dry and during the wet they were free
to follow their own pursuits. Station diaries and reports from custodians indicate that this was the time when they visited each other, conducted ceremonies, and buried their dead. Because there was a lot of movement in the wet season canoes were often used to cross the flooded Adelaide River plains. Traditional foods remained an important part of their own diet and they also began supplying the pastoralists with local foods. In these ways they were able to maintain links with their country (Ritchie 1998:26-28; Ritchie and Baumann 1991:21, 23, 28, 57, 59-61).

7.3 THE ETHNOGRAPHIC SOURCES

The information used is drawn from a number of sources, including the written reports of early European explorers and settlers, anthropologists and the testimony of the local Aboriginal custodians who are still resident in the area today.

The Explorers
John McDouall Stuart in June-July of 1862 spent a few nights along the Adelaide River on his epic journey from Adelaide to Point Stuart at the mouth of the Mary River (Map 7.1). Although his stay in the area was only transitory and he encountered no Aborigines, he provided some vivid images of the country in the mid-dry season and some tantalising descriptions of Aboriginal campsites (Stuart 1863).

John McKinlay, who was based at Escape Cliffs, led an ill-fated expedition to the East Alligator River in the wet season of 1865-66 and kept a diary of his journey, which was published in the Parliamentary Papers of South Australia (McKinlay 1865-66) (Map 7.1). His encounters (often hostile) were mainly with Aborigines of the Alligator Rivers region. However, the party became trapped for six weeks by rising flood waters on Marrakai Creek just to the south of the study area and he provided some descriptions of the Aborigines, probably from the Wulna tribe, who visited them at their camp. Knut Dahl (1926), a Norwegian naturalist, travelled from the Daly River to the headwaters of the South Alligator River on the Arnhem Land escarpment in 1898. Although the main aim of his trip was the collection of zoological specimens for the Oslo Museum, he recorded details of his encounters with Aborigines as he travelled. In 1882 G.K.McMinn conducted a survey of the Adelaide and Mary River plains to ascertain their agricultural potential.
Herbert Basedow was an administrator of the Northern Territory of South Australia. He assisted the government geologist H.Y.L. Brown on geological explorations in 1905 and supplied anthropological notes and sketches on his observations of the Aboriginal tribes they encountered to the Royal Society of South Australia (Basedow 1907).

**The Settlers**

Although the Escape Cliffs settlement was abandoned after only three years and relocated to Port Darwin in 1869, some useful information was recorded during this period by a number of sources. These sources are, for example, Boyle Finniss (1864-65), the government resident, J.T. Manton, who was acting government resident after Finniss was recalled (Manton 1866), and Clement Young (1866) one of the party who kept a diary. Robert Edmunds (1865-66) was chief surveyor and based one of his survey camps on the floodplains opposite Beatrice Lagoon. He also accompanied McKinlay on his trip to the East Alligator River. Although their reports and diaries were mainly concerned with their own interests, they also often supplied details about the activities of the local Aborigines. Initial contact was cordial. However relations deteriorated as a result of petty theft and the unsympathetic attitude of Government Resident Finniss. The white settlers retaliated and a number of Aborigines were killed. This resulted in the fatal spearing of one of the settlers and the recall of Finniss by the South Australian government. After that relations between the Aborigines and the settlers improved (Ritchie and Bauman 1991:18).

Paul Foelsche (1882), an inspector of police based in Port Darwin for many years, supplied notes on the Aborigines of northern Australia to the Royal Society of South Australia, based on his regular patrols into the hinterland. Both Foelsche and Basedow (see above) visited Wulna territory but their accounts of subsistence activities were not specific but referred in general terms to Aboriginal groups of the Top End.

**The Anthropologists**

David Ritchie and Toni Bauman, both anthropologists, researched the Limilngan-Wulna land claim, part of which covers the study area (Ritchie and Bauman 1991). This claim was successful and Ritchie (1998) subsequently completed a PhD dissertation on land claims, history and Aboriginal traditions in the Darwin hinterland. Ian Keen wrote the land claim book for the Alligator Rivers Stage II land claim, which included information...
about the Limilngan people of the Mary River. Robert Levitus (1982) investigated the social history of the Alligator Rivers region. Many of the people have links and shared histories with the Limilngan and Wulna peoples. Richard Baker (1981), an archaeologist, researched the archaeology of Point Stuart on the Mary River and investigated many ethnographic sources that have relevance to the Adelaide River.

The anthropological research was based on interviews with traditional custodians and extensive use of archival materials, including diaries of the early explorers and settlers, reports from patrol officers and other historical and anthropological sources. It was focussed on contemporary social traditions but land claims and social histories also rely on historical perspectives of links to country, foraging rights etc. This body of research therefore necessarily included much detail about past residence, mobility and foraging practices, from which a useful body of evidence can be gathered to compare with the archaeological evidence.

The Custodians
The senior members of the Wairuk Association have had a long connection with the study area. They are affiliated with the Wulna local descent group, who are the traditional custodians of this country (Basedow 1907:2; Ritchie and Bauman 1991). The custodians were born or grew up and worked on the local cattle stations (Koolpinyah, Humpty Doo, Marrakai and Woolner) (Map 7.1) and were involved with the local buffalo and crocodile hunting industries. They have maintained strong attachments to their country, through continuing residence and maintenance of traditions that have a demonstrated continuity from the ethnographic past (Ritchie and Bauman 1991). They are still actively engaged in hunting and gathering 'bush tucker', especially magpie geese, wallabies, fish, goannas, turtles and waterlilies.

According to the custodians Wulna country, or the 'Wulna Dreaming' as they express it, is bounded on the west by the high ground between the drainage systems of the Adelaide River and the Howard River. This boundary marks the division between Wulna and Larrakia country, and in the south west by Manton Dam. It covers the coastal plains to the north from Cape Hotham to Lake Finniss on the eastern side of the Adelaide River, and south to Marrakai Crossing where it borders on Limilngan country (Ritchie and Bauman 1991).
1991:13) (Map 7.2). To the east they are allied with the Limilngan (also known as the Minitja people) and linked through shared country, sacred sites, ceremonies, succession and history (Ritchie and Bauman 1991:14). Their neighbours to the west, the Larrakia, they describe as 'saltwater people' and themselves, the Wulna, as 'inland, freshwater people'. It is common for Aboriginal groups to describe themselves in such terms thereby defining their country (White et al. 1990). Relations with the Larrakia have been recorded as hostile (Ritchie and Bauman 1991:18). However, this may be more the result of historical circumstances following contact (see below) and may not in fact relate to the pre-contact situation. Certainly today the Larrakia and Wulna are linked both by marriage and shared Dreaming sites.

During the course of fieldwork I was accompanied by various members of the Wairuk Association, including Tony Kenyon, Joan Kenyon, Lena Henry, Felix Holmes, Graham Kenyon, Nowell Kenyon, Denise Kenyon, Justin Cooper, Rhonda Henry, Caroline Wandi, Sammy Fejo and Lynette Hays. They not only provided information about the sites that we visited but also gave assistance with the surveying of several sites. Discussions with the custodians were illuminating about the historic uses of archaeological sites, traditional camping places, hunting grounds, seasonal movements and environmental change this century. On several occasions we visited places not related to the archaeological survey but important to the local community for historical reasons or as popular fishing and hunting areas. During these trips I was provided with oral histories of the area, stories of the Dreaming features in the landscape and details of hunting and gathering activities.

7.4 THE ETHNOGRAPHIC EVIDENCE 1850-1900

I will present the ethnographic information chronologically and thematically. 'Environment' will contain descriptions of the physical landscape and changes that have taken place since contact. 'Settlement' will include details of demography, residence and mobility. 'Subsistence' will cover resource distribution, foraging patterns, and includes information on seasonality and technology.
Environment
Stuart (1863:404, 408) commented on the luxuriant nature of the country ‘one of the finest...man could wish to behold’ and the abundance of wildlife in the swamps ‘On and about the marsh are large flocks of geese, ibis, and numerous other aquatic birds...’ (1863:404). It must have been after a particularly good wet season as he also commented ‘[f]rom Newcastle Waters to the sea-beach, the main body of the horses have been only one night without water...’.

Although the countryside was attractive, the insect pests were not. In August 1838 Stokes complained about ‘...the swarms of flies which infest the Adelaide, and at meal times availed themselves of the opportunity of popping into our mouths’ (1846:426). Stuart complained of flies and frequently on the savagery of the mosquitoes as they passed around the swamps of the Adelaide-Mary River in June-July 1862. ‘The mosquitoes are very annoying, and the flies during the day are a perfect torment’ (1863:398). ‘The mosquitoes at this camp have been most annoying; scarcely one of us has been able to close his eyes in sleep during the whole night; I have never found them so bad anywhere – night and day they are at us’ (1863:401). ‘Mosquitoes terrible; no sleep last night; never found them so bad before; not a breath of wind to drive them away’ (1863:412). ‘We all passed a miserable night with the mosquitoes. My hands, wrists, and neck, were all blistered over with their bites, and were most painful’ (1863:413). On 13 December 1865 Young (1866:7) reported ‘[w]e were visited at Escape Cliffs by a horde of mosquitoes’ and the following day, ‘Mosquitoes very bad.’

Manton (1866:1) reported a ‘hurricane’ in December 1865, which destroyed Edmunds survey camp. Howard (1865:1) the commander of the schooner Beatrice showed extensive stands of bamboo on his map of the Adelaide River, opposite Middle Point. Buffaloes were not widespread on the coastal plains of the Adelaide and Mary Rivers during this period. However in March of 1866, Young (1866:8) reported that one of the settlers had found a large dead buffalo at Cape Hotham, which indicates that they had started moving into the region by then.

Settlement and Subsistence
Stuart commented that the rich country of the Adelaide-Mary River coastal plains apparently supported a large numbers of Aborigines, signs of whom became more
frequent as they approached the coast. 'Judging from the number of pathways from the water to the beach, across the valley, the natives must be very numerous; we have not seen any, although we have passed many of their recent tracks and encampments' (1863:408). Although they had seen no people since the Roper River, they also constantly reported the dry season fires of the Aborigines (1863:400,401,404).

A raiding party from the Escape Cliffs settlement reported a semi-permanent camp of about 200 people in the vicinity of Alligator Head on the Mary River in the late dry season of 1865 (Finniss 1865:3; Ritchie 1998:5). Edmunds (1865) while surveying 100 miles up the Adelaide River in September had frequent encounters and commented that 'the blacks appear to be rather numerous about here'.

There are indications that when McKinlay and Edmunds became stranded for six weeks by flooding on Marrakai Creek they may have interrupted a wet season ceremony when they encountered large groups of Aborigines. There is some suggestion that male initiation may have been involved (McKinlay 1866:7; Ritchie 1998:9) as Edmunds (1865) said that they were taking the 'children' away for an 'operation'.

The people were obviously in good health. Hutchison (1864:3), master of the vessel the 'Beatrice' surveying up the Adelaide River, reported the visit of 16 men, all over six foot tall who were strongly built and muscular (Ritchie 1998:5). Edmunds (1865) is also often admiring '...they were a splendidly built lot, tall and muscular...'. This is in contrast to a group of 59 people encountered at the headwaters of the Mary River two years later, whom the explorer McKinlay (1866:11) described as being 'poor, emaciated and half-starved wretches'. His surveyor Edmunds (1866) said '...they were the worst specimens I have ever seen, the younger ones and children had large scrofulous looking sores'. It may be that the people were already showing the effects of introduced disease. However, not only was the country in this region more marginal, the encounter occurred in April and the people may still have been recovering from wet season food shortages.

Edmunds (1865) and his surveying party received frequent visits from the Aborigines as they worked their way up the Adelaide River. Edmunds commented that there was a lot of fighting among them. Because of his success with treating their wounds, he gained a
reputation among them as a healer and became much sought after (Edmunds 19/9/1865). On 11 September 1865, Edmunds reported a group of 21 armed men visited the survey camp on the western side of the river opposite Beatrice Lagoon. They camped one and a half miles to the east of them on the floodplains. On 20 September 1865, 74 Aboriginal men armed with spears visited their camp. On 20 September 1865, Edmunds reported a visit from '39 natives apparently from another tribe from the east side of the river' (probably Limilngan) fearful of the local Aborigines. When the locals learned of their visit the following day, Edmunds and his party were given to understand that there was enmity between the two groups. Manton (1866:1) reported that Edmunds and his party left their survey camp in early December 1865. They returned to Escape Cliffs and some of the Aboriginal men followed them. At first they only visited the settlement, but by Christmas they had set up camp and in early February 1866 they moved their women and children there as well (Manton 1866:1; Young 1866:7). Manton commented ‘...this appears to be their season at Escape Cliffs for fishing and egg gathering [goose eggs] (1866:1)’.

New Aborigines kept arriving until by May 1866 up to about 200 Aborigines had visited the Escape Cliffs. Numbers fluctuated but as many as 150 were camped at or near the settlement, trading fresh food, labour and sex for desirable items from the settlers (Edmunds 1866; Ritchie 1998:5,6; Young 1866). Corroborees were held in February and March of 1866 (Young 1866:8). It appears that these people were a mixture of both Wulna and Larrakia, speaking distinct languages with the younger people being bilingual and the older people monolingual. There were frequent disputes in the camps and the settlement doctor Millner was often called upon to dress wounds (Young 1866:9). However it appeared that being on their own land, the Wulna were the dominant group.

When the settlement shifted to Port Darwin in Larrakia country in 1869, the Wulna lost their influence, and there followed a period of intense competition and conflict between the Larrakia and the Wulna for access to European goods (Ritchie 1998 7-8,12). By the mid 1880s this conflict had largely been resolved as the loss of population meant that the Wulna and Larrakia strengthened their ties through marriage (Ritchie 1998:23).

The explorer McMinn commented in January 1882 on the richness of the Adelaide-Mary River country, the large amounts of game to be obtained, the numerous people inhabiting
the area and the large number of camping places. He also reported a large camp at Lake Finniss on the eastern side of the Adelaide River (Ritchie 1998:17; Ritchie and Bauman 1991:14). In the early dry season of 1898, Dahl (1926:157-58) reported large numbers of Wulna camped on Marrakai Creek 30 km to the south of the study area, living mainly on local bush foods (Ritchie 1998:26).

Stuart (1863:404) (June-July) remarked about the coastal plains, just east of the Mary River, ‘...this seems to have been a favourite camping place for a large number of natives. There is a great quantity of fish bones, mussels and turtle shells, at a little distance from the camp, close to where there was some water...’

At Escape Cliffs, the settlers came to rely on seafood and other game supplied by the Aborigines (Ritchie and Baumann 1991:18). Young (1866:9,10) and Edmunds (1866) reported large quantities of crabs, fish and sea turtles arriving, ‘two hundredweights of small bream...240 pounds of salmon...130 pounds of turtle’. The fish were supplied right through the wet season and the dry season. In February and March 1866 geese eggs ‘which they collect from the numerous swamps about here’ were also provided ‘buckets full at a time’ (Manton 1866:1; Young 1866:7). A joint expedition between the Aborigines and the settlers was made to shoot fruit bats in February 1866. By early April, the Aborigines started leaving Escape Cliffs for up to two weeks to hunt (Young 1866:9).

In exchange for bush foods and labour the settlers supplied the Aborigines with rations of ‘bread and damaged flour, both of which articles they seem to highly appreciate’ (Young 1866:8). The flour was obviously valued as Young (1866:9) reported discontent when it was not supplied every day. They did not however seem to appreciate some items of European technology that were offered to them. Manton commented:

‘As to fish, the natives can get ten times as many as our people; they catch them by spearing and diving. Our mode of fishing with nets, hooks and lines, &c., the natives do not appear to think very highly of, for the fish hooks we have given them they appear to care very little about, and I have not heard of their ever making use of them to fish with’ (1866:1).
Swamps and lagoons were a focus of subsistence activities and provided a source of fish, geese, ducks, turtles, crocodiles and crocodile eggs, shellfish, and the roots of waterlilies and rushes (probably *Eleocharis dulcis*) (Foelsche 1882:12-14). Foelsche (1882:12-13) said that fish formed a large part of the diet and were captured in a variety of ways, including stunning them in waterholes with pounded bark (probably *Barringtonia acutangula*), netting and spearing. McMinn (1882) reported a network of fish weirs on his trip across the Adelaide and Mary Rivers to the Wildman River in January 1882.

On higher ground adjacent to the swamps and lagoons, wallabies, snakes, goannas and other small game were hunted. Snakes and lizards were killed with stones or sticks and grass fires were lit in the dry season to drive and capture game. Kangaroos were ambushed on paths to water (Foelsche 1882:13). Geese and ducks were taken by various methods. ‘Small sticks’ were hurled into flocks settled on the water, crippling them. Aborigines climbed trees and then threw sticks into flocks in flight. They crept up on them though the swamps camouflaged with lilies and grabbed them from under water. They also built small bell-shaped huts in the swamps, into which the geese were enticed with food and then captured (Foelsche 1882:13). 'Sugar bag' (honey of the native bee), yams and cabbage palm were also obtained in these areas. Small game was cooked whole over hot coals, while larger animals were dismembered and cooked the same way. Some species of yams were cooked in earth ovens with hot stones to leach them of poison (Foelsche 1882:13-14).

Foelsche (1882:12-13, 14) mentioned the widespread use of clubs and spears of great variety. He did not provide any detail except to say that some were made from solid wood and not propelled with woomerahs and stone spearheads were fixed to bamboo spear shafts with resin. Personal ornamentation was common and included sticks through the nasal septum, kangaroo teeth and ducks’ bills affixed to the hair with resin, white feathers in the hair, painted bark and grass belts, necklets and armlets (Foelsche 1882:14). Young (1866:8) reported the Aborigines at Escape Cliffs engaged in making baskets of ‘plaited grass’.

Explorers noted wells dug by Aboriginal people as they traversed the coastal plains of Chambers Bay to the north of Hope Inlet (Baker 1981:55-57). Records from the Escape
Cliffs settlement mention 'native wells' on several occasions (Finniss 1864:77; Young 1866:7). Baker (1981:56) comments that they all appear to be located on or near the coast, probably because of the lack of fresh water in such areas. Stuart, on the other hand, did not mention wells at all on his travels along the Mary River. Baker (1981:56) suggests that this was due to the fact that as Stuart was travelling in June-July surface water was probably still plentiful on the coastal plains, as Stuart himself described (see above).

The people of the Adelaide River were obviously adept with watercraft. Stokes (1846:423) reported that seven miles up the Adelaide River he ‘...met a party of natives...in a very pretty bark canoe, fifteen feet long, and about two deep. The bark was sewn together with much neatness, and it was altogether the most artistic piece of workmanship’. There were several reports of canoes from Escape Cliffs. ‘A bark canoe, about twelve feet long was also seen (merely a strip of bark of an oblong shape sewed together at the ends)’ (Hutchinson 1865:2). ‘Natives busy canoe building; their canoes are made of a sheet of bark neatly sewed together at each end' (Young 1866:8). At Escape Cliffs ‘The remains of a bark canoe were found close to the landing place, and there were evidences that in some places it had been curiously and ingeniously sewn with split bamboo’ (Territory of South Australia 1865:12). McMinn in 1882 reported Aborigines at Lake Finniss using both dugout canoes made from cottonwood and rafts made from sheets of paperbark tied together with vines and capable of carrying 10 to 12 people (Ritchie 1998:16-17). Foelsche describes bark canoes with ‘ends, instead of being bent up, are cut slanting and neatly sewed together with fine strips of bamboo, giving them a sharp stem and stern. The gunwhales are made of bamboo, thereby being nicely shaped. They are propelled through the water by small hand paddles at a great speed’ (1882:12).

A description comes from Edmunds (1865) of a man who had injured his hand and approached him for help as ‘a most intelligent and fine looking fellow wearing a bunch of white feathers over his forehead showing that he is superior to the others. He had his hand bound up in red pigment and some stinking fat’. McKinlay (1866:6) at Camp 14 on headwaters of the Mary River reported being given ‘a barbed fish spear, double, and two stone headed ones, with a womerah'.
Baker (1981:86) points out that the ethnography suggests that there were different types of shelters depending whether people were camped by the freshwater swamps or at the beach. He goes onto to say that the differences between the huts may relate to season. The beach type was used in the wet season for protection from rain and insects and the larger airier type at the swamps were used for shade (1981:87).

Stokes (1846:406) observed at Cape Hotham in 1839 (July) huts that ‘did not exceed five feet in height nor were they so substantially built; they were however, well thatched with the same kind of coarse grass. The entrances were carefully closed, except in one instance, when the aperture was so small that it was with difficulty I could crawl in.’

Hutchison (1865:2) at Escape Cliffs records ‘A few native wurleys were seen on the beach about 100 yards west of Charles Point. They were about six feet in diameter and three feet in height.’ Young (1866:8) reported that the Aborigines camped in ‘wurlies’ in the wet season, but did not describe them further except that they were ‘in a very primitive state’.

7.5 THE ETHNOGRAPHIC EVIDENCE 1900-1950

Environment
In 1946 the CSIRO surveyed the country between Darwin and Katherine, including the Adelaide River, with a view to assessing potential land use opportunities (Christian and Stewart 1953). It seems that environment remained much as it had fifty years before, with little development having taken place. Christian and Stewart reported that in their opinion ‘Over 100 years have elapsed since the first settlements in the north, yet vast areas remain unproductive and are still only sparsely populated’ (1953: Foreward). Large cattle stations and buffalo shooting on the coastal plains were the main industries in the region. There was some minor agriculture, mostly vegetables and peanuts. Mining, which had formerly been a major industry, was reduced to small-scale production (Christian and Stewart 1953:27).

Settlement and Subsistence
Basedow (1907:1) observed that during his travels in 1905, tribal distribution and territory appeared to be related directly to the extent of natural resources available. So, for
example, on the lower Daly River, which had extensive freshwater floodplains and billabongs teeming with as he put it 'abnormal game’, several distinct tribes were congregated in a relatively small area. The adjacent region to the west, which lacked such resources, supported only two tribes spread over an extensive area. He also observed that the original tribes south of Darwin, including the Warray who lived in the upper Adelaide River region had been greatly ‘disarranged’ by the presence of European and Chinese miners (1907:2).

Contact disrupted Aboriginal life, not only through introduced diseases but by people moving into land that was not theirs traditionally, creating conflicts with local groups. With the loss of key members of groups, strategies to deal with reduced population often involved people claiming land ownership based on language groups and recruiting members though mothers’ as well as fathers’ groups (Ritchie 1998:22). When the Northern Territory European economy entered a decline between 1890 and 1910, many Aboriginal groups returned to their own land, but brought with them members of other groups with whom they had been living (Ritchie 1998:36).

In 1907 Alfred Searcy, a government official, reported large numbers of Wulna camped near the old Humpty Doo homestead just north of Beatrice Hill (Ritchie 1998:26). In 1911, station diaries from Koolpinyah record people moving from Koolpinyah to Marrakai Station for a ceremony involving up to 200 people. These ceremonies were held regularly in the wet season (Ritchie and Baumann 1991:14, 23). This timing may have been a post-contact artefact as the Aboriginal people were busy with their station and buffalo camp duties throughout the dry season and the wet season was their 'holiday time' (Ritchie and Bauman 1991:52). The diaries make it clear that both Wulna and Limilngan people had established networks and were involved cooperatively in the ceremonies (Ritchie and Baumann 1991:23). In the buffalo shooting days, ties were formed with members of the Alligator Rivers groups who moved westward with the buffalo shooters and married into the Larrakia and Limilngan groups (Levitus 1982:14; Ritchie 1998:27).

Basedow (1907) described exploitation of similar resources and similar foraging strategies to those observed by Foelsche (1882). He also emphasised the importance of swamps and lagoons as resource bases. Magpie geese were captured in the swamps using
hides similar to those described by Foelsche. Imitating their calls lured both geese and ducks to their doom. Young crocodiles were caught from canoes (Basedow 1907:22). Fish were taken with nets, spears and shell or bone fish hooks, though metal hooks obtained through barter were already used widely in 1905 (Basedow 1907:23-26), overcoming the reluctance to use them reported by Manton in 1866. He described the common form of fish spears as being 'from ten to eleven feet in length, and consists of a single shaft of bamboo, tapered slightly at its thicker end, into which three slender, pointed rods of ironwood (or in semi-civilised tribes, fencing wire) are inserted, the attachment being tightly bound round with string' (Basedow 1907:25). Large fish were carried back to camp bound with loops made from reeds, the free ends of which were fashioned into a handle (Basedow 1907:25).

Kangaroos were hunted in the open woodlands and fire used to drive snakes, lizards and other small game (Basedow 1907:20-21, 27). Fruit bats were stunned with sticks as they roosted by day in bamboo and mangrove areas. They were then 'gathered and bitten...in the neck and the rump, by the hunters – in the former spot to kill, in the latter as a preliminary test of condition (Basedow 1907:21). Kangaroos were gutted and then placed with skin intact in pits on lumps of heated termite mound, covered with paper bark and then sealed with earth (Basedow 1907:27). 'Sugar bag' (honey of the native bee) was obtained using a long thin rod tied at the end with tassels made from vegetable fibre, which was then inserted into a tree and used to soak up ‘an appreciable amount of honey' (Basedow 1907:27).

Basedow (1907:30) describes the dome-like huts used as shelters from mosquitoes in infested areas. They were constructed using flexible branches as a framework, then covered with paperbark. They had four small entrances and a hole at the top to release smoke from the fire inside which also helped repel the insects. He also described armlets made from 'Reeds ... split longitudinally into long, thin strips, which are scraped into pieces of uniform breadth with stone knives' (1907:44). Shells of the land snail (Xanthomelon sp.) were used as a rasp in the manufacture of wooden weapons and implements (1907:49). Basedow also reported that a bivalve estuarine shell (Cyrena essingtonensis) was 'used in the final process of chipping stone spearheads and knives...For this final process, a fragment of quartzite or flint is often used...in the same
way as the shell' (1907:50). In 1914, people were regularly using canoes to travel from Humpty Doo to Marrakai Station over the flooded Adelaide River plains to attend wet season ceremonies (Ritchie and Baumann 1991:23).

7.6 THE ETHNOGRAPHIC EVIDENCE 1950-Present

Environment
The custodians have reported extensive changes to the Adelaide–Mary River floodplains in their lifetimes. Billabongs, previously used for fishing and gathering waterlilies, have silted up or become choked with exotic vegetation. They also believe that the channels of the Adelaide and Mary Rivers have become wider, which has been independently confirmed by the geomorphological evidence (Woodroffe and Mulrennan 1993). The extensive earthworks created on the western side of the Adelaide River for the rice farming experiments of the 1950s have altered some traditional sacred sites beyond recognition (Ritchie and Baumann 1991:11).

According to Tony Kenyon, both Middle Point and North Point used to be covered in monsoon rainforest rather than the pandanus vegetation of today. Smith (1981a) provided supporting evidence for a formerly wider spread distribution of monsoon rainforest in the study area. He noted a number of monsoon rainforest species growing on or around the mounds at Middle Point, and commented that they were out of context in the present day pandanus and open woodland setting. We also noted the presence of the sandpaper fig (Ficus scobina) on a number of the mounds at both North Point and Middle Point. On coastal plains this species is usually confined to monsoon rainforests (Brock 1988:189). Monsoon rainforest retreat has been a common phenomenon on floodplain margins of the Top End in the last century. It has been attributed to a number of factors, including late dry season uncontrolled burns following post-contact disruption to traditional firing regimes and cyclonic damage (see Chapter 2).

At North Point, Tony Kenyon said that the pandanus used not to be there and the whole area was covered in jungle. The lagoon at North Point has changed in Tony Kenyon's lifetime. It once contained permanent water all year round and the traditional custodians used to catch barramundi there. Now it has all but dried up by the middle of the dry season. Tony Kenyon said that mounds at the top of Middle Point also used to be located
in jungle rather than pandanus. There is a billabong out on the floodplains to the east of Harrison Dam, which is now mostly silted up, that the 'old people' used for fishing etc.

Insects remain problematic. Baker (1981:58) said that, having noted the rich resources of a mangrove creek at Point Stuart, he was wondering why there were no archaeological indicators of camps located on the banks. His question was answered at sunset when they were attacked by hordes of sand flies that drove him back to the vehicle for refuge.

Settlement and Subsistence
Today, the members of the Wairuk Association are permanently based at the Humpty Doo Station, part of their successful land claim. However, to this day, the people in the Darwin hinterland remain highly mobile (Ritchie 1998:xvii-xviii). Ownership of vehicles means that although they are now based in one place, they can travel regularly throughout the Darwin hinterland to visit their extended network of relatives to fulfil social and ceremonial obligations, for shopping and for work. The senior custodians frequently travel to traditional sacred sites for sacred site clearances, which are compulsory under the Northern Territory Sacred Sites Act (1989) before development can take place on non-Aboriginal land. There are also regular visits to favourite hunting and fishing locations where they may camp overnight. These trips constantly reinforce their ties with the land and guarantee the transmission of traditional social and economic knowledge to the younger generation.

Tony Kenyon said that when he was a boy, Wulna and Limilngan people used to camp together on the mounds at Middle Point and gather yams from the rainforest. There is a billabong (Reedy Lagoon) out on the floodplains near these sites that the 'old people', as he described them, used for fishing etc. People also used to camp to the south along the edge of the floodplains where Harrison Dam is now located. This area was surveyed but no sites were located there.

Tony Kenyon used to camp at North Point when he was a stockman on Koolpinyah Station. Remnants of the old stockyards are still visible. There is a large mound (NP21) adjacent to these stockyards. Tony Kenyon said the earth mound sites at North Point used to be campsites in the old days where Wulna and Limilngan people camped together. The
'old people' also used to camp out on the island in the middle of the floodplains (Adelaide River 1) to the east of the headland. Apparently the people used to walk out to the island along a sandy ridge and then down to a landing on the river. Remnants of this ridge can still be seen today on the floodplains and stone artefacts are located there (NP11). According to Tony Kenyon the rest of the ridge has since been washed away. The people then moved down to a landing on the river where they crossed to the other side at low tide. Since then the river has cut a deeper channel that permanently holds deep water, and the river can no longer be crossed at that point. Felix Holmes, a senior Limilngan man, has described himself making the same trip returning to his country on the Mary River by canoe from Koolpinyah Station at the beginning of the wet season (Ritchie and Baumann 1991:52). Tony Kenyon also described a journey he used to make as a young man from the western side of the Adelaide River across the Mary River at Shady Camp.

According to Tony Kenyon, the 'old people' also used to walk across the floodplains on the old beach ridge on the west side of North Point and camp on the higher ground at Koolpinyah Station for two or three years at a time. Felix Holmes said that the southern part of Black Jungle Swamp was a major hunting ground in the past.

The Dreaming paths of the Wulna/Limilngan today suggest a flow of information from east to west (Ritchie and Bauman 1991:41-46). Because of the inundation for six months of the year named places (sacred sites) tend to be located on areas of high ground (Ritchie and Bauman 1991:39).

Custodians today report a regular seasonal round of collecting goose eggs in the wet season, barramundi in channels on the floodplains in the late wet season, the corms of spike rush (Eleocharis dulcis) from mud on the swamps’ edges mid dry season, spearing barramundi trapped in ever-diminishing pools in the late dry season, turtle hunted by poking the mud with digging sticks, and magpie geese also hunted in the late dry, and goannas and wallabies at other times of the year (Goodfellow 1993:48; Ritchie and Bauman 1991:14, 57-58). Other items still collected include file snakes, lilies, long yams, round yams, and 'sugar bag' (Ritchie and Bauman 1991:60-61).
while the younger ones were bilingual, the enmity between the people of the eastern and western sides of the Adelaide River, and intense competition between the Wulna and Larrakia over access to European goods. However depopulation forced the people to make new alliances. The later ethnography shows that the Wulna of the Adelaide River had particular contacts to the east with the Limilngan people of the Mary River. These people were linked through traditional networks that were constantly reinforced by ceremonial activity. The Dreaming paths of the Wulna/Limilngan today suggest a flow of information from east to west.

The ethnography highlights the seasonal round of foraging activities. Clearly lagoon and swamp margins were seasonally the focal points for subsistence on the coastal plains of the Adelaide and Mary Rivers. The dry season was the main time when the floodplains were productive, especially the late dry season when fauna was concentrated around diminishing water sources. Alternative resource bases, such as monsoon rainforest and open woodland, were exploited during the wet season when many floodplain resources were flooded or dispersed. The early ethnography suggests that there may have been some movement of the population to the coast at that time as fish were plentiful and easily caught. However, people moved back to the swamps for the goose egg harvest in the late wet season.

The people of the Adelaide River used technology that was obviously well adapted for the exploitation of floodplains and adjacent resource zones. Spears, nets, hooks and poison were widely used to catch fish. Waterbirds and bats were felled with sticks. Kangaroos were speared and fire used to drive other woodland game. Grinding hollows and pestles were used to pound wet season fruits. Well-made canoes were used widely to transport people and to hunt and fish on the wetlands. Shelters were built to escape the torments of mosquitoes in the wet season and to provide shade in the dry season. Wells were dug to access water when it was scarce in the late dry season.
7.8 CHANGES IN PRE AND POST-CONTACT SETTLEMENT PATTERNS AND SUBSISTENCE STRATEGIES

In this last section I will compare the archaeological and ethnographic models. The ethnographic model has emphasised changes in environment, settlement patterns and subsistence strategies. However some things have remained the same, for example the marked seasonality of the climate and the flooding regime, which affected the resource base and influenced foraging strategies. Firstly I will revisit the archaeological model outlined at the end of the previous chapter, arranged according to the themes used to analyse the ethnography. As stated at the beginning of this chapter the ethnography can only be compared with the archaeology of the Freshwater and Contact Phases.

**Environment**
The early ethnography confirmed the productivity of the environment, as suggested by the establishment of multiple archaeological sites along the floodplain margins in the Early and Late Freshwater Phases. Not only could it support large numbers of Aborigines camped together at one time, it also easily accommodated the needs of the European colonists.

The interpretation of the archaeology of the Contact Phase is confirmed by the ethnography. The ethnographic model has highlighted changes to the physical environment. Uncontrolled late dry season burns and cyclones were probably responsible for the retreat of monsoon rainforest on the edge of the floodplains, as observed by the custodians. The post-contact impact of feral animals, the spread of exotic weeds and man-made earthworks all adversely affected the productivity of the floodplains. However, it is also true to say that some of the changes on the floodplains were part of a natural process that would have happened in any case. Although these changes were probably accelerated by post-contact factors, they also have relevance for the Early and Late Freshwater Phases. The physical landscape may not have been as stable as previously argued for these phases. Micro-environments within both the floodplains and on the Koolpinyah surface may have been in a constant state of flux, affected by natural processes such as
sedimentation and cyclones. These natural alterations to the landscape have implications for settlement patterns in the Early and Late Freshwater Phases.

**Settlement and Subsistence**

Peterson (1973:185-86) noted that for the people of the Arafura Swamp, a large freshwater swamp in central Arnhem Land, availability of water is the prime determinant of campsite location. The ethnography suggests that the existence of nearby lagoons on the floodplains of the Adelaide River was the rationale for the location of sites at Middle Point and North Point, and equally for their abandonment when the lagoons silted up in the Contact Phase.

The early ethnography was not specific about residence at Middle Point and North Point, although it seems that people who probably used those sites visited Edmunds frequently during his 1865 dry season survey, especially when he was camped opposite Beatrice Lagoon. However, it does suggest that the lower Adelaide and Mary River coastal plains generally supported large numbers of people. This representation agrees with the archaeological model of a high population resident in the Late and Early Freshwater Phases. The archaeology showed high levels of discard in the Contact Phase (cf Figure 4.39), which supported the evidence of the early ethnography that there were numerous people using the area. There were perhaps even more people present than formerly, attracted by what the Europeans had to offer. However, the later ethnographic record emphasizes depopulation as the effects of disease and changing settlement patterns kicked in, which is not reflected in the archaeological evidence.

The early ethnography implies that at contact the population was highly mobile, which conforms to the archaeological model of high residential mobility for the Late Freshwater but not the Early Freshwater Phase. The later testimony of the custodians confirmed that the sites at North Point were used in the Contact Phase, as the archaeological evidence demonstrated for NP20. The nature of highly mobile settlement for the Contact Phase suggested by the archaeological evidence is consistent with the ethnography that indicates the sites were used only fleetingly, the main focus of residence having shifted to European settlements and pastoral stations. The ethnography also states that the Middle Point sites were occupied in the recent past. The archaeological assemblages at Middle Point
contained no contact material, but this may have been a consequence of the fleeting nature of occupation in the Contact Phase. The effect of environmental change in the Contact Phase means that these sites are no longer used, but alternative places are still used today.

As both Peterson (1973) and Altman (1987:25) have pointed out, the seasonal factor in monsoonal Australia is the key determinant in campsite location, types of residential groups, mobility and subsistence activities, whether now or in pre-contact times. Wulna territory extended along the floodplains of the Adelaide River to the coast. The movement of the people who followed Edmunds down the river to Escape Cliffs and then camped there in the wet season of 1865 suggests that this may have been a regular seasonal relocation. If such was the case, seasonal occupation of the Adelaide River floodplains sites, as suggested by the archaeology of the Early and Late Freshwater Phases, is confirmed.

The movement of chert, tuff and ochre from the eastern to the western side of the Adelaide River suggests that connections to the east were established from the Transition Phase onwards. The Dreaming tracks of the Wulna/Limilngan mythological beings flow in the same direction and may be the abstract expression of the more mundane trade in stone and could be of equal antiquity.

There are also hints of well-defended territorial boundaries to the east in their enmity towards the people on the eastern side of the river, and to the west in their vigorous defence against Larrakia access to European resources at Escape Cliffs. This is not consistent with the archaeological model that suggests regular contact to the east in the form of non-local stone supplies in the Early and Late Freshwater Phases. Nor is it consistent with the later ethnography that indicates close ties between the eastern and western sides of the Adelaide River in terms of shared Dreaming tracks, marriage and residence. However, the two models are not mutually exclusive. What may be at issue is territorial boundaries and control of resources. The fact that average weight of non-local stone increased in the Late Freshwater Phase perhaps suggests a movement of territorial boundaries. If territorial boundaries had moved closer, supplies of non-local stone through trade and exchange may have been more accessible. The archaeology of the Late Freshwater Phase also suggests that the sites were occupied more frequently post 630
years BP. The tight territoriality implied by the early ethnography may be a direct result of more people wanting to use to the productive landscape of the lower Adelaide River. This reason would also explain the movement of territorial boundaries and improved access to non-local stone. This idea will be explored further in the discussion of regional archaeology in the following chapter. In the Contact Phase previously operational alliance networks may have been stretched to breaking point by demands of access to the Europeans and their highly desirable assets, as suggested by Ritchie (1998) for the Daly River. It may also be the case that former interactions and sharing of resources were sanctioned by formal arrangements such as joint ceremonies, and casual incursions onto each others’ land were not tolerated. The later ethnography suggests that this conflict was resolved by depopulation, which forced the Wulna to extend traditional alliance networks, and the spread of European settlement, which allowed regular access to European goods.

As the location of the sites and the archaeology of the Early and Late Freshwater Phases suggest, the ethnography confirms that subsistence strategies were focussed seasonally on the freshwater floodplains. The ethnography emphasised the seasonal abundance of the freshwater floodplains. It suggested that alternative foraging strategies on the coast and in open woodlands and monsoon rainforest were employed in the wet season when the floodplains were otherwise unproductive, apart from the goose egg harvest in the late wet season. The ethnography stressed the importance of waterbirds and their eggs in the diet, which the archaeology did not demonstrate. However, it must be concluded that waterbirds were also a major focus of exploitation in the pre-contact past and that taphonomic factors explain the absence of their faunal remains.

The archaeology of the Freshwater and Contact Phases has shown that stone was an important part of the material culture on the lower Adelaide River. The ethnography provides little information about the use of stone but has supplied a wealth of information about other aspects of the material culture, including the importance of the use of plants. The archaeology can only hint at these aspects. The existence of grinding tools suggests that grinding was an important activity throughout the Freshwater Phases; pounding wet season fruits is one explanation offered by the ethnography. However confirmation of other explanations can only be provided by usewear and residue analyses. The ethnography confirms that ochre was used as a decorative and trade item. Although there
are very few of them, the silica polish on flakes may be the result of stripping reeds to make armlets.

The ethnographic analysis has been able to confirm some aspects of the archaeological interpretations of the Freshwater and Contact Phases, and hints at other explanations, which must remain speculative. The archaeological model for the Contact Phase was essentially confirmed by the ethnography. Aspects of the archaeological model for the Freshwater Phases, such as the location of sites and seasonal mobility, were also confirmed. However, it was possible only to speculate at an explanation for the change from low to high residential mobility between the Early and Late Freshwater Phases. This result serves to emphasise that contact altered pre-contact systems so thoroughly that the use of ethnographic models as a tool in archaeological explanation is mainly valid only for the Contact Phase, as concluded by Gregory (1998). The following chapter will summarize the evidence for settlement patterns on the Adelaide River and place it in a regional context.
CHAPTER 8: THE ADELAIDE RIVER IN REGIONAL PERSPECTIVE

8.1 INTRODUCTION

The archaeology of the Adelaide River floodplain sites allows a fresh regional perspective on floodplains settlement and subsistence in other regions of the Top End. In this chapter I will review the archaeological evidence for settlement and subsistence patterns in other floodplain areas in the mid to late Holocene period. The questions that have been raised about floodplains and earth mound sites in this thesis, namely settlement patterns, residence, seasonality, resource use and subsistence strategies, also concern studies of other floodplains systems in northern Australia. These factors were affected by changing conditions on the floodplains from the mid to late Holocene period. During the Big Swamp Phase the floodplains were tidally inundated. Consequently the distribution of mangrove species and fauna was strongly regulated by tidal influence. During the Transition Phase, a mosaic environment of freshwater and estuarine areas existed on the floodplains. In the Freshwater Phases, the annual cycle of wet and dry became a crucial influence on the distribution of resources. During the wet season the freshwater floodplains are inundated. During the dry season they slowly dry up, although water may remain in the backwater swamps until the next wet season. This hydrology had a profound effect on regional distribution fauna and flora. I will compare the evidence from other regions with that from the Adelaide River and seek explanations as to why there appear to be differences in settlement strategies between areas that are both similar environmentally and close geographically in the Freshwater Phase. While the interpretation of the archaeology of all these areas is linked to the evolution of the floodplains, the differences between settlement patterns on the various river systems make it clear that no single model of human response to environmental change fits all floodplains occupation. I will use the regional perspective to suggest explanations of settlement patterns on the Adelaide River that are otherwise not readily explicable.
8.2 A SUMMARY OF THE EVIDENCE FROM THE ADELAIDE RIVER

Earth Mounds

Evidence of occupation along the Adelaide River comes mainly from earth mound sites. At the beginning of this thesis, a number of themes were raised in relation to earth mounds as a site type, including location, chronology, morphology, origins, function and their role as part of a wider settlement system. The rationale for the location of the Adelaide River earth mounds appears to be environmental. They are situated adjacent to the floodplain margins on natural rises, which provided well-drained, breezy positions in an environment that was seasonally inundated and infested with biting insects. They were also at the junction of a number of resource zones, including open woodlands, monsoon rainforest and, in the Big Swamp Phase, close to coastal resources. They were occupied continuously over a period of 4000 years until the recent past, during which time there was considerable environmental change on the floodplains. The mounds were either round or oval in shape and ranged from 38 m to 112 m across and from 0.6 m to 1.23 m in height. The Adelaide River earth mounds are cultural in origin and were built up through repeated occupation. Megapode nest-building seems an unlikely explanation for the origin of the earth mounds. Those mounds that were excavated contain cultural material throughout and their dates are in sequence - criteria that Mitchell (1993:183-4,190) used to distinguish humanly constructed mounds from megapode mounds. The abundance and diversity of the stone raw materials and faunal remains suggest that they were base camps. Throughout their history foraging strategies were focussed on the floodplains with minor exploitation of woodland fauna. In the Big Swamp Phase, it is possible that the earth mounds were occupied year-round as the availability of estuarine resources is related to tidal inundation rather than season. It is not possible to assess length of occupation in the Transition Phase, as there was a variable mosaic environment of estuarine and freshwater resources on the floodplains during this phase. In the Freshwater Phase, it was argued that occupation was seasonal. There are a number of reasons for this conclusion. The earth mound sites are located next to ephemeral lagoons on the high floodplains, which have all but dried out by the middle of the dry season. Freshwater floodplain resources, although highly productive, are only available seasonally. In the wet
season these resources are dispersed and there is no evidence among the faunal remains for floodplain resources that are specific to the wet season. In the late dry season the floodplains adjacent to the sites were dry and cracked. Drinkable water would have been scarce and it would have been impossible to procure turtle and fish, which made up the majority of the faunal remains from the Freshwater Phases. So it was concluded that the optimum period for occupation of the earth mound sites was in the early to mid dry season when water was still plentiful on the floodplains and in the lagoons. There was some suggestion in the literature that earth mounds may also have played a role as cultural markers of territory. Although the Adelaide River ethnography does not mention earth mounds, it demonstrates that people on the Adelaide River own land and control access to resources (cf Ritchie and Bauman 1991). So it is possible that in the past the mounds functioned not only as camping places but also as territorial markers. Although earth mounds were the major site type in the region, they formed part of a wider, more complex settlement system. This system included other site types on the floodplain margins, such as artefact scatters, quarried rock outcrops, wells, pounding hollows and contact sites, as well as sites in woodland locations, eg artefact scatters, quarried rock outcrops, axe grinding grooves and pounding hollows. The lack of bird bone in the faunal assemblages of the earth mounds also suggests that there are processing sites dated to the Freshwater Phases that have gone undetected.

**Settlement Patterns and Mobility Strategies**

The oldest earth mound site (HD1) on the Adelaide River was occupied during the Big Swamp Phase c. 4000 years BP, when *Rhizophora* mangrove forests dominated the floodplains. There is no direct analogue today for this kind of environment. For example during the Big Swamp Phase, the mangrove forests on the South Alligator River covered an area 30 times larger than those occupying estuaries there today and three times larger than in Darwin Harbour, currently the largest stand in the Northern Territory (Woodroffe *et al.* 1988:101). Therefore the nature of foraging strategies in this phase has been extrapolated from present-day environments that contain elements of the system. The subsistence effort would have focussed on the estuarine resources of the floodplains. Year-round residence was possible because the resources were available year-round and affected more by tidal inundation than by season. Some marine resources may also have been exploited at that time, as the study area was located close to the coast, but the
evidence has not demonstrated this. Fresh water would not have been available on the floodplains but would have been obtained from wells on the margins of the floodplains and in lagoons in the adjacent open woodlands. Availability of freshwater would have been crucial in the late dry season, as the lagoons are seasonal. Stone, such as quartz and quartzite, was available locally. As the mangroves created a barrier to the east, other stone resources were obtained from the south and west. It was concluded that residential mobility during the Big Swamp Phase was relatively low as the floodplains were highly productive during this phase and other subsistence requirements were available nearby. The lack of sites representative of this phase is probably due the fact that they have been obscured by the build-up of mud on the floodplains.

Following the retreat of the mangroves, the floodplains entered a Transition Phase when they consisted of a mosaic of estuarine and freshwater floodplains. This phase has been dated to c.3900-2000 years BP. It was concluded that during this phase foraging strategies were diversified to cope with the changes in the resource base. As a result residence became more mobile. The floodplains were still the focus of the subsistence effort at the earth mound sites. However the overall discard rate of faunal remains decreased during this phase, while the discard rate of woodland fauna increased. At the same time, the way to the east was opened up with the retreat of the mangroves and connections were made to the east where other desirable resources, such as chert and sandstone were located.

In the Early Freshwater Phase beginning c. 2000 years BP freshwater conditions were established on the floodplains and were the focus of foraging strategies. Multiple sites were established along the margins of the floodplains at Middle Point. Freshwater was available from lagoons on the floodplains adjacent to the mound sites. Connections to the east were maintained and intensified with increasing quantities of chert, tuff and sandstone entering the sites. Local stone sources were also used more intensively. The discard rate of faunal remains increased. It was concluded that the highly productive resource base meant that residence once more became less mobile. However, as the freshwater floodplains were seasonally productive, settlement remained seasonally mobile. The late dry season was the most productive time on the floodplains when resources became increasingly concentrated on diminishing water sources. There were relocations to other areas, perhaps to the coast, in
In the Contact Phase, the discard rate of both stone and fauna decreased. For a variety of reasons, the Adelaide River earth mound sites were gradually abandoned in the Contact Phase, from c. 1860 onwards. Although freshwater conditions persist to this day, the floodplains have become less productive due to the impact of feral animals, the invasion of exotic weed species and man-made earthworks on the western side of the river. The region in general became depopulated through the effects of introduced diseases and the drift of the population towards non-Aboriginal settlements. The custodians still reside locally but hunt and fish elsewhere on the floodplains as the lagoons next to the sites have silted up and can no longer be used as they were in the past.

8.3 AN OVERVIEW OF MID-LATE HOLOCENE SETTLEMENT AND SUBSISTENCE PATTERNS ON THE TOP END COASTAL PLAINS

The rivers of the Northern Territory of Australia share a similar geomorphic history. During the post-Pleistocene sea level rise, down-cut river valleys in northern Australia were drowned. The various river systems of northern Australia responded differently to this event. Some, like Darwin Harbour, became deep-water embayments. Others through processes of sedimentation formed widespread *Rhizophora* mangrove swamps. Continued sedimentation built the substrate higher and *Avicennia* replaced *Rhizophora*-dominated forests on the floodplains. Following further sedimentation and coastal progradation the tidal influence was restricted and the floodplains entered a transitional phase of estuarine and freshwater swamps interspersed with saline mudflats. Wet season rains ponded behind the chenier ridges and in the late Holocene formed the vast freshwater swamps that dominate the floodplains today. This scenario is common to the major river systems draining the coastal plains of the Top End, although the rivers themselves may be at different stages of evolution (Chappell 1988; Clark and Guppy 1988; Woodroffe and Mulrennan 1993; Woodroffe *et al.* 1993).

While there are similarities in the development of the northern rivers, Chappell (1988:52,54) has pointed out that there are also differences. Not all the rivers in the region have changed in the same way as the South Alligator. There is a spectrum ranging from the Adelaide
River, which has a highly sinuous course and a very low rate of channel migration, through to the Daly River which has a highly mobile channel in which meanders cut off and reform continually. However all probably flowed through sinuous meandering channels while their floodplains were forming, c. 5000 BP, and subsequent changes depend largely on catchment sizes and specific floodplain and tidal river systems.

The South Alligator River has the largest catchment and the Adelaide River has the largest estuarine plain (Woodroffe et al. 1993) (Table 8.1, Figure 8.1). The forms of their estuaries also differ. The South and East Alligator Rivers flow freely through funnel-shaped estuaries into the Van Diemen Gulf, while the estuary of the Adelaide River was diverted between 3500 BP and 2300 BP, and that of the Mary River is blocked (Woodroffe et al. 1993:267, 271). The South Alligator River, Magela Creek and Mary River all have perennial backwater swamps. However flooding on the Adelaide River floodplains is shallow and relatively short-lived, and areas of perennial swamp are much smaller compared to floodplains on river systems further east (Kingston 1991:32).

In Kakadu, as for the Adelaide River, it was discovered that the occupation of the floodplain margins was linked closely to the evolution of the landscape. The timing of these events on the South Alligator River and the Magela Creek was different from that for the Adelaide River. The Big Swamp Phase lasted from c. 6800-5300 years BP. Freshwater clays were being deposited from c. 4000-4500 years BP on the lower South Alligator River (Woodroffe et al. 1988:102). On the middle reaches of the South Alligator River the Freshwater Phase was dated to c. 1370±70 BP (Hope et al. 1985:235). However, the latter date is considered to be a minimum one (P. Hughes pers. comm.). On the Magela Creek the Big Swamp Phase lasted about 5000 years, from 8000 to 3000 years BP, and the Transition Phase lasted around 1700 years, from 3000 to 1300 years BP (Clark and Guppy 1988:680-81). The Freshwater Phase was established between 3000 and 4000 BP, but not widespread on the lower reaches until between 1300 and 1700 years BP (Clark and Guppy 1988:680-81; Clark et al. 1992; Nanson et al. 1993). The floodplains of the Daly River have a similar evolutionary timing as the South Alligator, though the formation of the freshwater floodplains has not been dated (Chappell 1988). On the Mary River, radiocarbon results show that the Big Swamp Phase
was established by c. 7000 years BP and lasted till c. 4000 years BP. The establishment of freshwater conditions was not dated (Woodroffe et al. 1993:269).

**The Big Swamps**

Western Arnhem Land is the only other region that contains floodplain occupation sites dating back to the Big Swamp Phase. These sites are located in rockshelters in outliers of the Arnhem Land plateau on the floodplain margins of the East Alligator River (Nawamoyn, Malangangerr, Ngarradj Warde Jobkeng and Arguluk) and Magela Creek (Malakunanja II and Paribari) (Allen 1996; Allen and Barton 1989; Kamminga and Allen 1973; Roberts et al. 1990; Schrire 1982). They contain middens dated between 7000 and 3000 years BP, which were comprised of mangrove and mudflat crabs and shellfish, fish remains and bone points. The shellfish species present *Nerita, Cerithidea, Terebralia, Telescopium, Cassidula, Ellobium* and *Geloina* sp. indicate that mangrove and mudflat zones were exploited. Along with the mangrove species, there were also the remains of barramundi and catfish and freshwater fish and turtle showing tidal channels and freshwater lagoons were exploited, along with the mangroves (Allen and Barton 1989:104; Allen 1996:198). Allen (1996:198) concluded that the landward edges of the mangrove forest were exploited rather than within the mangrove forest itself, as the majority of crab remains were of *Sesarma* sp., which inhabits tidal channels rather than the large mangrove crab, *Scylla serrata*.

Allen (1996:198, 201; Allen and Barton 1989:104) made the point that the mangrove forests of the Big Swamp Phase would have presented a formidable barrier to movement and settlement. Access to the river channels and the coastal plains would have been impossible. The distribution of sites during the Big Swamp Phase in Kakadu reflects this situation and is consistent with Allen and Barton’s prediction that ‘Seasonal movement and sites would have been restricted to the plateau valleys, the plateau margins, and the lowland corridors between the tidal floodplains’ (1989:104).

During the Big Swamp Phase, occupation of the coastal plains of western Arnhem Land was not limited to sites along the floodplain margins. Hiscock and Mowat (1993), Mowat (1995) and Woodroffe et al. (1988) have investigated shell mounds at the mouths of the South and
West Alligator Rivers. Variability in species composition between mounds was linked to the formation of mounds at different times and reflects changing environmental conditions along the coast in the mid to late Holocene (Mowat 1995:154, 163). Mowat (1995:163) concluded that the coastal areas were not abandoned as conditions changed, but rather the inhabitants adapted their foraging strategies accordingly. During occupation between 4000-5000 years BP, the mounds would have been located on beach ridges close to the sea. Some West Alligator mounds from this period are dominated by *Anadara*, and others by species such as *Marcia* and *Circe*, which indicate that the occupants were exploiting open mud and sandy beaches extant in the mid-Holocene (Mowat 1995:154-55). *Anadara* dominated the South Alligator mound (KH2) dated to this period (Mowat 1995:116; Woodroffe *et al.* 1988:97). Hiscock (1999) concluded that the existence of shell mounds from different areas indicates widespread foraging along the coast at this time.

Along the coast at Point Stuart on the mouth of the Mary River, Baker (1981:79), on the basis of geomorphological investigations, inferred a date of 4500 years BP for a midden located on a chenier ridge. In the lower levels *Telescopium* and *Crassostrea* dominated the midden. These estuarine species inhabit stands of *Rhizophora* mangroves, which were extant on the floodplains during the Big Swamp Phase.

**The Transition Phase**

In western Arnhem Land rockshelter sites on the floodplains margins continued to be used in the Transition Phase. However there was a change in the shellfish composition of the middens. *Telescopium* and *Geloina* species that had dominated the lower levels of the middens declined and *Cerithidea* sp. became much more common (Hiscock 1999:94-95; Schrire 1982:233-34). *Telescopium* prefers a *Rhizophora* mangrove habitat, which dominated in the Big Swamp Phase. Similarly *Geloina* is likely to be more abundant in *Rhizophora* forests where it is found along small streams. *Cerithidea* can be gathered in large numbers from the trunks of *Avicennia* and *Bruguiera* mangroves, which survive in drier conditions, and replaced *Rhizophora* at the end of the Big Swamp Phase in Kakadu (Hiscock 1999:95-96). At the same time, settlement patterns changed and the floodplains themselves were occupied. The sites were in the form of shell mounds close to the lower
South Alligator River where mangroves still grew along the tidal channels. The mounds were comprised of the mangrove species *Cerithidea*, *Nerita* and *Meretrix* (Woodroffe *et al.* 1988:97).

On the basis of radiocarbon dates from the tops of the midden deposits in Ngarradj Warde Jobkeng and Malakanunja II, Allen (1987:6-7; 1996:199; Allen and Barton 1989:105-106) concluded that the accumulation of estuarine middens in northern Kakadu ceased with the decline of the big swamps, and that the rockshelters were abandoned c. 3000 years BP. Hiscock (1999:96) argued that the timing for this model of abandonment may be too rigid and that at the rockshelter of Paribari accumulation of midden deposit continued for sometime afterwards. Dates from Paribari indicate that midden layers containing estuarine shell were forming c. 3000 years BP when Ngarradj Warde Jobkeng and Malakanunja II were being abandoned, which suggests local shifts in settlement and subsistence according to the increasingly mosaic environment on the floodplains in the Transition Phase (Hiscock 1999:96). Hiscock further suggests that settlement may have shifted away from the escarpment and floodplains to the coast, which was rapidly prograding and probably productive during the Transition Phase (1999:97).

Scotch Creek is a tributary of the Adelaide River, which flows in from the eastern side of the floodplains. Scotch Creek I is an open site located next to a deep and permanent freshwater billabong located in open woodland two to three kilometres south east of the main floodplains (Map 3.1). In 1980 Smith (1981a, 1981b; Smith and Brockwell 1994) excavated a test pit and located cultural remains in a layer of black soil between 60-70 cm in depth above a clay substrate. A horizon of stone points located 10-15 cm above the clay substrate was dated to c. 3000 at and therefore to the Transition Phase (Smith 1995; Smith and Brockwell 1994:91). It was argued that the age of the site was no older than 4000 years as there are no mangrove shell present (Smith and Brockwell 1994:93). The site has been occupied repeatedly since then (Crassweller 1996:1). There were stone artefacts and faunal remains throughout the excavation (Smith and Brockwell 1994:91). The animal taxa present include macropods, bird, freshwater turtle and fish (the only identified species being *Arius* sp.). The proportions of taxa to each other indicate that macropod was always a relatively more important taxon than at the Adelaide River floodplain sites (Crassweller 1996:78).
Crassweller (1996:78) argued against wet season occupation at the site, as it is regularly flooded. The presence of catfish also suggests dry season occupation as they return to the estuaries to spawn in the wet season. It was concluded that the site was used as a base camp to exploit the main floodplain and that manufacture and repair of stone artefacts took place there.

Guse and Majar (2000:34) recorded earth mounds located on relict chenier ridges as part of a wider survey of the Finniss/Reynolds/Daly Rivers biogeographic region. It appears that these earth mounds are caps of dark humic soil overlying a midden layer of edible shells, mostly of *Anadara*. Shell from the midden layer has been dated to c. 4000 and c. 3500 years BP and the site appears to have been occupied continuously since then (Guse and Majar 2000:37). The presence of *Anadara* suggests that when the sites were established, the occupants were exploiting the resources of an open sandy coastline.

**The Freshwater Phase**

Most sites occupied after the formation of the freshwater floodplains are open sites located on the floodplain margins dating to post-2000 BP. Detailed investigations of these sites have been carried out on the South Alligator River (Brockwell 1983, 1989, 1996b; Guse 1992; Hiscock 1996, 1999; Hiscock *et al.* 1992; Kamminga and Allen 1973; Meehan *et al.* 1985), East Alligator River and Magela Creek (Allen and Barton 1989; Bowen 1996; Kamminga and Allen 1973; Schrire 1982), and Mary River (Baker 1981; Guse 1992). These investigations have revealed some intriguing differences in settlement patterns. On the Magela Creek and East Alligator River, deposits containing freshwater fauna are mostly found in rockshelter sites. On the South Alligator River occupation is in the form of large artefact scatters along the floodplain margins that have little depth of deposit. They contain numerous stone artefacts made from a wide variety of local and non-local raw materials and virtually no organic remains. On the higher areas adjacent to the floodplains there are a small number of earth mound clusters. In the open woodland behind the floodplains there are small artefact scatters containing only one or two lithic raw materials. On the edges of the Mary River freshwater floodplains, there are only artefact scatters rather like those on the South Alligator, no earth mounds and no open woodland sites. The data from the Adelaide River
earth mounds has allowed a fresh perspective on the archaeology of freshwater floodplains in the Top End.

In northern Kakadu, small amounts of freshwater fauna on the surface of middens provides some indication of reoccupation at Ngarradj Warde Jobkeng, Malakanunja II, Nawamoyn and Malangangerr in the Freshwater Phase c. 1000 years BP. However it is only the rockshelter Paribari on the Magela floodplains that is firmly linked to the freshwater period post-1500 BP through large amounts of the freshwater bivalve *Velesunio*. Bowen (1996:155-7) carried out a number of systematic and purposeful surveys across the Magela Creek floodplains. His surveys also covered adjacent open woodland and 'mixed scrub'. He established that, apart from the rockshelters, sites were generally lacking in this area. Only two sites, both open artefact scatters on the floodplain margins, contained artefacts in any abundance (Bowen 1996:176-88). Kamminga and Allen (1973) previously recorded one of these sites. Allen and Barton (1989:106) mention that some small earth mounds also occur in the vicinity of the floodplains sites, but do not state how many.

Thus three site types can be identified for the Magela floodplains; open sites, earth mounds and rockshelter sites. Rockshelter occupation on the Magela Creek can be attributed to the proximity of the escarpment to the floodplains in the northern sector of Kakadu. The differences in settlement patterns between the Magela and South Alligator systems is the paucity of floodplain sites dated to the Freshwater Phase on the Magela, despite the similarities between their resource bases. While acknowledging the differences between settlement patterns on the South Alligator River and the Magela Creek floodplains, Bowen (1996:195) does not offer any overt explanations, apart from hinting that it relates to the availability of perennial water sources.

On the South Alligator River floodplains settlement tends to occur in a strip pattern on headlands that jut into the freshwater floodplains. These sites are flooded in the wet season. They consist of open scatters of artefacts up to a kilometre in length with a high diversity of stone artefact types and raw materials (Brockwell 1989; Kamminga and Allen 1973:10-17; Meehan *et al.* 1985). One of the sites, Kina, includes an earth mound with freshwater
mussel shell (*Velesunio*). A date of 280±140 BP was obtained 20 cm above the base of the deposit (Meehan *et al.* 1985:152). The surface sites had no datable material. However, because of their association with the freshwater floodplains, it was concluded that these sites were occupied after the establishment of the freshwater conditions on the floodplains opposite Kina, which was dated to a minimum of c.1400 BP (Hope *et al.* 1985:235; Meehan *et al.* 1985:152). Earth mounds littered with stone artefacts were also located at two sites on higher ground adjacent to the freshwater floodplains (Brockwell 1989:158-62; Meehan *et al.* 1985:126-7).

Meehan *et al.* (1985:119,121,123) concluded that the South Alligator floodplains open sites were occupied at different times during the dry season and used for different activities according to resource availability. Brockwell (1983, 1989; Brockwell *et al.* 2001) concluded that the differences between the mound sites and the open sites on the South Alligator River floodplains reflected different seasonal occupation. While site distribution and ethnographic evidence suggested that the floodplain margins were occupied year round, the large open sites were probably dry season base camps, while the earth mounds were occupied during the wet (Brockwell 1983:72-4, 1989:293; Brockwell *et al.* 2001:377-76).

Subsequent surveys located surface scatters of stone artefacts, mainly quartz flakes, in the open woodland behind the floodplains (Hiscock *et al.* 1992; Guse 1992). These are mostly quartz quarrying and knapping sites. For this reason they often have a high density of artefacts, but are generally substantially smaller than the floodplain sites, have fewer stone artefacts, and a smaller range of artefact types and raw materials (Guse 1992:92-3). Hiscock *et al.* (1992:86) concluded that the existence of these sites demonstrated a more complex settlement system in the floodplain areas than was revealed by the work of Meehan *et al.* (1985). Using definitions supplied by Thomas (1989:86), Guse (1992:66) interpreted the floodplain sites as being 'long term residential areas' exploiting the floodplains resources. The open woodlands sites he described as 'logistic encampments' and 'diurnal use' sites that people used for specific activities, such as quarries and knapping sites (Guse 1992:93). Hiscock (1996:156) concurred with this assessment of low residential mobility along the floodplain margins and higher mobility at the woodland sites. He based his conclusion on the fact that the bipolar technique, which is a more economic method of producing flakes, is
an indicator of low mobility among populations. Bipolar cores occurred more frequently at the South Alligator floodplain sites than in the woodland sites.

The surveys on the South Alligator River defined three classes of sites; open sites on the floodplain margins, earth mounds on the higher ground adjacent to the floodplains, and open sites in the woodlands. The earlier surveys located eleven sites associated with the floodplains, and six earth mounds in two clusters on higher ground adjacent to the floodplains (Brockwell 1989; Brockwell 2001; Kamminga and Allen 1973:10-17; Meehan et al. 1985). Guse (1992:78) located eight additional floodplains sites and eleven in the open woodlands.

Guse (1992) conducted surveys adjacent to the freshwater floodplains of the Mary River to use as comparative evidence for the settlement patterns revealed on the South Alligator River floodplains. The surveys revealed thirteen sites, all open artefact scatters, located on the floodplain margins in various ecological niches that included river levees, black soil plains and permanent water. No sites were located in the open woodlands adjacent to the floodplains (Guse 1992:94). Guse (1992:94) concluded that, on the Mary River, settlement was focussed mainly on the floodplains as there were no sites located in the open woodland, and that these open sites reflected both long term and short term activities.

At Point Stuart at the mouth of the Mary River, Baker (1981) recorded many different site types including middens, earth mounds and lithic scatters. The majority of sites were located on beach ridges (Baker 1981:68). Although not dated, Baker (1981:77) suggested that many of these sites are likely to be much younger than the ridges. Chenier building ceased in the Adelaide-Mary River region c. 3000 years BP; Therefore they are likely to belong to the Freshwater Phase, especially those midden sites capped with earth, which are very similar in description to sites described by Guse and Majar (2000) for the Reynolds River (see below). Three of the earth mounds that are composed entirely of earth with no shell appear to be located at the junction of the freshwater floodplains and are likely to belong to the Freshwater Phase. Baker (1981:77-78) interpreted wet season habitation of the beach ridge sites, based on their location on the landward side of the beach ridges that are exposed to
insect-dispersing winds. He concluded that the occupants obtained availability of freshwater available between the dunes and foraged on fish and shellfish.

Although the upper level of Scotch Creek was not dated; Crassweller (1996:96) assigned it to the Freshwater Phase. She concluded that people still used the site frequently but for shorter periods of time as they moved out onto the main floodplain to take advantage of the newly established resources there (1996:97-98). She related changes in the stone assemblages from the Transition Phase to a greater reliance on plant material (1996:98). The changes in proportions of faunal material indicated an increase of turtle and bird in the upper level, and a decrease in macropod (Crassweller 1996:80). If the bird remains represent freshwater species, these changes could be related to a greater reliance on freshwater fauna coincident with widespread freshwater conditions on the main floodplain. Crassweller (1996:98) suggests that occupation may have been confined to the late dry season when other areas were stressed. The presence of permanent water would certainly account for extra bird life at this time. Scotch Creek may represent an alternative site that was occupied on the seasonal round of the Adelaide River people when the resources around the floodplain sites were no longer productive.

Middens containing *Anadara* shell are located on the eastern side of Darwin Harbour and around Hope Inlet. Dates indicate that they started to form c. 1500 years BP and ceased accumulation c. 700 to 1000 years ago (Bourke 2000, in press; Burns 1994; Hiscock 1997). The presence of *Anadara* indicates foraging along open sandy beach fronts. Today the same areas of Darwin Harbour and Hope Inlet mainly support mangroves. Hiscock (1997:448) suggests that sites were abandoned c. 700 years BP and that this was related to an environmental change that led to a transformation from open sandy beaches to the expansion of mangrove forest. One possibility he (1999:99) suggests is that the occupants switched from coastal foraging and relocated to sub-coastal areas. Bourke (2000) on the other hand suggests that the Darwin Harbour people merely shifted locally to alternative coastal sites that have yet to be dated. The evidence of increased occupation of the Adelaide River mound sites supports Hiscock's interpretation of relocation from coastal to sub-coastal areas.
Today many of the chenier ridge earth mounds dated to the Transition Phase are located close to the freshwater floodplains of the Reynolds River on the coastal plains in the western portion of the Northern Territory (Guse and Majar 2000:35) (Map 1.1). As occupation of these sites was presumed to be continuous, the cap of dark humic soil overlying the Anadara middens can be linked to occupation following the establishment of the freshwater floodplains. Guse and Majar (2000) also recorded earth mound sites along the lowland/floodplain margins of the Reynolds River. In contrast to the earth mounds located on the chenier ridges, there was no shell in these mounds. They were located close to the resources of the freshwater floodplains within 500 metres of large freshwater billabongs or river channels (Guse and Majar 2000:34). This location is similar to that of the earth mounds of the Adelaide River and South Alligator Rivers. Although the analysis is only preliminary, two of these mounds have been dated within the last 1000 years with a marked increase in occupation after 600 years BP (Guse and Majar 2000:37). Again this result is similar to the results from the Adelaide River.

8.4 DISCUSSION

The Big Swamp Phase

The Adelaide River sites can be seen to fit into a general pattern of foraging that existed right across the coastal plains at the end of the Big Swamp Phase. The difference is that occupation was in the form of earth mound sites, rather than rockshelters, as there are no outliers close to the Adelaide River. Along the edge of the floodplains of the major rivers in the north, exploitation strategies were focussed on resources of the mangrove forests, although there was local variation according to the availability of resources. A range of other resources from the open woodlands and freshwater lagoons supplemented this diet. It is likely that this pattern of foraging had been in place since the establishment of the mangrove forests on the floodplains c. 7000 years BP, following the post-Pleistocene marine transgression. Exploitation of mangrove areas would have added to a previous strategy of exploitation of woodlands flora and fauna (Allen 1996:198; Hiscock 1999:94), with riverine exploitation in the down-cut river valleys. Any such riverine sites are now obscured by the Holocene infill of the floodplains. Settlement was concentrated along the floodplain margins in rockshelters in escarpment outliers in western Arnhem Land and in open sites in areas that lacked escarpment. In contrast to the Freshwater
Phase, seasonality was not such an issue as mangrove resources were available year round, influenced more by tides and the storms of the wet season rather than seasonal inundation. The mangrove forests however represented a barrier to movement across the rivers. On the western side of the Adelaide River area access to non-local resources was to the south or south west as the coast lay immediately to the north in the Big Swamp Phase. Rockshelter sites in the Litchfield escarpment, some 70 km to the south-west, contain evidence of occupation that dates to the mid-Holocene (Guse and Majar 2000). Sandstone, which was among the non-local stone resources found at the Adelaide River sites, is available from that region. Given that I have argued for low residential mobility among the Adelaide River people during the Big Swamp Phase, this evidence implies that some kind of alliance/trade network operated between the two groups.

On the coast, settlement was in the form of shell middens on beach ridges containing species foraged from open sandy and muddy beaches. Although no such sites have been recorded for the coastal portion of the Adelaide River, it is highly likely that they exist, given their presence in similar situations on the Mary, West Alligator and South Alligator Rivers.

The Transition Phase

With the retreat of the mangroves in the Transition Phase, the floodplains opened up and a mosaic freshwater and estuarine environment came into existence. It is likely that, although species diversity on the floodplains was high, the resources were not predictable and therefore subsistence and settlement strategies were adjusted accordingly. Floodplain resources were still exploited but there was an increased reliance on other environments. Foraging strategies became more broadly based and residence became more mobile. New sites were established on the floodplains themselves to take advantage of mangrove resources that had retreated to tidal channels. The full extent of this strategy cannot be estimated, as it is likely that many sites have been obscured by ongoing floodplain accretion during the Transition Phase (Allen 1996:199; Hiscock 1999:97). New sites used as bases to exploit shellfish and fish were also established along the actively prograding coastline. Neither site type has been located on the Adelaide River. However, it is likely that midden sites on the floodplains have been covered with mud and chenier ridge sites are yet to be located. Crassweller’s (1996) analysis of the Scotch Creek assemblages demonstrated that
this open woodland site, located away from the floodplain margins, was used more frequently during the Transition Phase. The woodlands remained a stable and predictable resource base through the Transition Phase of the floodplains. The faunal analysis from Scotch Creek showed that foraging strategies were based on woodland fauna as much as fauna from the billabong (Crassweller 1996).

It is likely that the end of the Big Swamp Phase and the beginning of the Transition Phase had profound economic and social consequences for the inhabitants of the coastal plains. Settlement strategies were reorganized, which no doubt required an adjustment to territorial organization. With the retreat of the mangrove forests, access to the rivers and lands beyond became possible and new resources became available. The presence of chert, tuff and sandstone from the east at the western Adelaide River sites implies that connections to the east were established in order to gain access to these resources. These connections may have been in the form of extended alliance networks with the people from the eastern side of the river. If so, it is likely that this was a region wide phenomenon and that extended alliance and trade networks may have opened up across the coastal plains of the Top End.

**The Freshwater Phase**

The beginning of the Freshwater Phase heralded a new era of floodplain occupation. The rich and abundant resources of the freshwater floodplains meant that the floodplain margins once more became a regional focus for occupation and many new sites were established. However the seasonal nature of resource availability also meant that occupation was of necessity seasonally mobile. The availability of these new resources and the new settlement patterns again implies that territorial organization would have been affected. The freshwater floodplains were capable of supporting large numbers of people on a seasonal basis. However, negotiation in some form would have been required with the owners of these areas to gain access to the resources.

Base camps on the floodplains were the focus of settlement for the Adelaide River, Mary River, South Alligator River and the Magela Creek in the Freshwater Phase. However within this generalisation, it is clear that the settlement patterns are different for each river.
(Brockwell 2001). The South Alligator River has a significant number of woodland sites, while the Magela, Mary and Adelaide systems have none or few in open woodland. The Magela Creek floodplains lack sites generally and the Adelaide River is dominated by mound sites. What can account for this variability of settlement patterns on the floodplains in the Freshwater Phase, all of which are similar ecologically? The explanation may lie in the scale of the comparison, which is at a macro-level. At this level, the freshwater floodplains may seem similar. At a micro-level landforms and stream flow and therefore habitat, biology and vegetation render them very different and may account for variation in social and settlement patterns.

Although we are looking at the same phase of development for all rivers - the Freshwater Phase on the floodplains - this event was not necessarily synchronous on individual rivers, as their floodplains became fresh water at different stages. On the lower South Alligator River, Woodroffe et al. (1988:101) say that freshwater floodplains may have been extant as long ago as 4000 years BP. They base this conclusion on the fact that there are very few radiocarbon dates on mangrove remains in Big Swamp mangrove mud after this date and that one of the middens containing estuarine shell was overlying freshwater clays. However, this situation could equally represent the mosaic environment of the Transition Phase on the lower reaches of the river. The Freshwater Phase has a minimum date of 1400 years BP on the middle reaches of the South Alligator (Hope et al. 1985:237) but may have been established earlier (P. Hughes pers. comm). This event is dated to c. 1650 BP on the Magela Creek (Clark et al. 1992:47), c. 2000 BP on the Mary River (Woodroffe and Mulrennan 1993:61). It has not been dated directly on the Adelaide River. However, faunal remains from earth mounds on the edge of the Adelaide River floodplains link these sites to exploitation of freshwater wetlands. They are mostly dated to within the last 2000 years.

Hiscock (1999:99) suggests that, even though the environment may have been broadly similar to today over the last 1500-2000 years, changes have continued to occur at a local level, adaptations to which are reflected in the archaeological record. In western Arnhem Land where the South Alligator and Magela systems are located, he suggests a coastal focus of settlement from 1500 BP to 700 BP, based on dates from coastal Anadara middens (Hiscock and Mowat 1993; Mowat 1995). Subsequently, environmental changes led to the
disappearance of these resources. Hiscock (1999:99-100) suggested that between 1000 BP and 700 BP the subsistence focus may have shifted to sub-coastal resources on the floodplains of the river, for which the relatively recent date of 280±140 years BP from Kina on the South Alligator River (Meehan et al. 1985:152) fits well. However, the pattern seems to be different on the Adelaide River where the earth mounds from the freshwater phase date from c. 2000 BP. In this light, the evidence from the South Alligator River may be reassessed. Jones (1985:292) concluded that the South Alligator River floodplain sites were no more than 1000 years old. He based this conclusion on the minimum date of c. 1400 years BP for the establishment of the freshwater floodplains on the middle reaches of the South Alligator River and a date of c. 300 years BP at the adjacent site of Kina (Hope et al. 1985:235). However, it may be that the freshwater floodplains were in place earlier as dates from the lower South Alligator River suggest (Woodroffe et al. 1988:101). If this is the case the South Alligator floodplains sites may have a similar antiquity to the Adelaide River sites.

Environmental explanations for site distributions include arguments based on seasonality of occupation, and differences in site use and mobility strategies linked to the availability of water and other resources. Meehan et al. (1985:119,121,123) argued that the South Alligator floodplains open sites were occupied sequentially during the dry season as the swamps dried out and were used for different activities according to resource availability. Brockwell (1983:72-4, 1989:293) concluded that the mound sites represented wet season occupation.

Guse (1992:8) suggested that environmental factors explain the broad differences in site size, site artefact density and artefact assemblage composition between sites on the South Alligator and Mary Rivers. He proposed that the availability of raw material resources and utilisation of certain food resources might be responsible. As a result of his surveys on the South Alligator and Mary Rivers, Guse (1992) constructed a model of Aboriginal subsistence/settlement patterns that could be applied generally to floodplain utilisation, similar to that proposed by Brockwell (1996). He suggested that floodplains use was year round (1992:96-97). Wet season occupation was restricted to floodplains margins while goose eggs were harvested and geese taken during the laying season. At the same time there would be a dispersal of groups into other environmental zones, like the open woodlands, while other floodplains resources were either flooded or dispersed. There would be more
intense occupation of the floodplains during the dry season especially late in the season when diminishing water sources would concentrate water birds and the geese were fat from a season of eating *Eleocharis* spp. and wild rice, carbohydrate sources also exploited by the humans.

Guse (1992) predicted that the archaeological signature of this pattern would be large open sites on the floodplains margins, close to sources of avifauna and plants. These sites would contain 'low average artefact density, high richness in artefact and raw material types and large total numbers of artefacts' (Guse 1992:97-98). Sites in the open woodlands would be smaller and contain higher densities of artefacts, reflecting stone procurement and manufacture of artefacts in these areas, as well as single use sites such as grinding hollows. Artefact and raw material type richness in these sites would be low, as would be total artefact numbers. Site frequency would be similar for both floodplains and open woodlands (Guse 1992:98).

Surveys on the floodplain margins of the Adelaide River and in the open woodlands, however, revealed quite a different pattern of occupation. The sites were located mostly next to the floodplains and conformed to Guse's (1992:97-8) description of 'high richness in artefact and raw material types'. But mound sites rather than artefact scatters dominated and they have a high artefact density as well as high total numbers. The diversity of artefact types and raw materials indicate that they were base camps. In the Freshwater Phase, the faunal remains suggest exploitation of both floodplains and open woodland. So the mound sites could have been occupied on a year-round basis (Brockwell 1996:56-7; Schrire 1968). However, the dominance of freshwater fauna suggests a mainly dry season focus.

Rowland (1994:155-6) is firmly convinced that mounds occur in areas of high biomass where there is a non-linear distribution of resources. On the other hand, linear distribution of resources will result in a pattern of linear occupation, such as continuous middens along open coastlines. It is also true that northern Australian mounds, whether of shell or earth, appear to be located at the junction of different resource zones (Bailey 1977; Baker 1981; Beaton 1985; Bourke in press; Burns 1999; Cribb 1986; Guse and Majar 2000; Meehan
Peterson (1973:186) assigned a seasonal role to earth mounds from his observations of the movements of a group of people at the Arafura Swamp. The mounds were located on the edge of the floodplains at the base of a plateau containing monsoon forest and open woodland, and close to pools of water that persist well into the dry season. He noted that,

'Each area where the mounds are located is one where it is desirable to camp when the streams on the plateau have stopped running but where the ground is either flooded or remains muddy and damp under foot for several months. By the height of the dry season all the clusters of mounds are high and dry with no water close by' (1973:186).

In the case of the South Alligator and Adelaide River mounds, they are all located at the junction of the floodplains and the open woodland. From an examination of topographic maps, it appears also that the mounds located on the South Alligator River (Brockwell 1989:158-62; Meehan et al. 1985:126-7), the Magela Creek (Allen and Barton 1989:106) and the Adelaide River are located adjacent to seasonal high floodplains rather than permanent swamps, usually beside a lagoon or old river channel. I think therefore that in northern Australia earth mound sites fulfil a definite late wet/early dry season functional role. If this is the case, it is also possible to make a prediction that they will be found in specific locations, along the margins of freshwater floodplains adjacent to a water body, at the junction of a number of resource zones.

Cultural explanations for settlement patterns on the floodplains in the Freshwater Phase include population expansion, demographic shifts and increased sedentism. Bowen alluded to a cultural explanation when he said that, in contrast to the South Alligator floodplains, site distribution on the Magela floodplain 'suggests that environmental bounty was not the only factor influencing the spatial organisation of Aboriginal people' (1996:206). But he does not elaborate on this point.

In southern Australia, Williams (1988) argued that earth mound sites in southwestern Victoria, found in similar topographic circumstances to those in northern Australia, were the
result of social rather than environmental change. She concluded that mound-building was not only an environmental adaptation associated with exploitation of swampy areas but also linked to changes in social networks which led to increases in production and allowed more sedentary occupation of sites and a consequent increase in population (1988:220-1).

Hiscock (1996) argued that low residential mobility on the South Alligator River freshwater floodplains was one of the reasons for variability between stone assemblages from the floodplain and woodland sites in the late Holocene. Jones argued that the increase of sites along the South Alligator River post-1000 BP signalled an increase in the population of the region overall. However he cautioned against explanations such as 'intensification' and said that environmental evidence such as the seasonal abundance of resources on the adjacent floodplains should be considered as well (Jones 1985a:294). Lourandos (1996:86), a proponent of 'intensification' himself, acknowledged that the model was not designed to be tested on unstable coastal landforms for the very reason that it was too difficult to separate environment from other factors. Rowland (1994:156) argued against mounds being indicative of population growth or intensification, though he did not discard either theory entirely. He also pointed out that it is still difficult to resolve whether mound sites are the result of repeated occupation over a long period or intense occupation over a short period. It may be a case of the latter at the South Alligator River mound site of Kina that is dated to c. 300 BP (Meehan *et al.* 1985:147-52). However it seems that is a case of the former with the Adelaide River where some mounds have dates spread over a 2000-year period.

Hiscock (1999:100) argued the case for changes in demography in response to the appearance of the freshwater floodplains. He maintained that increased settlement of these areas post-2000 BP was merely the result of a relocation of population from elsewhere, rather than a uniform increase of population throughout the region. He cited the case of Bayview Haven on Darwin Harbour where there was an intense period of coastal occupation, in the form of *Anadara* shell middens, from 1500 BP until 700 BP (1999:99). Subsequently mangroves colonised the open beaches, which led to the demise of the *Anadara* beds. Roberts (1994:185) reported a similar situation for coastal sites at Milinginmbi. *Anadara* beds were established c. 1500 years BP and exploitation of the species ceased several hundred years ago. Roberts (1985:185) concluded that the decline of *Anadara* was due to
environmental change or over-exploitation of the species. The fate of the inhabitants is uncertain. Hiscock (1999:99) suggested that they may have moved to sub-coastal resource areas, such as the lower Adelaide River. There did indeed appear to be an expansion of occupation post-630 years BP there, as Guse and Majar (2000:37) have also proposed for the Reynolds River. Whether this was as a result of increased productivity of the environment or a general demographic shift from coastal to sub-coastal areas post 700 years BP is impossible to say. However if there was a population increase in the region, there are implications for territorial organization. The fact that not only did the discard rates of bone and stone at the Adelaide River sites increase, but the size of non-local stone increased at the same time, perhaps hints that borders had moved closer. Jones (1990:32-34) has argued that an increase of population does not necessarily imply a change of social structure just a tighter packing of clans into smaller spaces, which may be what was observed ethnographically at contact on the Adelaide River.

8.5 CONCLUSION

This chapter has demonstrated that settlement and subsistence strategies on the Adelaide River are similar to those of other coastal plains in the Big Swamp and Transition Phases. However it has also highlighted the differences in settlement patterns between the Magela Creek and the South Alligator, Mary and Adelaide Rivers in the Freshwater Phase. A closer examination of the environment has indicated that, despite broad similarities between the floodplains post-2000 BP, there are a number of spatial and temporal factors that may have influenced settlement strategies. Catchment and floodplain size and subsequent hydrological regimes have created microenvironments or sub-regions on individual rivers that have affected resource distribution. Even though the archaeology under consideration is contained within the freshwater phase of the last 2000 years, these microenvironments have not necessarily remained stable, and there have been local environmental changes that have affected each river system individually. Additionally, although the development of the floodplains was broadly similar, the chronology of these changes is different for different systems, for example the freshwater phase began earlier on the Adelaide and Mary than the South Alligator River and the Magela Creek. Topographic differences may also have been responsible for different types of occupation. The earth mounds under discussion are all
associated with discrete seasonal water bodies located adjacent to the high floodplains, which dry out early in the dry season, whereas the open artefact scatters exist adjacent to perennial backwater swamps. Therefore earth mound occupation may be associated with swamp resources that are distributed in a compact non-linear way, as suggested by Rowland (1994:155), whereas open artefact scatters are the type of occupation associated almost exclusively with linear distributions of resources along permanent swamps. If such is the case, it may be that earth mounds and open artefact scatters are merely different topographic expressions of the same phenomenon of swamp exploitation. This model would explain the absence of large open artefact scatters on the Adelaide River floodplains, which lack the vast perennial backwater swamps of the South Alligator River. However, I think that the explanation goes further than this. Repeated early to mid dry season occupation of raised dry ground adjacent to freshwater swamps would have led to the build up of mounds. As the dry season progressed people would have abandoned the mounds and relocated closer to the retreating water, now able to camp anywhere on the dried out floodplains. The open artefacts scatters along swamp edges are the archaeological expression of this late dry season settlement strategy. I have argued against wet season occupation of mounds. Freshwater floodplains fauna are not easily accessible in the wet, mosquitoes and sandflies abound and the faunal remains lack eggshell, which would firmly link the sites to wet season exploitation of goose eggs.

How much the differences in settlement patterns in the Freshwater Phase were a result of cultural factors is unclear. 'Intensification' has been an argument used particularly in relation to mound occupation in southern Australia. However, as pointed out by various authors, the creation of the freshwater swamps was sufficient reason for an expansion of occupation, not necessarily preceded by social and/or technological changes. Population growth as an explanation is also difficult to demonstrate, and site expansion on the floodplain margins post 2000 BP and later again post 630 years BP may simply be a result of population relocation that reflects locally changing resource bases.

The model of floodplains settlement that emerges from these regional studies is one of sedentary dry season occupation of multi-purpose base camps located on the edge of the highly productive freshwater floodplains. It is possible that occupation of the lower
Adelaide River region was year round, with the resources of adjacent open woodland and monsoon rainforest being exploited in the wet season when the floodplain resources were flooded or dispersed. However the sites that were found in the open woodland indicate high mobility, being either single purpose or short term encampments. Woodland base camps on the eastern side of the river are lacking and where people resided at this time is unclear, although wet season relocation to the coast has been suggested for the Adelaide and Mary Rivers. Although I have previously argued for wet season occupation of the earth mound sites in western Arnhem Land (cf Brockwell 1983, 1989; Brockwell et al. 2001), faunal evidence was not available from these sites. Therefore I think this model can be revised, in the light of the Adelaide River evidence. I have argued that the earth mound sites at the Adelaide River are early to mid dry season base camps because of their location and the nature of the stone and faunal assemblages. However, the archaeological expression of this settlement model may differ regionally, according to the factors discussed above, all of which must be considered when reconstructing patterns of floodplains settlement in northern Australia (Brockwell 2001).
APPENDIX 1

SITES ON THE LOWER ADELAIDE RIVER RECORDED PRIOR TO THE PRESENT STUDY

<table>
<thead>
<tr>
<th>Site ID</th>
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Key: 1= Cultural deposit; 2= Stone artefact scatter; 5 Quarry other; 19= Earth mound; 32= Grindstone portable; 33= Grinding hollow non-portable
### APPENDIX 2

#### 1993 ADELAIDE RIVER ARCHAEOLOGICAL SITE RECORDS

<table>
<thead>
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<td>Middle Point 4 (MP4)</td>
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<td>Earth Mound</td>
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