Between the Desert and the Gulf:
Evolutionary Anthropology and Aboriginal Prehistory in the
Riversleigh / Lawn Hill Region,
Northern Australia.

Michael Jon Slack
Bachelor of Arts (Hons), University of New South Wales
Master of Arts, The Australian National University

Thesis submitted for the degree of Doctor of Philosophy
Department of Archaeology
School of Philosophical and Historical Inquiry
The University of Sydney

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"Having mastered the capacity to cross water, the true barrier to the colonisation of the Australian continent lay not in the occupation of the tropical north but in the ability to establish and maintain human settlement in the arid country to the south" (Jones 1987:666)
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Part of this work has been published elsewhere:


Parts of this work have been presented in reports and at national and international conferences:

submitted in whole or in part for any other degree. The work of other researchers has been acknowledged. This thesis has not been declared that the work in this thesis is the result of my own research and all references to

DECLARATION

Queensland Australian Archaeological Association Conference, Brisbane, NSW.

Stack, M.J., Fuller, R., Field, J., and A. Bocket, 2003, Ice Pleistocene settlement in northern

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ABSTRACT

This thesis applies an evolutionary approach to the regional prehistory of the Riversleigh/Lawn Hill region of Northern Australia. The research examines (i) the timing of colonisation of Australia and (ii) the nature of subsequent arid zone settlement and adaptation. Both of these research concerns are addressed through development of a regional settlement and subsistence model that is based within an overall framework of evolutionary theory and specifically from various models used by Human Behavioral Ecology (HBE). Using this approach this research presents new regional archaeological data and develops (i) a new model of north Australian Pleistocene settlement relating to Lake/Gulf of Carpentaria and (ii) an evaluation of competing models of Aboriginal subsistence during different climatic phases, with a specific focus on the Last Glacial Maximum (LGM).

The model of settlement and subsistence for the study region sets out expected responses of hunter-gatherers to large scale climatic changes over the last 40,000 years. These expectations are evaluated by quantifying changes in the nature of flaked stone technology, and in the frequency and range of faunal remains in archaeological sites.

I argue that climate change forced modifications to hunter-gatherer behaviours that are evident in the archaeological record. Significant behavioural changes occurred during the LGM, and included refuge occupation along the Gregory River, specialization in resources of low rank and conservatism in lithic reduction strategies. During improved climatic conditions, residential mobility increased, and subsistence expanded in range to include more high ranked resources, and lithic reduction altered to include new forms. Similar

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models of human behavior.

Theoretical shifts to local scale studies that can continue to regional and more general

a valuable methodology for examinations of the archeological record, providing

environmental record is needed, the functional approach of Human Behavioral Ecology is

The results of this research show that although further research concerning the paleo-

chronologies.

HBE approach, and an emphasis on developing detailed local and regional archeological

1989, 1993). The bio-geographic model used in this thesis stresses the importance of the

reduced occupation of the Ganges River corridor, but probably not the Ganges. The

combination of Australian and bio-geographic model of 1GM settlement that included

The results of this thesis support a short 40,000 - 45,000 year chronology of Aboriginal

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more subtle changes in settlement and subsistence are also critical during the early and
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Chapter 1

Introduction

1.1 Introduction and background

This thesis examines the human settlement of the Riversleigh/Lawn Hill region, northwest Queensland, Australia. It presents the results of excavation and analysis of eleven archaeological sites, including two rockshelters excavated and previously reported from Lawn Hill (Hiscock, 1988). There are two aims to this thesis. The first aim is to provide new data that aids in addressing two important questions in Australian prehistory: (i) when did people arrive in Australia and (ii) what was the timing and nature of the colonisation of the inland areas of the continent. The second aim is to determine whether evolutionary theory, as applied to archaeological data, can provide a useful interpretive framework for investigations involving long time depth.

1.2 Research Questions

1.2.1 Colonisation of Australia

Most researchers agree that initial human arrivals in Sahul (greater Pleistocene Australia) occurred in the north of the continent (see Allen et al. 1977). However, opinion is divided as to how, and by what routes, people colonised the continent: a northern route through New Guinea, or from the north west through the islands of Indonesia and Timor (Birdsell 1975, 1977; Bowdler 1977; Irwin 1992; Allen and O'Connell 1995; O'Connell and Allen 1988, 2004). Different colonisation routes may signify different material cultures and adaptation strategies for colonising populations. For example, colonisation from Timor is often argued to have been made by people with a coastal economy (see Chappell 1993, 2000, Pardoe 2006). The alternative route through New Guinea and then south into
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Introduction

discussed are remote.

associated with early occupation might be present in these hilly environments, the chances of his
of exposed parent rock. They have since been hillyd, and while a varied climate
which are well vescenste with savannah grassland and resource rich, were vast and mostly devoid
was the Gulf of Carpentaria. The shores and surrounding landscape of the Gulf

The research model formulated for this study explores a colocation zone from New

compelling evidence for early human settlement in this region (Hiscox 1984a, 1988).

However, Coles Creek Cave, 200 km inland to the south of the Gulf, has provided

No early sites are known surrounding the shores of the Gulf of Carpentaria

she on this northern route: Mungnahiline Cave in north eastern Queensland (Davies et al

around the shores of the Gulf of Carpentaria. Currently there is only one archaeological

Llewellyn13; Biddle 2000; Birdsall et al 2001; Roberts et al 1990; B.

Northwestern and northern Australia, including Carpenters Gap, River, and

supported by the growing number of reported Late Pleistocene archeological sites in

Recent research has paid most attention to the southern migration route which is

Australia. In the Carpentaria Plain, did not necessarily require the same marine adaptive
A number of sizeable freshwater rivers feed into the southern reaches of the Gulf of Carpentaria including the Nicholson, Gregory and Leichhardt Rivers. These rivers may have provided corridors for human settlement within rich riverine environments (after Veth 1989, 1993).

The study area is well placed to provide insights into the timing of colonisation, the routes taken and the technology transported into Australia. The geology and topography of the region is known to support the preservation of suitable occupation sites and previous studies have highlighted the potential of the region to yield lengthy cultural sequences (i.e. Hiscock 1984a, 1988).

### 1.2.2 Settlement of the Arid Zone

Whilst there is strong archaeological evidence that humans penetrated what is now the most extreme arid regions of the continent by about 40,000 years ago (Bowler et al. 2003; Grun et al. 2000; Roberts et al. 1996; Smith and Sharp 1993; Smith et al. 1997, 2001), the timing and nature of subsequent settlement is still hotly debated (see Hiscock and Wallis 2005). The antiquity of arid zone occupation is less of an issue, than the mode of settlement, particularly during the Last Glacial Maximum (LGM). There are a number of competing models of human settlement and subsistence for the arid zone, but none have been conclusively resolved (e.g. Hiscock 1988; Hiscock and Wallis 2005; O'Connor et al. 1993; Smith 1988, 1989a, 1989b; Thorley 1998a, b, 2001; Veth 1989, 1993).

Three competing models for arid zone occupation have been proposed to account for settlement since colonisation: (i) continual occupation; (ii) fluctuating occupation; and (iii) a bio-geographic model. The primary difference between these models relates to the nature of occupation of the arid zone during the LGM. Was the arid zone occupied continuously, was it abandoned, or was there a pattern of occupation intermediate between the two that occurred, with expansion and contraction from refuge areas? Three locations have been
northern Australia is necessary built upon the stone artefact record.

...This is important as the archaeology of
and anthropological signatures (Murphy 2002). Evolutionary processes are
underpinned by understanding the study of flaked stone artefacts; their production, use
models need to be developed to explain the feasting of past behaviours that may be invisible. Evolutionary
provides a strong basis by which to distinguish behaviour in the archaeological record.

specific events (O'Connell and Birn 2006). The evolutionary theoretical background
arguments explain processes that operate universally rather than being confined on
functional rather than historical explanations of past human behaviour. Functional
chronology of considered time - depth. The strength of the approach is that it uses
COSPORE and PIRO-TAP 2002, 2004), but only COSPORE is included in a recent
Recent archaeological studies in Australia have applied the evolutionary theoretical

...evolutionary theory is developed to explore unique and patterns of occupation.

Chapter 1

Research Approach

Caparrubian, where refuge occupation is most likely to be found. Research focuses on the permanent homing areas of the southern Caparrubian
of O'Connell and Birn 2002; Smith 1998; Veth 1999). To further test this proposal the
refuge occupation occurred during the LGM (see Hiscock 1988; Hiscock and Willcox 2005).
The south-western Gulf of Caparrubia Region has been proposed as a region where
Caparrese 2003; Marwick 2004, 2005). The sites have often been interpreted differently by researchers (e.g. Brown 1987;
The Australian Pleistocene archaeological record includes relatively few sites, with few opportunities for the development of substantial theoretical models, and yet generalisations have often been made across the entire continent. Examples include the broad application of a “core tool and scraper tradition” (see Bowler et al. 1970; Bowdler 1981; Bowdler and O’Connor 1991; Dortch 1977; McCarthy 1964, 1967; Smith and Cundy 1985; but also see Clarkson and David 1995; Hiscock and Attenbrow 2002), simple colonisation models (e.g. Bowdler 1977), and simplistic notions of human causality in megafaunal extinctions (Jones 1968, 1969, Flannery 1994; Roberts et al. 2001). Evolutionary approaches specifically applied to regional studies aim to explain changes in settlement and subsistence on the basis of predictions based on a knowledge of human behaviour. These studies aim to avoid weak generalizations and provide readily testable models.

In regard to the regional archaeological model and evolutionary models this research further aims to investigate the changes and continuity in settlement and subsistence in the study area with particular reference to mobility, activity locations, and technological innovation. Sites investigated in this study cover different time periods and different environmental contexts ranging from the Late Pleistocene up to the historic period. Variability in stone artefact reduction across time and space will be investigated to chart changes in mobility and subsistence strategies. Analysis of faunal material, where available, will also aid in identifying target prey. These results will then be compared with predicted responses in human behaviour, developed from evolutionary anthropological models and human behavioural ecology.

1.4 The Study Region
Riversleigh/Lawn Hill is located in far north-western Queensland adjacent to the Northern Territory border, approximately 250 km south of the modern Gulf of Carpentaria coastline, and 400 km northwest of the city of Mount Isa (Figure 1.1). At the height of the

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Chapter 1

Introduction

probably accurate for the late Neolithic century, but by this time most of the dislocation
Northern Territory, encompassing both the plains and the plains of the Gulf. This is
Tindale (1974) shows Wawany Territory as extending from the western Queensland into the
attributing with the Guna people across the Northern Territory/Queensland border.
The Wawany people are speakers of the Pan Nunggum language group and share a common

1.5 Componentary Associations

Steele 2002a; Yan der Meer 1997).
rockshelters and excavate open sites including middens and which scatter are common
is among the excavated grotto systems that the archaeologist Sturgeon is shown.
Caves, fossils, and rock formations of the Pleistocene, and later Tertiary rock formations has resulted in deeply
Prehistoric, Middle Campanian, and Late Tertiary rock formations also contain a vast
expanse of the National Park, the combination of these water courses and exposed
eastern edge of the National Park, the combination of these water courses and exposed
Lore, Collin's and Law Hill Creeks, and the Gregory and O'Shannessy Rivers. Along the
throughout Boodjamulla National Park in a north eastern direction - Elizabeth, Muselmahook,
and the Riversleigh World Heritage Area. Seven permanent water courses now
conduct at the junction of these land and where within Boodjamulla (Law Hill) National
rugged plateau of the Bulky Tableland, where the research presented here has been
southern woodlands and black soil plains (associated with the Gulf of Carpentaria), to the
of the Wawany people (Tindale and Frye 2003). It is situated at the transition from
Today the entire region is found within the traditional country and Nange the claim area

Red streams have always supported water, independent of droughts and climate change.
Last Glacial Maximum between 30,000 and 18,000 BP the study area was at the very heart
and upheaval of the Aboriginal population of the region had been completed, resulting in the Waanyi expanding their territory to encompass neighbouring language groups.

The areas where this research has been undertaken occur along the boundaries of Waanyi-Ngborindji and Waanyi-Indjilandji-Wakabuna. The Waanyi, Ngborindji and Indjilandji people appear to have been from the same cultural block (Sharp 1939). These associations are fairly recent and most likely the result of historical connections as a result of the fusing of other related groups (see Trigger 1980, 1982a, 1982b, 1985, 1987a, 1987b, 1992; Trigger and Fietz 2003). Substantial disruption is known to have taken place to Aboriginal territories with the onset of European settlement. Other neighbouring Aboriginal language groups including the Ngborindji were decimated by the combined effects of frontier violence and European introduced diseases. The Waanyi who are described as ‘hill people’ by Trigger (1992) are thought to have retreated within the gorge systems of the various rivers that spread across the region very soon after contact (Slack 1998, 2002a, b; Trigger 1992). During the historical period, the Waanyi expanded their territory to encompass the Ngborindji, with an eastern boundary following the west bank of the Gregory River.

Figure 1.1: The southern Gulf of Carpentaria in northern Australia showing the research area of Boodjamulla (Lawn Hill) National Park and Riversleigh World Heritage Area within the Waanyi Native Title Claim Area and the regional centres of Doomadgee and Burketown.
Chapter 1: Introduction

and zone settlement, and assess the archaeological evidence that supports these models. Archaeological data are presented. The chapter then discusses the competing models for Australia and the research region. Competing models of colonisation and reviews of the discussion of climatic change during the Late Pleistocene, with a focus on northern Australia. It commences with a review of the archaeological of northern and Australian. It commences with a review of the archaeological of northern

Chapter 1: Introduction

The thesis is divided into 8 chapters.

1.6 Previous Research in the Study Area

McKay 1992a, b, C. Tugger 1992

plains area of the region in the course of the development at the Century Zinc Project (Bakker 1990). During the 1990s various consulting projects focused on the eastern plains based on surveys by van der Meer (1988) and a woman’s history project (Smith and others 1998). Research at Riversleigh has included an historical honours thesis (Skeck 1999) and honours thesis (Skeck 2002). Archaeological work focused on the cape study region (Stack 2002).


and Andrew Border conducted a similar study of Lawn Hill in 1989 and

Hiscock 1988). Gisborne Walsh conducted a rock-art census of the Lawn Hill quartz area in

Peter Hiscock subsequently completed a PhD thesis on this and other local sites in 1988.

date from Collies Creek Cave at Lawn Hill in the centre of the study area (Hedges 1987).

commenced with excavations by Phil Hughes and Ken Aplin, who obtained a Pleistocene


and Stack 2004; Hiscock 1988; Hiscock and Hughes 1980, 1984; Pekering 1997; Robins

and commercial consulting surveys (Border and Hayes 1997; Dwyer 1998; Dwyer 1999; Hilder

Previous archaeological research in the study area is comprised of both academic research
Chapter 3 provides a detailed review of the results of previously excavated sites at Lawn Hill by Hiscock (1988). Hiscock’s model of the relationship between lithic technology and settlement is explored, and his overall model of fluctuating arid zone occupation is reviewed.

Chapter 4 is a detailed discussion of the theoretical approach used in this research. The key concepts of evolutionary theory are presented, and a comprehensive discussion of the models of human behavioural ecology is presented. These models are reviewed and illustrated by archaeological examples.

Chapter 5 builds upon the theory presented in the previous chapter. It presents a land-use model based on the concepts of human behavioural ecology that will be applied to the research region. In developing this model the chapter also provides environmental background for the study region.

Chapter 6 and 7 are the primary result chapters of the thesis, with presentation of studies of excavated and surveyed sites. Chapter 6 focuses research on sites near and more distant from the most substantive watercourse of the research region, the Gregory River. Chapter 7 focuses on the north of the study area which also includes permanent streams, and explores the nature of the archaeological record at sites located on far less permanent watercourses.

Chapter 8 provides a discussion of the results and the main conclusions of this research. The data presented in the previous two chapters is interpreted in light of the evolutionary models presented in chapters 4 and 5. This chapter concludes with a summary of the main findings of the research, and reviews how the Boodjamulla data is important in reconstructing Australia’s Pleistocene prehistory.
Chapter 2  Archaeology of Northern and And Australia

Climate of northern Australia. This research is primarily interested in the following six events over the last 50,000 years that have been numerons and extreme oscillations in the Earth's environment. The challenges for human populations since first arrived 400 years ago, have all influenced northern Australia. These pronounced changes in climate and environment have significant impacts on the Younger Dryas (c. 11,000 cal. B.P.).

The Australian Chumac the last 50,000 years. The Australian climate has always played a large role in human subsistence systems from Niue and the present day. No matter when the hunter-gatherers arrived in Australia, they contributed to the formation of extant human subsistence systems. The Australian climate has always played a large role in human subsistence systems from Niue and the present day.

2.1 Introduction

The Archaeology of Northern Australia and the And Zone:

2.2 Chronologies and Settlement Models.
phases: (i) the colonisation period (MIS3 50,000-30,000 BP), (ii) the Last Glacial Maximum (MIS2 30,000-18,000 BP), (iii) the post LGM Late Pleistocene (18,000-10,000 BP), (iv) the Early Holocene (10,500-5,500 BP), (v) the Mid Holocene (5,500-2,000 BP), and (vi) the recent past (2,000 BP - present). Each of these phases is marked by significant changes in climate. These six phases are necessarily broad, as there is no detailed environmental history known from the study area, and therefore reconstructions are necessarily based on extrapolation of palaeo-environmental data from sources up to 500 km distant.

2.2.1 Phase 1 (50,000 - 30,000 BP)

During the period between 50,000 and 30,000 BP, humans entered Australia, as dramatic changes to the climate and environment of Northern Australia were in train. Sea levels around Australia fluctuated significantly due to cyclic growth and decay of the northern continental ice sheet resulting in the continual reshaping of the continent. From about 62,000 BP, sea levels rose after a low-stand at 85-90 m below present, with four high stands: at 32,000, 36,000, 44,000 and 49,000 - 52,000 BP (Lambeck et al. 2002:201). During the height of the LGM sea levels fell to c. 130 m below present, and by 26,000 BP they had reached 70 - 50 m below present (Chappell 1983, 1991, 1993, 2000, 2002; Harrison 1993; Lambeck and Chappell 2001; Magee and Miller 1998; Nanson et al. 1991; Roberts et al. 1991). Lambeck et al. (2002) note that the ice volumes that mark the end of this phase were reached at approximately 19,000 BP. Up to this point the drops in sea level appear to have been rapid and, at times of colder periods, sea-level oscillations might have reached magnitudes of tens of metres in under 1,000 years (see Chappell 2001; Chappell et al. 1996; Lambeck et al. 2002; Yokoyama et al. 2000, 2001).

During this phase Australia and New Guinea constituted one landmass, referred to as Sahul. The Gulf of Carpentaria was almost an enclosed body for most of the period and constituted a brackish estuarine water mass, but between 80,000 and 40,000 BP sea levels
Gradual drying and cooling of the continent, massice drops in sea level, reduced steady rainfall during the cold period. This period is known as Oxygen Isotope Stage 2 (OIS2) and is marked by a significant event. From 30,000 BP until approximately 18,000 BP, the Australian climate determined from 30,000 BP until approximately 18,000 BP.

**Figure 2.2: Phase 2 - The LGM (30,000 - 18,000 BP)**

Vegetation communities during the LGM period. The diagram shows the extent of different vegetation types in Australia, with the evolution of different ecosystems.

Carpentaria (Jones and Toftersen 1998; Toftersen et al. 1998; 258) (Figure 2.1). The climate became drier with enhanced wet-season precipitation for the Gulf of Carpentaria (Jones and Toftersen 1998; Toftersen et al. 1998; 258) (Figure 2.1). From about 35,000 BP to 27,000 BP, the climate was drier, and vegetation communities corresponded with the Gulf of Carpentaria. From approximately 30,000 BP to 26,000 BP, the climate was drier, and vegetation communities corresponded with the Gulf of Carpentaria. From approximate 27,000 BP to 22,000 BP, the climate was drier, and vegetation communities corresponded with the Gulf of Carpentaria. 2001: Lamber and Ria (2001; Lamber and Ria 1972). In Shrub with several megalakes remaining in central Australia, Lamber and Ria (2001; Lamber and Ria 1972). In Shrub with several megalakes remaining in central Australia, Lamber and Ria (2001; Lamber and Ria 1972). In Shrub with several megalakes remaining in central Australia, Lamber and Ria (2001; Lamber and Ria 1972). In Shrub with several megalakes remaining in central Australia, Lamber and Ria (2001; Lamber and Ria 1972).
precipitation, and greater prevailing winds. Until recently it was believed that the LGM had a relatively sudden onset, lasting only a couple of thousand years. However, recent research has shown the LGM to be more drawn out, enduring for c. 10,000 years. LGM ice volumes were approached at about 30,000 BP, increasing only slowly during the next 10,000 years. The onset of the LGM is represented by the minimum sea levels recorded; beginning around 30,000 BP (Lambeck and Chappell 2001; Van der Kaars et al. 2006). Fine resolution analysis of the Greenland polar ice core record and ocean sediment core records from the northern hemisphere indicate that the interstadials during the last glaciation were subject to considerable fluctuation at certain times and that "transitions between longer warm and cold periods... occur over periods of less than 10 years" (Taylor et al. 1993:435) and that similar trends might also relate to the southern hemisphere albeit with a time lag (Bluiner and Brook 2007). This issue is also raised by Chappell (2001) but who also notes that these oscillations have only "so far been recognized in records from northern hemisphere sites, both sedimentary and archaeological" (Chappell 2001).

Regardless of the potential for abrupt short term changes during this period, Sahul experienced significant reductions in temperature, severe droughts, high winds, dust storms. Declines in atmospheric CO$_2$ levels persisted and in some areas of Northern Australia, dune fields expanded (Hesse et al. 2004; Hesse et al. 2005). The effects of the LGM were dramatic with a substantial expansion of the arid zone and associated vegetation and hydrological systems which have not yet been repeated (DeDeckker 2001; DeDeckker et al. 2003; Horton 1993; Lambeck and Chappell 2001).

The large scale effects of the LGM included an increase in the size of the Sahul landmass by up to 30% at this time with documented local sea drops of 130 m below present by 19,000 ago (Lambeck et al. 2002). When sea levels dropped to 53 m below present, much of the Gulf of Carpentaria was drained along with the Arafura Sea in the north, creating

Chapter 2 Archaeology of Northern and Arid Australia
reduced precipitation spread north and ice cover became sparse (Figure 2.7). Reduced rainfall
all vegetation communities would have contracted or disappeared, as the impact of
south-west of the continent (Hope 1987; Hesse et al 2005:57). Within the research region
isolated pockets in inland areas and as a narrow strip along the coast above the east and
woodland areas and focuses that had spread across Northern Australia were reduced to

The effect of the LGM on the vegetation was also dramatic. Previously extensive
most of the lower river courses no surface water was available.

correlation of these effects would have greatly reduced water volumes, and that alone
would have been the lake itself and a small number of isolated lakes. It is possible that
21,500 BP (De Deckker 2001). The only available permanent water within the catchment
depression due to intensive irrigation within the catchment basin. Due to high rainfall and
formation of the lake, much of the Carpentaria basin did not have significant and
Sandhill to the LGM (Webster and Stenton 1978). Marine cores show that following the
reduced by a lack of onshore cyclones that had consistently brought rain to the interior of
precipitation, widespread aridity resulted (De Deckker 2001). Lake Carpentaria was further
size of the continent – particularly in the north. As a consequence of depressed
throughout the Carpentaria region. This was largely due to the immense increase in the

The LGM was characterized by a period of reduced temperatures and precipitation

De Deckker 2001; L'orange et al 1988).
From 23,000 BP until about 11,800 BP, the Gulf of Carpentaria was a fresh water to-brackish lake. Although substantially reduced in size during the LGM, pollen records indicate that the surrounding area was dominated by terrestrial grasses rather than truly arid vegetation (Hesse et al. 2004; Hesse et al. 2005:66). Pollen and charcoal counts indicate a cyclical wet-dry sequence which may have been seasonal even during the LGM. The overall Gulf region was characterized by a savannah-like environment with vegetation consistent with savannah grasslands and black soil plains (Torgersen et al. 1988:258, Figure 2.3).
2.2.3 Phase 3 - Terminal Pleistocene (18,000 - 10,000 BP)

Following the LGM, phase 3 was a period of large scale climatic amelioration. Average temperatures and rainfall increased as a result of glacial melting from 19,000 BP until 7,000 BP. Although, the rate of global melting was initially relatively slow between 19,000 BP and 16,000 BP, sea levels rose about 3.3 mm/year (Lambeck et al., 2002:344; Lambeck and Chappell 2001).

In many areas of northern Australia, tropical cyclones replaced cold glacial winds by about 13,000 BP (Hussey et al., 2004). Enhanced rainfall combined with glacial melting resulted in...
sea level rises, and across the northern end of Sahul the effects were sudden. The continental shelf surrounding the Arafura plain was inundated and this rise may have resulted in a lateral flooding of up to a metre a week (Mulvaney and Kamminga 1999:121). If the estimates of rates of sea level rise of 1 – 3 m per year are correct then the effects on local flora and fauna surrounding Lake Carpentaria would have changed significantly and very quickly (Torgersen et al. 1983). However, Lambeck et al. (2002) note that during the post-LGM, sea level rises are marked by variability. Maximum rates of sea level rise are thought to have occurred between 16,000 and 12,500 BP and again between 11,500 and 9,000 BP (Lambeck et al. 2002:343). By about 12,000 BP sea-levels had risen sufficiently that a permanent and open connection from Lake Carpentaria to the sea had once again been established (Chivas et al. 2001). Salinity is considered to have remained low due to restricted water exchange and the wetter climatic conditions aided by the increased incidence of tropical cyclones.

Within the most recent of this phase (10,200–10,800 BP), a period known as the Younger Dryas is thought to occur (Lambeck et al. 2002:343; Edwards et al. 1993; Bard et al. 1997). It is marked by a spike of colder weather, as a notable swing back to cold and arid conditions took place for c. 600 years (Kershaw 1995; Kershaw et al. 1993).

Climatic change and the associated flooding of Lake Carpentaria would have had significant impacts on the environment of the study area. Enhanced seasonal rainfall and higher water levels in seasonal and permanent rivers would have driven expansion in riverine, woodland, and with shrublands replacing the arid vegetation (Figure 2.4).
there is extensive regional variation concerning the timing and extent of this change. Towards the middle of the Holocene a general trend towards dryer conditions occurred. Although
Kershaw 1983, 1995; Kershaw and Nix 1989; McEwan 1992, Nix and Kershaw 1972. Precipitation reaching an optimum between 8,000 BP to 5,000 BP (Cagney 1994 a). The first 4,500 years of the Holocene were wetter and warmer than previous phases with

Southern Oscillation event (Allan et al 1996) approximately 9,700 BP (Cleere et al 2001:19) and the mid Holocene El Nino

Lake Campianda being transformed into one of the largest embayments in the world at

Chalice Cove. Sea level transgression through Torres Strait leading to

the last 10,000 years have provided a relatively stable climate in Northern Australia when

Phases 4, 5, and 6 – The Holocene (10,000 BP–Present)

Figure 2.4 Northern Australia during the early Holocene transition of the arid zone and expansion

Shrubland

Low open woodland

Woodland
change, it was probably triggered by the onset of enhanced El Niño/Southern Oscillation (ENSO) conditions at c. 5,000 BP. These conditions developed as the result of warmer sea surface temperatures in the Pacific Ocean, leading to increased evaporation and heating of the troposphere (Allan et al. 1996; Anderson 1992).

In Northern Australia, the effects of the El Niño Southern Oscillation (ENSO) have included decreasing strength in trade winds and greatly reduced precipitation, which have often ended in drought. Although the duration and configuration of ENSO is variable, it is generally believed that dry conditions have intensified over the last 5,000 years (Anderson 1992; McGlone et al. 1992). ENSO may have driven increased aridity later in northern Australia than in the southern temperate latitudes. Analysis of δ¹⁸O records from coral and sea sediments in the Gulf of Carpentaria, and pollen records from Groote Eylandt indicate that reduction in precipitation did not occur until about 4,000-3,500 BP (Hope and Golson 1995; Kershaw 1995; McCarthy et al. 1996; McCarthy and Head 2001). This mid Holocene arid phase extended until approximately 2,000 BP, when the increased rainfall and warmer temperatures that are associated with the present climate commenced (Schulmeister and Lees 1992; 1995).

The effects of the mid Holocene arid phase would have significantly altered the spread of local vegetation communities. The enhanced vegetation richness along rivers and expansion of woodlands created during the early Holocene would have been substantially reduced, with less certainty of seasonal precipitation as rainfall associated with cyclones was replaced by winds from the interior (Figure 2.5). All but major rivers would have failed and resulted in a corresponding expansion of grassland communities.

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Zone settlement on the landscape would have all influenced how humans colonised Australia, and later and hunter gatherer populations. Sea levels, water availability, and the palaeoecology of resources, Australia probably played a pivotal role in the timing of settlement and the spread of The subsurface and sometimes dramatic changes in climate over the last 50,000 years in

2.2.5 Summary

Convergence Zone and EAC denotes East Australian Current. The annual mean location of the director, TEZ, denotes Inter-Tropical Convergence Zone. Figure 2.5: Holocene atmospheric circulation over northern Australia during the Australian summer.
2.3 Dating the colonisation of Australia – 'the Long and the Short of It'

There are many issues that affect our understanding of the timing and nature of the initial colonisation of Australia and the nature of subsequent settlement patterns. These include: (i) the sample number of known sites; (ii) complexities and uncertainties in dating techniques; (iii) the small number of cultural assemblages for the Pleistocene in general, and (iv) a lack of detailed reporting of Pleistocene sites (see O’Connor and Veth 2005).

Presently there are only fifteen archaeological sites in Australia that feature an antiquity of occupation greater than 35,000 years BP. Of these sites, four are older than 45,000 years BP, and only three have been claimed to be greater than 55,000 years old. With such a small sample of sites which are located across the continent in varying environments, no directionality of colonisation seems apparent (Hiscock and Wallis 2005). Furthermore, there is little detail available concerning the cultural material recovered at these sites, and the composition of the early occupation phase assemblages. Where published, often these assemblages are extremely small (e.g. Balme 2000) <200 artefacts and are compounded by the complexities associated with the different dating techniques applied. Numerous age determinations by the C14 method are approaching the limits of the technique (c. 40,000 years). Some very small size carbon samples have been subjected to various pre treatments and extended counting (AMS) to push this radiocarbon limit back a further few thousand years. Luminescence techniques have also been used and which whilst having limits far older than conventional dating, can suffer from problems of exposure and bleaching of sediments as well as contamination, and large error margins.

1 Title from Allen and O’Connell 2003

Chapter 2 Archaeology of Northern and Arid Australia
Chapter 2: Archaeology of Northern and Aboriginal Australia

Region 2 is worth considering this debate, particularly as it relates to northern Australia, where there was no immediate evidence of occupation for the southern Gulf of Carpentaria or an antiquity of over 25,000 years - the Long Chronology. As one of the aims of this study was to investigate the antiquity of occupation for the southern Gulf of Carpentaria, the "Long Chronology" was the starting point for discussion (see Appendix B).

Some researchers have also proposed earlier colonization dates but these claims have been generally dismissed or unsupported (see Pullen et al. 1999b; Kersley 1996). Since then, general consensus in Australian archaeology has modern humans arrived on Australia at least 50,000 years ago, but since then there have been several significant archaeological discoveries and advancements in understanding the antiquity of human occupation in Australia. Recent research by archaeologists such as Hedges et al. (1999), O'Connell and Allen (2004), and O'Connell and Allen (2004) have shed light on the antiquity of human occupation in Australia, with some researchers suggesting a much earlier arrival date, possibly as early as 100,000 years ago (see Mulvaney 1991). However, by 1981, archaeologists were in agreement that the antiquity of occupation was less than 10,000 years ago. By the 1960s, there was a growing consensus among researchers that the human colonization of Australia had taken place relatively early, around 40,000 to 50,000 years ago (see Mulvaney 1991).
Figure 2.6: The northern Australian region showing sites with an occupation date greater than 35,000 BP mentioned in the text.

2.4 The Long Chronology

A colonisation date prior to 55,000 years BP is primarily based on evidence from three archaeological sites; Malakunanja II and Nauwalabila I in northern Australia, and from Lake Mungo in western New South Wales (Roberts et al. 1990, 1994; Bowler et al. 1970).

The Kimberley site Jinmium had also been reported as yielding much older occupation ages including artefacts associated with sediments that had been thermo-luminescence dated to between 116,000 and 176,000 years (Fullagar et al. 1996). If these dates were accepted, then the Jinmium data would have extended the known chronology of Aboriginal occupation of Australia by up to 135,000 years and opened up the debate on Pleistocene human evolution. Jinmium was soon dismissed due to apparent taphonomic and sampling problems, including the possibility that the dated grains may have been derived from in situ disintegration of sandstone rubble after burial in the deposit. Furthermore, abbreviated temperature curves of samples were possibly related to short periods of re-exposure (Roberts et al. 1998).
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also provide a compelling critique of disparities between radiocarbon determinations of remaining activity (O'Connell and Allen 1998:139; Allen and O'Connell 2004:15). They argue that the lower

results rejecting the site to less than 4000 years. They argue that the lower

O'Connell and Allen (1998, 2004) criticized the analysis and reporting of the Nauwaluba

33,000 ± 4,432 and 60,000 ± 6,779 K.a (Roberts et al. 1994 but also see Hiscock 1993). The lower of these indications that the site was first occupied between bracketed dates of

14 further radiocarbon and 5 electronmumescence dates were reported for Nauwaluba I. 150 cm below surface recovered a date of 19.7 ± 3.5 BP (SU 237). In 1994, a number of samples obtained from horizon of the 3 main strata reveal dates between 170 and 180 cm below the ground surface. The initial radiocarbon determination based on charcoals samples obtained from the site. An initial radiocarbon determination based on charcoal samples 286 cm below the ground surface. Stone artifacts occurred throughout 25 cm of sandy deposit and continued into underlying sandstone rubble. Well below the lower charcoal

excavations consisted of single 1 m 2 test plots that were terminated at bedrock at approximately

and re-excavated in 1988 by RVJ Jones and Ian Johnson (Jones and Johnson 1989). National Park in northern Australia. The site was first excavated by Karmunia in 1973.)

Nauwaluba I is a sandstone rockshelter located along Deeradder Creek in Kakadu


Description of artefacts and (ii) combination of samples (iii) Allen and O'Connell

reasons including (i) dating techniques and interpretations, (ii) possible vertical

displacement of artefacts, and (iii) combination of samples (iv) Allen and O'Connell

for Australia. Both sites have received critical attention in a variety of

Nauwaluba I and Makanunna II

Archaeology in support of the Long Chronology

II
(including ABOX-C AMS samples), and their divergence from the OSL determinations. The latter are rejected on the basis of low palaeo-dose levels (refer to Table 7 and text in O’Connell and Allen 2004:845). O’Connell and Allen have pointed to other unresolved issues with the dating, including confusion over inversions of some dates and claimed mislabeling of samples (O’Connell and Allen 1998:135).

Malakunanja II is a small rockshelter at the foot of the western escarpment of the Arnhem land plateau about 50 km north of Nauwalabila. The site has been extensively excavated since the 1970s (Kamminga and Allen 1973; Schrire 1982; Roberts et al. 1990a). The deposit at Malakunanja II is comprised of 4.6 m of ‘poorly sorted’ sand overlying rubble (Roberts et al. 1990a:153). In 1990 Roberts et al. collected thermoluminescence samples from auger holes and excavations upon which basal occupation of the site is argued to be bracketed by TL dates of 61,000 ± 13,000 years (KTL 162) and 45,000 ± 9,000 years (KTL 164) (Roberts et al. 1990a:153).

Hiscock and Bowdler have argued that it is difficult to reconcile the radiocarbon and luminescence results with the cultural sequence at Malakunanja II, given the very different recovery techniques and sample recovery locations (Bowdler 1990:93; Hiscock 1990:122). Hiscock raised questions relating to the reliability of the age estimates for the stone artefacts from the site, and specifically argued that taphonomic processes, although noted by Roberts et al., were not satisfactorily addressed. He also noted that there was high potential for vertical displacement of artefacts between 20,000 and 40,000 BP (Hiscock 1990:123). Roberts et al. (1990b:125-129; 1990c:94-97) response to both Hiscock and Bowdler’s criticisms was on the basis of the validity of the TL samples and sedimentation rates, and what they saw as an implausible relationship with treadage.
The nature of the site consists of eleven separate levels which are bracketed by dated archaeological deposits. The lowest level, which consists of a small assemblage of stone artifacts, and the second a human burial (Allen 1972; Bowler 1972, 1988; Bowler 1992; Bowler 1996; Clark 1966; Johnson 1993). Within the lower Mungo unit, two levels of alluvium have been subject to excaving and various units and sub-units of sediments at Mungo have been known as the Zancan unit. The upper unit, which consists of three known as the Mungo unit, which is again separated into lower and upper layers. Overlying this layer is the Mungo unit, which is other separated into lower and upper horizons. The lowest of these, known as the Mungo, consists of soil developed on clayey layers of humus associated with the lake basins, the two primary stratigraphic divisions of the Lake Mungo system, located on the Lachlan River in South Western New South Wales. Lake Mungo is one of a series of thirteen interconnected lake basins known as the Lake Mungo system (Connell and Allen 2004:84).
BP, 49,700 ± 2, 700 BP below (Bowler et al. 2003; Shawcross 2003). The association of these artefacts with the dates is questioned because of the small sample size, problematic stratigraphic relationships, and an inversion between dates and possible post depositional movement (O'Connell and Allen 2004:843).

The Mungo III site consists of a human burial located in a partly exposed context in lower Mungo sediments. Original reports state that Mungo III was in place prior to the formation of the surrounding lower Mungo sediments (Bowler et al. 1970). This assertion has since been rejected (Bowler et al. 2003) and a general consensus that the remains were about 36,000 years old ensued for some time. Recent dating studies by Thorne et al. however have challenged this position (Thorne et al. 1999).

Thorne and his colleagues published the results of uranium and electron spin resonance (ESR) analyses of the human remains and OSL determinations of surrounding sediments which were claimed to be stratigraphically equivalent to the burial (Thorne et al. 1999). The determinations ranged between 50,000 years and 103,000 years, and Thorne et al. argued for an antiquity of 62,000 ± 6,000 years (Thorne et al. 1999). Bowler et al. (2000), Gillespie (2002) and Gillespie and Roberts (2000) subsequently disputed Thorne’s claims. Bowler et al. (2003) argue that of all the luminescence determinations that Thorne et al completed, only one is greater in antiquity than 52,000 years and that luminescence samples were collected from locations a few hundred metres from the burial location and are therefore of uncertain context. Grun (2006) notes that subsequent dating work by Bowler and colleagues (Bowler et al. 2003) has placed the age of both Mungo burials at 40 ± 2 ka (Bowler et al. 2003) and that when considering the entire dating data sets there is considerable overlap (Grun 2006:40). All of these issues cause O'Connell and Allen (2004:843) to conclude that "neither the M-III burial nor the local archaeological record provides solid evidence for a human presence at Lake Mungo before ca. 43 ka".

Chapter 2 Archaeology of Northern and Arid Australia
Chapter 2
Archaeology of Northern and Austraia

From the earliest and semi-arid zones of the continent...

Geographic region, with a particular focus placed on locations in northern Australia, and those sites that support a 'short colonization model'. Sites are discussed in relation to their inclusion into the database, then a further seven sites are added. This section discusses...

1.0.1. When early human archaeological sites in Southeast Asia and New Guinea are Australia that have rapid colonization determinations between 35,000 BP and 43,000 BP (FeB)

If the early dates for colonization are accepted, we are left with a suite of two sites in...

2.5 The Short Chronology


significantly provide any more evidence for the "long" model (Crematz... of a select number of sites and failed to
manifoldly extended basal occupation dates of a select number of sites and failed to
Re-dating of sequences has provided little extra benefit to research. These studies had
more that colonization remained a contentious issue despite a lengthy period of research,
push back initial occupation dates. By 2004 O'Connell and Allen were again compelled to
base techniques applied to these new archaeological sequences in attempts to reduce or
similar ambiguity. The last 10 years has seen a debate about site excavation.

Since the excavation of these sites have been no further discoveries of localities of
population where no other old sites have been discovered (O'Connell and Allen 1998:143).

size to high levels within just a few thousand years and have asked that given this large
and Allen have modeled how a small First Colonizing Group could be expected to grow in
expect evidence of human occupation elsewhere in the continent at this time. O'Connell
Australia was colonized by 55,000 BP as the dating studies claim, then we might also

The northern Australian sites of Wadjumana II and Nauwalabila I are problematic. If

2.4.2 Summary of Long Chronology
<table>
<thead>
<tr>
<th>site</th>
<th>region</th>
<th>environmental zone</th>
<th>technique</th>
<th>earliest date (ka)</th>
<th>reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riwi</td>
<td>Kimberley</td>
<td>semi arid - arid</td>
<td>14C</td>
<td>41.3 ± 1.02</td>
<td>Balme 2000</td>
</tr>
<tr>
<td>Carpenter's Gap 1</td>
<td>Kimberley</td>
<td>semi arid - arid</td>
<td>ABOX/AMS</td>
<td>40.6 ±0.8</td>
<td>Fife1d et al. 2001</td>
</tr>
<tr>
<td>Cuddie Springs</td>
<td>Western NSW</td>
<td>semi arid</td>
<td>OSL</td>
<td>35.4 ± 2.8</td>
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</tr>
<tr>
<td>Lake Arumpo</td>
<td>Western NSW</td>
<td>arid</td>
<td></td>
<td>38.5</td>
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</tr>
<tr>
<td>Lake Tangou</td>
<td>Western NSW</td>
<td>arid</td>
<td></td>
<td>36</td>
<td>Clark 1986</td>
</tr>
<tr>
<td>Allen's Cave</td>
<td>Nullabor Plain</td>
<td>arid</td>
<td>OSL</td>
<td>39.8 ± 3.1</td>
<td>Roberts et al. 1996</td>
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<tr>
<td>Purtijarra</td>
<td>Central Australia</td>
<td>arid</td>
<td>C14</td>
<td>34.6 ± 1.6</td>
<td>Smith et al. 1997</td>
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<td>temperate</td>
<td>ABOX/AMS</td>
<td>45.47 ± 1.42</td>
<td>Turney et al. 2001</td>
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<td></td>
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<td>Smith and Sharp 1993</td>
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<td>Ngarrabulgan</td>
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<td>AMS, OSL</td>
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</tr>
<tr>
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<td>C14</td>
<td>35</td>
<td>Allen 1996</td>
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<tr>
<td>Niah Cave</td>
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<td>C14</td>
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<td>Buang Merabak</td>
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<td>tropical</td>
<td>C14</td>
<td>40</td>
<td>Leavesley and Chappell 2004</td>
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<td>C14</td>
<td>35</td>
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<td>TL/OSL</td>
<td>40-53</td>
<td>Groube et al 1986</td>
</tr>
</tbody>
</table>

Table 1.0.1: Archaeological sites in Australia and Southeast Asia with basal dates greater than 35,000 years BP excluding Mungo, Malakunanja II and Nauwalabila I.

2.5.1 Archaeology in support of the short chronology

Northwestern Australia

Two sites that pre-date 35,000 BP are located in the Kimberley region of Western Australia. Carpenter's Gap 1 and Riwi are situated well inland within an arid landscape. The antiquity of these sites points to a colonisation from island southeast Asia rather than a more northern route through New Guinea.

Carpenter's Gap

Carpenter's Gap 1 is a limestone rockshelter located in the Napier Ranges in north west Western Australia. In 1993 and 1994, five 1 m x 1 m test squares were excavated at the site. The oldest deposits were recorded from an isolated 1 m square away from the main excavations (O'Connor 1995:59). O'Connor has argued that Carpenter's Gap 1 was at the time the oldest conventionally dated site in Australia with a lowest determination of 39,700

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Archaeology of Northern and Mid-Australia

By its location in the arid zone (see Fischbeck and Wills 2002), the site and region, considered with the communication of the LCM, unsurprisingly given discontinuity occurs between 30,000 and 30,000 BP, that is interpreted as abandonment of FL 1020 BP (KAM-13015) (flame 2000-2). A stratigraphic exercise begun in 1999, these basal redcooking dates were obtained of over 40,000 BP, the approximate 200 km southeast of Carpenter's Gap is the immersion rockshelter site River

Years BP, the site may indeed provide support for a short colonisation period post-dating 42,000 BP. The site may indeed provide support for a short colonisation period post-dating 42,000 BP.

Cultural material and the radiocarbon determinations for Carpenter's Gap 1 are accepted, first used by people. Once the Lithic assemblage is preserved and association between deposit is said to have accumulated at an almost uninterrupted rate soon after the site was occupied prior to 40,000 BP, detailed concordant the nature of the assemblage itself are yet to be published. Also problematic is the unresolved issue that almost 25% of the cultural material O'Connor has provided compelling arguments that Carpenter's Gap 1 was occupied during the earlier period of occupation (O'Connor 1997; O'Connor 1997). Further C-14 samples were submitted and unpublished. O'Connor believes that this might be caused by rapid sedimentation during the earlier period of occupation (O'Connor, 1997; O'Connor 1997). A second date (probable the basal date) was obtained 20 cm further down the sequence and

620 BP (AUN-11241) were also presented (O'Connor and Purchase 2001), 370 BP (ANU-11163) and 23140 ± 370 BP (AUN-11163) and 23140 ± 370 new basal date and two dates from spR 40 of 26370 BP (AUN-11163) from spR 45, just 7 cm above the inclusion of 370 BP (AUN-11163) and 23140 ± 370 BP (AUN-11163) and 23140 ± 370. Other dates, 42880 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP (OZD-161) (O'Connor and Purchase 2001), 1850 ± 1850 BP
Southeastern Australia

Inland arid and semi-arid region

Three sites with an initial occupation date greater than 35,000 BP are reported from the inland semi-arid and arid region of southeastern Australia. All are found in western New South Wales. Two sites are located in and near to the Willandra Lakes region: Lake Arumpo and Lake Tandou about 100 km to the north. Both sites consist of hearth features in association with stone artefacts within wind-blown lunettes (Clark 1987).

The third site with occupation greater than 35,000 BP is an ephemeral lake named Cuddie Springs in the northwest of the State. Excavations since 1991 by Judith Field have concentrated on an area of over 20 m² in the centre of the lake within which six archaeological units were identified from 1.7 m to 1 m below the surface. Both extant and extinct fauna are also known to occur in situ from c. 10 m to approximately 1 m below the surface. In the upper archaeological levels of the site human/megafauna associations are reported between c. 36,000 and c. 27,000 BP, based on both luminescence and radiocarbon methods (see Field et al. 2001, 2004; Wroe and Field 2006). Although the association between humans and extinct fauna is often challenged on taphonomic grounds (see Gillespie and David 2001; Roberts et al. 2001 but see Dodson et al. 1993; Field 2004; Field et al. 2006; Field and Dodson 1999; Trueman et al. 2005; Wroe and Field 2006), the basal dates of c. 35,000 BP are generally held as reliable, indicating that humans had definitely settled the inland of southeastern Australia by this time.

Coastal temperate and southern regions

Evidence for a pre 35,000 BP settlement date from this part of the continent is restricted to two archaeological sites. In Victoria, the site of Keilor has been dated to 38,800 BP (Gallus 1983). This date has not been generally accepted, as the nature of possibly redeposited sediments and their association with cultural material is uncertain (see Munro
Dates of 31,000 ÷ 19,650 BP (VeI 29), 21,900 ÷ 14,900 BP (VNU-24), and 19,000 ÷ 720 BP and the lowest avenues (Roberts et al. 1999). This same heath has previously yielded C14 occupation ages determined at 39,800 BP from sediments immediately below a hearth excavated in the 1960s. Recent OSL dating studies of the site have produced a basal occupation within a collapsed structure on the Nullarbor Plain in South Australia. First rockshelter within a collapsed structure on the Nullarbor Plain in South Australia. Allen’s Cave and Punthara Rockshelter. Allen’s Cave is a small rockshelter within a collapsed structure on the Nullarbor Plain in South Australia. Evidence of pre-35,000 BP settlement of central and southern Australia comes from central and southern Australia.

(Trumper et al. 2001.)

Determinations of between 41,000 - 45,000 years (DLT) and 42,300 - 46,500 years (D17) radiocarbon dated to 41,460 ÷ 14,900 BP (VNA-11709), with associated OSL. O’Connell and Allen 2004:84:1, 46,500 years (D17). This evidence comes from a hearth in the older conventional (C14) dated site on the continental (Flaherty et al. 1997), O’Connell and Allen 2004:84:1, 46,500 years (D17). This evidence comes from a hearth in the older conventional (C14) dated site on the continental (Flaherty et al. 1997), O’Connell and Allen 2004:84:1, 46,500 years (D17). This evidence comes from a hearth in the older conventional (C14) dated site on the continental (Flaherty et al. 1997).

The wedge river region of the south-west of Western Australia. It is widely accepted as the wedge river region of the south-west of Western Australia. It is widely accepted as a geographical feature in the south-west of Western Australia.

Southwest Western Australia

Behaviour that spans the IGM

Mechanist, Cosgrove has developed a model of hunter-gatherer settlement and subsistence.
(V96), with little dateable material above this level (O’Connell and Allen 1998:142). There is disagreement over the nature of subsequent occupation sequences above the hearth. Initially, the sequence was interpreted as showing complete abandonment between c. 19,000 and 14,000 BP (Martin 1973; Wright 1971a, b). Recently others argue for continuity in occupation through the LGM (Roberts et al. 1996:15; Turney et al. 2001).

Puritjarra is a sandstone rockshelter located in the Cleland Hills approximately 300 km west of Alice Springs in the Northern Territory. The site is interesting given its location in the centre of the arid zone, in relatively close proximity to permanent water (3 km away) and being situated on the edge of an extensive area of sand ridge dune fields. Puritjarra has been argued by Smith to display evidence of “sustained occupation of the central desert from about 35,000 years ago” (Smith 2005:103).

Smith has argued that Puritjarra was occupied throughout the Pleistocene (from first occupation), including the LGM (Smith et al. 2001). However, the nature of this occupation was “likely to have involved multiple short-lived occupations before 35,000 years, with early establishment of populations in only a few focal areas” (Smith 2005:103-5). It is important to note however that cultural material from the Pleistocene layers represents less than 10% of the total site assemblage (Law 2003:122, 2005) and that on average, artefacts are discarded at a rate of less than 4 per 1000 years prior to 18,000 BP (Law 2003:128).

*Northeastern Australia*

*Temperate, sub-tropical and tropical regions*

Evidence of early colonisation in the northeast of Australia comes from Ngarrabullgan in far north Queensland. Ngarrabullgan is a large sandstone rockshelter located on top of a table-top mountain 18 km in length, 100 km west of Cairns in north east Australia.
When considering the colonization of Australia, it is important to include archaeological

2.3.2 Shalt Great Australia

Indubitably before 7,410 ± 60 BP (Davd. and Dae 1993:52; see also Davd. et al. 1997),

suggests only intermittent occupation at other times, with a major stratigraphic break.

BP. Davd. considers that Narrabulgan contains a number of occupational horizons and

occupation units and high accumulation rates of cultural materials occur only after 5,000

occupation units and high accumulation rates of cultural materials occur in lower

This level are highly stratified sediments comprising at least four stratigraphic units (Davd. and Dae 1993:52). Overlying

surface and is dated to >37,170 BP (Davd. et al. 1990) (Davd. and Dae 1993:51). Overlying

3.5 m. The lowest radiocarbon determination for the site is from 0.6 cm below the

Excavations at Narrabulgan have established a basal occupation depth at approximately

Chapte 2: Archaeology of Northern and And Australia
<table>
<thead>
<tr>
<th>site</th>
<th>region</th>
<th>technique</th>
<th>earliest date (ka)</th>
<th>reference</th>
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<tr>
<td>Huon</td>
<td>NewGuinea</td>
<td>TL/OSL</td>
<td>40-53</td>
<td>Groube et al 1986</td>
</tr>
<tr>
<td>Lachitu</td>
<td>NewGuinea</td>
<td>C14</td>
<td>35</td>
<td>O'Connell and Allen 1998</td>
</tr>
<tr>
<td>Matenlupkum</td>
<td>NewIreland</td>
<td>C14</td>
<td>35</td>
<td>Chappell 2000</td>
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<tr>
<td>Buang Merabak</td>
<td>NewIreland</td>
<td>C14</td>
<td>40</td>
<td>Leavesly and Chappell 2004</td>
</tr>
<tr>
<td>Lene Hara</td>
<td>Timor</td>
<td>C14</td>
<td>34,650±0.63</td>
<td>O'Connor et al. 2002</td>
</tr>
<tr>
<td>Leang Buran2</td>
<td>Sulawesi</td>
<td>C14</td>
<td>31</td>
<td>Glover 1981</td>
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<tr>
<td>Niah</td>
<td>Borneo</td>
<td>C14</td>
<td>40</td>
<td>Zuraina 1982</td>
</tr>
</tbody>
</table>

Table 5.2.1: Oldest radiocarbon dates for sites in Southeast Asia and New Guinea that have occupation dated at greater than 30,000 BP.

2.5.3 Summary

Current chronologies from C14 and luminescence dating of Australian and southeast Asian sites indicate that initial human occupation of the entire region occurred c. 45,000 - 35,000 BP. In Australia there are three sites that are dated to 55,000 - 60,000 BP. On the available evidence from the region it is difficult to accept these older dates. While publications concerning Malakunanja II and Nauwalabila I remain confined to matters of dating it is difficult to scrutinize the stratigraphic and archaeological data, and hence they will continue to remain contentious. The current dataset is consistent with a 'short' chronology of human occupation with initial settlement of Australia by 45,000 BP and the remainder of most of the continent including the interior by 35,000 BP.
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Archaeology of Northern and And Australia

...
to be c. 22,000 BP - 12,000 BP (see Horton 1981:23) or 20,000 BP and 14,000 BP (Bowler 1977:72-73). The model does not define how extensive this abandonment might have been, with Horton suggesting a movement to the coasts, whilst Bowler favoured minimal movement, suggesting relocation to better watered areas of tropical and temperate regions.

Bowdler’s coastal model anticipates that the arid zone was not settled until about 12,000 BP. Any late Pleistocene sites recorded within the arid zone would constitute evidence of a ‘transliterated coastal economy’ that was focused on the rivers and lakes. Arid zone occupation would have only been opportunistic and temporary along a fringe, rather than a being related to permanent adaptation (Bowdler 1990b:339). As such, the discovery of continual occupation greater than 30,000 BP in areas that are truly arid and distant to water effectively refutes Bowdler’s coastally adapted settlement model.

Figure 2.7: Colonisation models for Australia - (a) Rapid colonisation (b) Coastal colonisation (c) Fluctuating occupation (Flood 1983:80).

2.7 Settlement of the Australian Arid Zone
This section describes the background and development of current models that specifically describe the settlement of the Australian arid zone. It details the nature and extent of the arid zone, archaeological sites from the zone that date to the Pleistocene, and the main developments of the proposed model for arid zone settlement. The detailed arid zone
believed their sand dunes might have extended to most of the Australian coasts (Hesse 2005:60). This perspective does not accurately reflect the nature of occupation (Veth et al. 2005:51). Recent research has noted that deserts have community, and interconnectivity.

**Deserts and Arid Areas**

above, and at a scale greater, the pathways into Australia.
2.7.2 A Background to Arid Zone Archaeology

European occupation of the northern and central arid zone occurred fairly late, relative to other parts of the continent. As a result, in areas such as the Western Desert, some Aboriginal groups were able to maintain foraging based economies and lifestyle until up to the 1950s. This has resulted in a history of anthropological and ethno-archaeological research in Australia that has targeted living hunter-gather societies and their relationship with the arid environment (see Binford 1977, 1986; Binford and O’Connell 1984; Hayden 1977, 1979; Gould 1980; O’Connell 1977, 1987; O’Connell and Hawkes 1981, 1984).

Early approaches to this research, promoted in particular by Richard Gould, stressed a uniformity in Aboriginal culture that became known as the ‘Australian Desert Culture’ (Gould 1980; Gould and Sagers 1985). This culture was thought to have spread across inland Australia from about 10,000 BP and had endured until recent years (Gould 1980). Gould’s ‘Desert Culture’ model was based on ethnographic analogy, observations of Aboriginal settlement and subsistence combined with recent occupation sequences obtained at the archaeological site of Puntutjarpa (Gould 1977). This view of arid zone hunter-gatherers became a dominant paradigm for the next decade in Australia.

Following Gould’s’ research a resurgence in field archaeology took place during the 1980s that has had lasting effects on arid zone Australian archaeology. Three research projects were completed during this time: (i) in the sandy deserts of Western Australia (Veth 1989); (ii) in the Cleland Hills in central Australia (Smith 1988); and (iii) on the edge of the Barkly Tableland in Queensland (Hiscock 1988). These research projects have significantly altered conceptions of Aboriginal hunter-gatherer subsistence, highlighting much more regional and temporal variability than was previously considered (Smith 2005:226). Although numerous researchers have since contributed to the expanding archaeological picture of the arid zone (e.g. Barton 2001; Cane 1984; Gunn 1995; Law 2002, 2005; Przywolnik 2002,
Chapter 2: Archaeology of Northern and Arid Australia

in the desert before colonization, or were adaptations changes which occurred in
on hiving and herding resources and then adapted technology and economy in order to
vironments. For example, were the first occupants Generalist Foragers who concentrated
on the name of modern human behavior and in particular adaptations to maintain
these models relate to human responses to different climatic conditions. These responses
I take Winrock to the Southern Kimberley Region (Smith 2002:72). The differences between
gatherers were using parts of the interior from Central Australia to the Pilbara, and from
Australia desertic prior to 35,000 BP and that within 5,000 years groups of hunter-
Risk Minimizing Model (Veth 2005b). All of the models agree that humans moved into
(2) the Desert Transformation Model (Hiscock and Veth 2002) and the
recent model; (b) the Desert Transformation Model (Hiscock and Veth 2002) and the
should be seen as mutually exclusive of the others and are largely complementary of two
Hiscock 1998); and (c) a bio-geographical model (Hiscock 1998). None of these models
how much of the period is habitation and zone settlement that have ended with recent times. These are:
but the late 1980s and early 1990s Smith, Hiscock and Veth; and provided three primary

2.8 Models of And Zone Settlement

and social histories (Smith 1998, Hiscock ad quoted in Veth 1998:18), provide an explanatory framework for subsequent settlement, economic, technological
period and Australia. After initial Pleistocene settlement from about 35,000 BP each model
(1999a, p. 10). Each author provides detailed models of settlement and subsistence for
essentially continued to be driven by Smith, Veth and Hiscock, and more recently Thorley
2005, O'Connor 1995, 1999), despite concurrences models of settlement of the region has
2.8.1 The Continual Occupation Model

The Continual Occupation Model has been developed by Mike Smith and is primarily based on the results of his investigations at Puritjarra. Under the Continual Occupation Model, settlement of the arid zone is considered to have occurred as the result of an initial dispersal of humans during a lactustral climatic phase that persisted until c. 22,000 BP. At this time freshwater sources were more common and closely spaced on the landscape (cf. Bowler 1976; Jones 1979). Between 22,000 and 15,000 BP, as arid conditions intensified, significant decreases in water availability caused humans to abandon lowland areas and retreat to montane/piedmont areas, but staying within the arid zone (Smith 1988:309). Reoccupation of the greater landscape did not occur until approximately 15,000 BP, and by 4,000 BP population levels had reached a correlate with the known ethnographic models (Smith 1988:310). A further arid phase between 4,000 and 2,000 BP is considered to have increased resource stress and acted as a catalyst for further reconfigurations, including changes in technology (Smith 1988:341). This in turn led to the development of seed grinding and water conservation that supported larger populations by 1,500 BP.

Recently Smith has provided further refinement to this model and has specifically rejected ideas of settlement based purely on lactustral resource exploitation (contra Hiscock and Wallis 2005), arguing instead that such places were resource poor, and that people preferentially targeted terrestrial dry land resources (Smith 2005:98). There are four components to this revised Continual Occupation Model: (i) humans colonised Australia by at least 45,000 BP; (ii) first movements into deserts took place between 35,000 and 45,000 BP; (iii) temporary climatic amelioration allowed humans to move into deserts, (iv) this allowed multiple short-term occupations and early establishment of populations in a few areas (Smith 2005).

Chapter 2 Archaeology of Northern and Arid Australia
resource availability. Differences, particularly among water availability, are expected to
the timing of abandonment and resettlement during the final stage. By the end of the
Chapter 2: Archaeology of Northern and Mid-Australia
model proposes that environmental differences within both and semi-arid regions, and
periods before resettlement begins. Examples of areas for extended
local and regional scales resource availability during the past 45,000 years. They moved on both
place continuously anywhere in Australia during the last 45,000 years. People did not remain in
local environmental region and a response to climatic changes. People did not remain in
local environmental region and a response to climatic changes. People did not remain in

The Punctuated Occupation Model
model proposes that occupation of the and zone differed by

2.8.2 Punctuated Occupation Model

record for some of these sites is continuous and demand detailed review. There are several inconsistencies with this model, and the nature of the archaeological
capacities varied over successive millennia, particularly for larger areas. At least 45 - 50,000 BP (Smith 2005:102-3), most of these sites appear to display repeated
occupation periods of Alkoven's Cave at 39,800 BP, and Initial and terminal regions by Mann and Mann (34,000 yrs BP, and Pijuranah Creek (32,000 BP), Riverine and Lake habitats at Lake Munro date to 26,000 BP; Karrt
Evidence of occupation in sandy deserts is provided by Serpentine Gorge at 29,500 BP, and Neumann Rockshelter in the Hamersley Range is 26,000 BP. These regions support the intermittent Pilbara and Pilbara regions. Smith notes that archaeological sites in
Australian Ranges and the Hamersley Region. Smith notes that archaeological sites in
have been occupied prior to the TEC. Regional and regional areas include the Central
region and the Northern and Desert regions. Smith notes that different landscapes are considered to

(a) Inland and lake areas (Smith 2005:102-3). Each of these landscapes is considered to

(b) Sand deserts; (c) Desert and semi-arid deserts; (d) Sandy deserts; (e) Karst landscapes; and

Sandy (2005) gives examples of five different and landscapes that support this model.
result in different settlement responses during periods of aridity. In this light Hiscock (1988) proposed that the fluctuating model might include four patterns of response during the LGM. These include: (i) abandonment, (ii) oasis occupation, (iii) short term visitation of arid areas by groups at nearby oases, and (iv) short term visits to oasis areas within arid regions from non-arid regions (see Hiscock 1988:257; Veth 1993:103-114).

In most areas of the arid zone the Fluctuating Model predicts that abandonment would have occurred during the LGM, whereas at places that featured permanent water, occupation might persist at what is termed an oasis or ‘refuge’ location.

Hiscock’s study of two rockshelters on Colless and Louie Creeks at Lawn Hill in northwest Queensland provided the first support for the fluctuating model of human settlement (Hiscock 1988). At Lawn Hill, occupation is argued to occur first during the Late Pleistocene. During the period following the peak in aridity at 18,000 BP, humans in this region retreated into gorges (considered an oasis or refuge). Occupation of these areas persisted for the next 4,000 years until the climate ameliorated (Hiscock 1988). During this time foraging range and mobility were very low, with a focus only on the gorges. After climatic improvement, range expanded and resource exploitation in once-abandoned landscapes was then reinitiated (see Hiscock and Wallis 2005:46).

2.8.3 The Bio-geographic Model

This third model of arid settlement has three core propositions similar to the Fluctuating Occupation Model: (i) people maintained a presence in some parts of Australian deserts even during the height of the LGM; (ii) that changes in territory were a response to climate change; and (iii) economic and social changes continued to unfold within the arid zone during the late Holocene (Veth 1987, 1989, 1993, 1995, 2005a, 2005b; Veth et al. 2000).
Figure 2.9. 

Areas shown in red indicate regions in green and contours. 

Based on these concepts: refuges, barriers, and corridors. 

The model is a bio-geographic approach to and zone colonization in which the model is broader and zone colonization model for Australia (Holliday 1999).
Barriers are those areas of Australia where occupation would not have been possible during periods of aridity. These areas include large sand ridge deserts and are characterised by uncoordinated and internal drainage systems (Veth 1989:81). Examples of barriers include the dune fields of the Great Sandy, Great Victoria and Simpson Deserts (see Figure 2.9). Barriers however, are not thought of as unchanging permanent features, as there have been numerous periods of formation and removal of temporary examples during the late Pleistocene. Veth’s model sees these changes as a possible mechanism for connection and isolation of refuges (Veth 1989:84).

Corridors are comprised of large areas of sandy and stony lowlands. The Bio-geographical Model considers these areas to have been habitable only during climatically favourable periods, and were abandoned during the LGM as food and water resources became depleted (Veth 1989:81). Corridors would have included large tracts of land between the refuges and barriers. Occupation is expected only in the early lacustrine phase of the Pleistocene and Holocene (Veth 1989:84). During periods of climatic stress corridor sites are expected to be either abandoned, or if they are in locations rich in local resources, occupied perhaps even continually, but with a shift away from regional resource acquisition to increased reliance on local foods (Veth 1989:86). As such, the Bio-geographical Model compliments that of Hiscock - Lawn Hill is a refuge in Hiscock’s terms, and a ‘Corridor’ with sufficient resources to enable its continual occupation in Veth’s terms.

The Bio-geographical Model allows for arid zone settlement during the Pleistocene prior to the LGM. During the LGM, both barrier and corridor areas were abandoned and humans retreated either to refuges or the coast. The terminal Pleistocene/early Holocene period resulted in a gradual re-colonisation of arid lands which were previously abandoned during the LGM. Over time, increases in population in these areas were associated with the emergence of regionally specific settlement and subsistence systems. From approximately

Chapter 2 Archaeology of Northern and Arid Australia 45
explain how early colonists were able to migrate into the Australian and zone, the desert
more likely to have evolved and been maintained over long periods. Instead of having to
years rather than a 4,000 year period (see Hancock et al. 2002), economic structures were
previously thought (the Last Glacial Maximum) now thought to be a period of about 12,000
conditions (Hiscock and Wallis 2005:41). As agriculture was more drawn out than
concepts and economic and social systems that were developed in response to local
factors and would have been regionally specific. Hiscock and Wallis also expect that
As such, colonisation pathways would have followed local environmental landscapes
extraction of the interior (Hiscock and Wallis 2005:41).
Under this model greater reliance on the availability of resources prior to 40,000 BP would have

suggests allowed people to maintain a presence in the
(Wallis 2005:35). As climate changed, the dynamic nature of settlement and subsistence
conditions and maintained a presence in a rapidly changing environment (Hiscock and
not colonise deserts. Instead people settled in inland Australia before the onset of drier
modelled. Their Desert Transformation Model, proposes that hunter-gatherer groups did
model of and zone settlement that is highly complemented by Velets' Bio-Geographic
in a recent synthesis of the archaeology of deserts, Hiscock and Wallis proposed another

2.9.1 Desert Transformation Model

Recent developments in and zone models

of the arid interior even prior to the LGM (Velets 1998:40),
would have emerged, providing long distance reciprocally networks. Long term settlement
exploration of seas and hard tools. By the mid-Holocene, extended social networks
transformation' model explains how deserts effectively came to people (Hiscock and Wallis 2005:42; see also Fullagar and Field 1997, Gorecki et al. 1997).

The lack of directionality colonisation dates for the sites that provide the oldest evidence of occupation is used in this model to propose that pre - 40,000 BP occupation was not restricted to coasts. When the climatic pressures of the LGM took hold, humans consequently altered strategies and technologies in order to maintain a presence in the landscape (Hiscock and Wallis 2005:41). In this way the model predicts that human occupation of some areas of the arid zone would have persisted during OIS2 (see Balme 2000; O'Connor et al. 1998), whilst other areas were abandoned, including the barriers of the sandy deserts which arose during the period of extreme aridification marking the LGM (Hiscock and Wallis 2005:45).

2.9.2 Risk Minimizing Model

Veth has recently applied a risk minimizing model to the Western Desert data (Veth 2005c). This model acknowledges the role that mobility strategies play in hunter-gatherer attempts to minimize risk during periods of environmental stress. The application of this theory to the Western Desert has explored how high residential mobility might have been coupled with low logistical mobility during the terminal Pleistocene, within an overall territorial mobility strategy where areas were abandoned for long periods of time. Veth's analysis focuses on eight different lines of evidence: (i) the intensity of stone artefact reduction; (ii) artefact diversity; (iii) the presence of local and exotic raw materials; (iv) the quantity of grinding material; (v) stylistic uniformity in rock - art; (vi) changes in sedimentary records; (vii) change in ochre provenance; and (viii) continuity in occupation of sites. The
Chapter 2: Archaeology of Northern and Mid-Australia

The Kimberley (O'Connor and Veitch 2005).

1993:109). More recently, research has also added the area surrounding Cape Range in the Purnululu Ranges in South Australia (Hammer and Hughes 1988; Veitch 1988, 1989, 1998, 1999, 1998a, 1999a, 1999b, and Hammer and Hughes 1988). The Kimberley region of Western Australia (see S. Brown 1987; Maynard 1980), the Pilbara region of Western Australia (see S. Brown 1987; Maynard 1980), and the Hamersley Plains in the Pilbara region of Western Australia have occupied during periods of climatic instability. These regions of Australia have received detailed attention in the literature on the basis of archaeological evidence of continued occupation. Although many areas are proposed as potential refuge areas, areas remain that are often provide a central focus for discussion of both the and zone.

2.1.2 Refuge Areas

others (e.g. Hiscok and Williams 2005).

each of the bio-geographical zones proposed by Veitch (1988), and generally accepted by examining the archaeological record for the and zone. The approach to avoiding academic and consulting archaeological interest in the and zone. This section of each of the and zone settlement models can be tested against a wealth of archaeological data available for inland Australia. Since the 1980s, there has been both a wealth of archaeological data available for inland Australia. Since the 1980s, there has been both a wealth of

2.10 Archaeology of And Zone Settlement

Pleistocene was very restricted and of low intensity. Evidence is argued to indicate that for the Western Desert, occupation during the
The Pilbara

Hamersley Plateau

The Hamersley Plateau is an elevated area of 45,000 km² within the arid zone of the Pilbara region of Western Australia. Extensive parts of the plateau have been cut by the watershed of the Ashburton and Fortescue Rivers, and feature numerous archaeological sites including many rockshelters and caves. Owing to extensive iron ore deposits and the requirement for archaeological assessment in development processes, the area has constituted a growing focus of archaeological research over the last 30 years. Six sites are recorded as being occupied during the late Pleistocene: Yirra, Malea, Newman Rockshelter (PO2055), Mesa JJ24, Newman Orebody XXIX (PO187), and Milly's Cave (Figure 2.10).

Figure 2.10 The Hamersley Plateau showing the location of sites discussed in the text.

At each of these locations arguments have been made for continual occupation throughout the LGM and the termination of the Pleistocene. At Newman Orebody XXIX (PO187) an occupation sequence commences at $20,740 \pm 345$ BP (SUA1041) and is considered a conservative estimate of initial use (Maynard 1980; Troillet 1982). However, there are issues concerning the validity of the interpretations of the site. Sediments between a hearth in spit 6 are dated to $9,870 \pm 80$ BP and a combined date from spits 8 - 10 to 20,000 BP. The exact depth of each spit is unknown, but considered to be "roughly 10 cm" (Maynard 1978:2). Both Brown and Smith have argued that the site continued to be used
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...therefore may potentially be non-arising (see Hiscock 1988, Anthony 1999).

...suggested that these baked pieces are comprised of material that is non-durable, and

99% of the assemblage is classified as unmodified flakes and baked pieces. It has been

recorded from the excavations, discrete areas during the prehistoric are unclear, and over

can depth (Edwards et al. 2001:45). Although a large number of stone artefacts were

39.0 to 23.0 cm deep) and 15.230 to 23.0 BP (18.490 to 25.0 cAL BP) (vK-382) (72.5

example, two radiocarbon determinations of 20.360 to 23.0 BP (20.370 to 25.0 cAL BP) (vK-

diose slabs have poor chronological resolution (Conway and Veth 2002:38). As no date for

Mesa 2,184, and the Milly's cave (Veth and Hoek 2002); 2 (t) Mesa (Edwards et al. 2001):

the LCM include: (3) Warna (Veth and Hoek 2002); (3) Warna (Edwards et al. 2001);

Rockshelter slabs that have also been recorded as possible Pilbara Regional locations


Williams 1988:136), decreases to zero in sp1.12, and with spines 13 and 14 yielding just

years between these two levels artefact discard is extremely low, with < 5 artefacts/1,000 years.

correlate with section data from which show a maximum depth of approximately 1 m.

those samples were recovered is unknown (the authors estimate of 10 cm spans does not

uniformly the Newman Ochrebody XXIX (P0187) the depth below surface from which

radiocarbon determination from sp1 10 is only 6,270 ± 210 BP (vWATL-121).

(Comerrese 2003:120). The 26,000 BP determination comes from sp1 16, whilst a

(Comerrese 1987:24), there is doubt as to whether a continuous of occupation can be claimed

When Newman Rockshelter (P02055) has a basal date of 26,300 ± 500 BP(8UV-1510) (S.


and artefactual data, and radiocarbon dates do not negate a phases in occupation (Veth

during the LCM (S. Brown 1987:23; Smith 1988:305). However, the lack of stratigraphic
Neither the Yirra or Mesa J24 sites have been reported in enough detail to provide review here. At Yirra, a date of 19,270 ± 140 (Wk-8954) has been obtained from a concentration of artefacts and charcoal, and is thought to be a refuge occupation (Veitch and Hook 2005). At Mesa J24 a single date of 23,500 BP (28,380 ± 450 cal BP) (Wk-2514) has been recorded below a date of 3,950 BP (Hughes and Quartermaine 1992).

Milly’s Cave features a deposit of approximately 70 cm depth that has evidence of occupation from at least 18,750 ± 460 BP (Wk-2188) (Marwick 2002:183; O’Connor and Veth 2005:39). The site appears to have been occupied periodically during the LGM when artefact discard appears to be high. However, the lowest radiocarbon determination occurs at the conclusion of the LGM and discard rates underlying this level are very low (see Marwick 2002:188). Marwick has suggested that changes in raw material discard at Milly’s Cave provide evidence of a reduction in territorial range similar to that at Lawn Hill for the LGM (Marwick 2002:211-12; O’Connor and Veth 2005:40). However, as with Lawn Hill the Milly’s Cave data provides more compelling evidence of occupation immediately post-dating, rather than during, the LGM.

O’Connor and Veth (2005) and Veth (2005b) have proposed a model for the Late Pleistocene occupation of the Hamersley Plateau: (i) human occupation persisted in uplands areas during the LGM; (ii) within these areas there was a territorial retraction into ranges; and (iii) intensity of visitation of sites is differential in relation to locally available resources (O’Connor and Veth 2005:41). There is however, no clear evidence for occupation of the region between 17,000 - 13,000 BP (Veth 2005b:137). The nature and extent of occupation in the Pilbara uplands is hotly debated (see Marwick 2002; Comtesse 2003) and at this time fails to meet Veth’s requirements for refuge occupation, which includes occupation through the LGM with evidence of multiple occupation events (Veth 1989:86).
### Table 2.3: Separation of the Premier deposit into analytical units based on age determinations

<table>
<thead>
<tr>
<th>Surface</th>
<th>Depth Below</th>
<th>Smith's Uplodesed (BP) Age Range</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only occupation horizon</td>
<td>0-0.8 cm</td>
<td>0-800</td>
<td>Unit</td>
</tr>
<tr>
<td>72-8 cm</td>
<td>3.2-0.32 cm</td>
<td>10-800</td>
<td>Unit</td>
</tr>
<tr>
<td>65-75 cm</td>
<td>7.5-0.01 cm</td>
<td>1800-3200</td>
<td>Unit</td>
</tr>
<tr>
<td>43-65 cm</td>
<td>3-2 cm</td>
<td>7500-18000</td>
<td>Unit</td>
</tr>
<tr>
<td>31-4 cm</td>
<td>3-5 cm</td>
<td>3500-7500</td>
<td>Unit</td>
</tr>
<tr>
<td>12-31 cm</td>
<td>800-3500</td>
<td>0-800</td>
<td>Unit</td>
</tr>
<tr>
<td>1 cm</td>
<td>1-1 cm</td>
<td>0-0</td>
<td>Unit</td>
</tr>
</tbody>
</table>


Large scale dating programs have been completed and interpretations of the site have changed. 3 analytical units, and layer 2 into 4 analytical units (Table 2). Since Smith's study (1988) a small part of the Holocene is also represented in layer 2. Smith further divided layer 1 into two subunits within two stratigraphic layers were identified at Pullarina. Layer 1 represents the Holocene, and layer 2 the Pleistocene. However, it should be noted that a.

The natural stratigraphy and a stone artefact assemblage were identified at Pullarina, including a trench consisting of 8 m² from which almost 10'000 stone artefacts were recovered (Law 2003, Smith 2006). Smith developed a detailed chronology for Pullarina, including a trench consisting of 8 m² from which almost 10'000 stone artefacts were recovered (Law 2003, Smith 2006). Smith developed a detailed chronology for Pullarina, including a trench consisting of 8 m² from which almost 10'000 stone artefacts were recovered (Law 2003, Smith 2006).
Smith has proposed that Puritjarra rockshelter provides evidence of occupation of the arid zone prior to c. 35,000 BP (Smith et al. 2001). Following this time, changes in resource availability brought about by changes in climate, particularly during the LGM, caused changes in the territory, mobility and possibly trade of hunter–gatherers that are reflected in the use of the site. However, following his Continual Occupation Model, whilst settlement at and near Puritjarra was restricted to springs and permanent waterholes during the height of the LGM, occupation is argued to be continuous through all the different climatic periods of the last 30,000 years (Smith 1989b:93). Smith considers that particular adaptations (including the development of specialist technologies like seed grinding), were the result of human responses to increasing aridity that must have occurred in situ (Smith 1988, 1989a, 1989b).

Smith has argued that Puritjarra was visited continuously but with low intensity throughout the LGM (Smith 1988, 1989b, 2005). As with other continental sites, the intensity of occupation (or visitation) increased markedly during the Holocene (cf. Hughes and Hiscock 2004), particularly in the last 1000 years (Smith 2005:102). On the basis of the current data, rates of sediment accumulation and artefact discard during the glacial period, an alternative interpretation is also justified. Radiocarbon determinations from the main excavations in square N10 are separated by only a few centimetres, and range from 21,950 ± 270 BP from spit 11 to 12,020 ± 240 BP in spit 9 (Smith 1988: Table 4.3). A radiocarbon determination of 17,460 ± 840 BP from an adjacent trench (M11) with a “continuous presence of lithic material” is argued by Smith to provide evidence of at least intermittent occupation (Smith 1988). Smith does consider that there is less evidence of occupation during the LGM, reflecting changes in the location of activities within the site and a decline in the frequency of visitation, as it became increasingly difficult to gain access to the Cleland Hills for groups, argued by Smith to be resident in ranges to the east (Smith 1988:99).
Chapter 2  Archaeology of Northern and West Australia

Two hearths near Cooper Creek have been dated at providing such evidence. Once again, sites south of Lake Eyre and Harker Lagoon, JSN, and Smith et al. (1990) have shown that these regions had been occupied a Pleistocene refuge (see

Lake Eyre and Harker Lagoon

and where possible exploring temporally sources.

throughout settlement strategies that aimed to conserve resources around permanent water.

(K-thory 2001:1). Populations appear to have implemented risk minimizing behavior

reflected in a trend towards smaller group sizes associated with general resource scarcity

permanently water sources. Theory interprets settlement and subsistence strategies as

when this time higher aquatic densities are associated with ephemeral rather than

contain. Smith et al. 1988), there is clear evidence that a prehistoric occupation after 12,000 BP (Thorne 1998a:44)

additional, though the core of the 172 km3 forested people from the region (Thorne 1998a:45)

Theory considers that initial occupation of this region was independent of developments to

contain a large assemblage of flaked stone and organic items.

From 12,000 BP the usage increased and the upper layer of the site dated to 7,500 BP

Thorne has suggested that a cultural hiatus occurred during this period (Thorne 2001).

between 24,000 - 12,000 BP accumulation of artefacts and sediments is very low and

Deeser (1998) has predicted a basal occupation date of 29,510 ± 230 BP (Thorne 1998a:45)

Kulhpa Maria is a large sandstone rockshelter located on the eastern side of the Western

then abandoned between 24,000 and 12,000 BP, when occupation commenced again.

Thorne (1998a, p. 200) have shown that the region was first occupied prior to 30,000 BP.

precisely of settlement and subsistence has been proposed. Excavations at Kulhpa Maria by

Very close to Punmara in the Palmer River catchment in Central Australia, a different

Kulhpa Maria
there are issues with interpretations of these sites. Hughes and Hiscock (2005) point out that Hawker Lagoon is located in the semi-arid Flinders Ranges, near to permanent springs. At this site, an *in situ* industry of large artefacts dated to 18,000 BP is overlain by late Holocene assemblages (Lampert 1985; Lampert and Hughes 1988). Further research in the area has failed to record additional sites of Pleistocene antiquity (Hughes and Hiscock 2005; Lampert 1985).

The JSN site consists of a single hearth with no associated stone artefacts. Smith *et al.* have argued that radiocarbon determinations indicate that the site was used more than once between 17,500 and 11,500 BP (Smith *et al.* 1991). Finally, the Cooper Creek hearths both date to approximately 14,000 BP and are associated with stone artefacts (Veth *et al.* 1990).

Archaeological evidence of Pleistocene settlement for this region is marginal (contra Smith *et al.* 1991). The few sites that date to the Pleistocene supports the assertion that there might have been very episodic use of the arid zone in this region from the late Pleistocene (Hughes and Hiscock 2005:10).

_Northwestern Australia_

_Carpenter’s Gap_

The area around Carpenter’s Gap has been occupied for at least 42,000 years (O’Connor and Fankhauser 2001), though at Carpenter’s Gap 1 there is little evidence for occupation between 30,000 and 11,000 BP. O’Connor and Veth have argued that after the initial occupation at Carpenter’s Gap 1 evidence of occupation is sparse. A lack of cultural material is considered the result of intermittent occupation during and immediately after the LGM (O’Connor and Veth 2005:35). In fact, flaked stone artefacts decrease in number ‘dramatically’ from spit 16 and are found in ‘negligible numbers’ from spits 19 to 46.

**Chapter 2** Archaeology of Northern and Arid Australia
These sites are small limestone rockshelters located in the Cape Range National Park, on the coast and those areas considered refuges discussed above. Usually made explicit in the literature, other than they are located between the Pleistocene Australia, and (ii) northwestern Queensland. Why these regions constitute corridors is not

5 regions of Australia are considered as corridor areas: (i) the coastal Pilliga and

2.10.2 Corridor Areas

and therefore it is difficult to evaluate these claims. and with 2000 BC. At this time there is no published data concerning Carpenter's Gap, the O'Connor and Vault 2000 BC. Stone artefacts and faunal remains are also chronicle a consistent human presence in the O'Connor and Vault 2000 BC. They conclude that when the caves from both sites are combined they material from another local site (Carpenters Gap 2), which is not full of complect (O'Connor and Vault 2000 BC). This assertion is based on analyses of Carpenter's Gap area persist through the LGM. Carpenter's Gap are considered the LGM. O'Connor and Vault have recently argued that occupation of the Napper Ranges and exclusive phases of occupation during the LGM rather than sparse occupation. However, reported from site 16 onwards, then it is more likely that Carpenter's Gap 1 remains an
the North West Cape. Both Mandu Mandu and Pilgonaman Creek were excavated by Morse (1993, 1998), and the latter two sites were recently excavated by Przywolnik (2002).

At Mandu Mandu rockshelter test excavations revealed a stratified deposit extending to a depth of 80 cm. A radiocarbon determination on a carbonate nodule returned a date of 34,200 BP (Wk-1513) (Morse 1993). Morse defined two main phases of occupation separated by a temporal disconformity dated between 2,420 ± 200 (WALT 117) and 19,500 ± 440 years BP (marine corrected date based on 20,040 ± 440 BP SUA 2614), indicating both a sedimentary and occupational hiatus for about 18,000 years (during and after the height of the Last Glacial Maximum).

Morse argues that occupation of the Pilgonaman Creek site is roughly contemporary with Mandu Mandu, with a (near) basal date of 31,770 (R1698/1). However, she notes that this early date does not date occupation, which begins about 17,410 BP (R11879/1)(Morse 1993). The same hiatus in both sediment accumulation and occupation debris recorded at Mandu Mandu is thought to persist until about 11,000 BP. At least two significant inversions in the radiocarbon determination sequence for the site have been reported (see Przywolnik 2005:184).

The two rockshelters, Jansz and C99 excavated by Przywolnik (2002), contain basal occupation dates of 35,230 BP (Wk-8919) and 33,930 BP (Wk-8925) respectively. Both sites were subsequently abandoned during the LGM - Jansz between 31,000 and 11,000 BP, and C99 at the end of the LGM between 21,000 and 8,000 BP (Przywolnik 2002:300, 2005:190). Unlike other coastal regions, the onset of the LGM did not have a significant effect on the position of the coastline relative to Cape Range. It is unclear why the area was abandoned during the LGM, although it is considered most likely that populations

Chapter 2 Archaeology of Northern and Arid Australia
to document post LGM re-occupation of a Kimberley corridor (Droesch 1972; 1984)

Within rockshelter, located in the Keep River in the eastern Kimberley has been positioned

Wimmera

incidences for a local population to remain in the region.

which became an inland mountain range during the height of the LGM, provided few

above 11,000 BP (O’Connor 1999:49, 60). It appears that for this area the local landscapes

the Keep. In 2 she appears to have been abandoned from approximately 21,000 BP until

600 BP, with a cultural hiatus between 18,450 ± 1,800 BP and 7,500 ± 400 BP. Similarly

corridor abandonment W shed in I has an occupation sequence commencing at 27,190

and 2005; Wether 1996, Walsh 2000). Of these, two are present in evidence of

Newman; Barrowton, Wandal and Domesdale; 2 and 3 (O’Connor 1995, 1999, O’Connor

may encompass the late Pleistocene period. W shed in I, Keep 2, High Cliffs I, I

there are other archaeological sites with radiocarbon chronologies from this region that are

addition to the route identified around Carpenters Gap (O’Connor and Wether 2005).

Wether (1993)) notes that a corridor area would have formed in the Kimberley region in

Kimberley

she is identified (Wether 2005:136).

radiocarbon determinations immediately post LGM to ca 12,000 BP abandonment of the

rises of both sediments and marl and cultural deposits. Combined with an absence of

zones and were not limited to marine resources, and there are consistent changes in the

coast from 34,000 BP; related to a wide variety of resources from different environmental

based on the Palaeo coastal data, Wether (2005b) concludes that humans occupied the and

might have moved to regions with more reliable resources, particularly water (Peytovich

2005:190).
Dortch and Roberts 1996). Initial occupation of the site occurs at 17,980 ± 1,370/- 1170 BP (ANU-1008) and features abundant stone artefact and faunal assemblages through the Late Pleistocene horizons (Dortch and Roberts 1996:33). However, radiocarbon determinations from bone carbonate, obtained from similar depths within the same stratigraphic unit of the site, have provided very different determinations of 4,900 ± 850 BP (ARL-246) and 7,600 ± 700 BP (ARL-246B).

**Inland Western Australia**

**Serpents Glen**

Serpents Glen rockshelter is located on the margin of the Great Sandy Desert in inland central Western Australia is another cited example of a site located in a corridor area, positioned in a sandstone range surrounded by low relief dunes. Excavations by O’Connor have identified three primary stratigraphic layers at the site, the lowest of which has returned a radiocarbon date of 23,550 BP with a cultural hiatus shortly after this time (O’Connor et al. 1998). Near Serpents Glen is another site – Katampul - which also has a reported date of > 21,000 BP. There is very little cultural material above this date until reaching the upper layers of the site which date from 4,710 BP to the modern period and the upper-most layer at Katampul contains over 98% of the stone artefact assemblage. As such, there is a high probability that the site was abandoned between 20,000 BP and 5,000 BP (O’Connor and Veth 2005:37; Veth 2005b:139).

Based on the data from Riwi and Carpenter’s Gap, Veth has argued that occupation of the margins of the Western Desert is of great antiquity (Veth 2005b). Occupation sequences at these sites do not continue during periods of climatic stress and the Western Desert margin
Chapter 2: Archaeology of Northeastern and Australia

whilst at Lone Creek Cave the occupation sequence commences from 17,000 BP, around 30,000 BP (with a hiatus for an unknown period up to approximately 17,000 BP). There is evidence of settlement preceding the onset of glacial conditions (probably excavaions at Colleen and Lone Creek Caves at Tarn Hill (Hiscock 1988). Colleen Creek Evidence of Pleistocene human occupation of northwest Queensland focuses on Hiscock's...

Northwest Queensland

People were not settled in this and region during the LGM.

abandoned between 19,500 and 14,000 BP and that there is a continuing presence that appears to have been interrupted by a gap of between 12,000 and 9,000 BP (Andrefsky 1992). After 9,000 BP the region was intermittently occupied between 9,000 and 7,500 BP (Whelan 1991). Another date from the proximal area of the site is 13,700 BP (Whelan 1991). Recent evidence from the site indicates that it was abandoned during the LGM and that occupation was infrequent.

The Nullabor Plain

(Whalen 2005b:140)
According to both the Fluctuating and Bio-geographic models, the Lawn Hill region has been labeled as both a corridor and a refuge area. As a corridor area the region was expected to reflect evidence of abandonment between 20,000 until 14,000 BP (Hiscock 1988:259). However, Hiscock considered that the archaeological evidence ultimately contradicted this prediction and that it provided the basis for further refinement of the fluctuating model. He argued that the two excavated rockshelters, Colless Creek and Louie Creek, were occupied before, during and after the late Pleistocene arid period (Hiscock 1988:259). During the height of the LGM there was permanent occupation surrounding an oasis at Lawn Hill, but population densities were low and foraging territory was greatly reduced. The Lawn Hill data has shown that once the aridity of the LGM ameliorated, foraging ranges expanded once more and that the late Holocene was characterized by both extensive foraging range and associated population increases (Hiscock 1988:259).

More recently the Lawn Hill data has been cited as evidence of a ‘refuge’ during the LGM period (see O’Connor and Veth 2005). In reality the data actually provides compelling support for the argument that Lawn Hill was abandoned during the LGM and OIS2, rather than being a focus of human occupation.

2.10.2 Reoccupation of Corridors and first settlement of barriers

According to the Bio-geographic Model a proliferation of new sites were occupied within corridor areas shortly after the amelioration of glacial conditions, as groups that had previously occupied either refuges and/or well-watered corridor areas expanded in territory. During the late Holocene the final bio-geographic area ‘barriers’ were finally settled. Veth specifically uses examples of three archaeological sites to support the post LGM corridor reoccupation: Puntutjarpa, Walga Rock and Balcoracana Creek. All three
Chapter 2: Archaeology of North and Central Australia

The lack of systematic sampling of the continuous record identification of one old could be due to errors in the excavation or to 10,000 years. Secondary, there is a confidence limit of error margins can be potentially up to 15% with TL and OSL dates having 68% and zone. Finally, the age estimates are broad with TL and OSL dates having 68% and zone. These crucial issues concern the colonization of Australia and settlement of the region. The crucial issues concern the colonization of Australia and settlement of the region. The crucial issues concern the colonization of Australia and settlement of the region.

This chapter has examined the evidence and issues surrounding the timing and routes that humans took into Australia and the subsequent migration into the and zone. The human migration into Australia and their subsequent migration into the and zone.

II. Conclusions

Starting to 3,040 BP (Smith 1988:269, Veth 1989:89), Yampi, All sites dated to the mid-Holocene, with exceptions, including the Simpson Desert also to test this assertion and include the Pilbara, Kalumburu, Wyndham, Kalumburu, and excavated by Veth in the Kurradji River region of the Pilbara/Cat Creek Sandy Desert were used resulting in a range of economic and social translocations (Veth 1991:11). Since occurred last of all, during the mid-Holocene, as a result of increasing population levels, according to Veth's model, occupation of barrier regions including sandy desert areas expansion.

According to Veth's model, occupation of barrier regions including sandy desert areas expansion.
archaeological deposit in any region should be regarded as a minimum antiquity for that area (see Hiscock and Wallis 2005:36). Thirdly, there is a deficiency of detailed discussion of taphonomic/formational processes for almost every deposit cited in discussions of these issues (see also O'Connor and Veth 2005).

Veth has observed that developing a model for the settlement of the Australian interior has been a matter of "the filling-in of great blanks on the archaeological map, once survey and excavation has begun to explore them" (Veth 1995). Excavations by Veth in the Western Desert, Hiscock at Lawn Hill, O'Connor at Carpenters Gap and Smith at Puritjarra have only just started to build the explanatory frameworks for this transitional story. Given the enormity of the Australian continent, further excavations and detailed regional studies are required.

Given the proximity of the Riversleigh and Lawn Hill research area to both possible colonisation routes and to the interior, the issues of colonisation and arid zone settlement models are of central concern. The following chapters now turn to a more detailed presentation of the Lawn Hill data and the development of a regional settlement model that is complementary to the risk minimizing model described.
Chapter 3: Lawn Hill and Cult / Lake Carpentaria

Artefacts from the site. A further reconnaissance held trip by Hughes, Hiscock, Morwood
The site drew widespread interest, with Hiscock employed in c. 1980 to examine the stone
occupation of Collens Creek Cave was at least 30,000 BP and much have been much older
continuous 50 cm x 50 cm test pits (Hughes nd). Hughes argued that the initial
date of c. 17,500 BP (Hughes 1980). Over 200,000 stone artefacts were recovered from
Cave on Collens Creek (a tributary of Lawn Hill Creek), which yielded an initial occupation
1981), further interest developed following archaeological excavations at Collens Creek
attacked in first scientific attention by those interested in inland northern Australia (Apin
During the late 1970's and early 1980's, the southwestern region of the Gulf of Carpentaria

3.2.1 Background – Interest in the Region

Subsistence activities for the region.

Drawing from these sites formed the basis of Hiscock's model of settlement and
assembly from these sites formed the basis of Hiscock's model of settlement and
excavation of numerous archaeological sites. Detailed analyses of the phase stone
within the present study area (see Figure 3.1) and involved survey, and subsequent
human settlement. Hiscock's PhD research focused on the Lawn Hill Region, which is
northwest Queensland. The chapter presents Hiscock's model of and semi- and
the Australian and zone and refuge models, specifically in relation to his research in
This chapter reviews the contribution of Peter Hiscock to the issues of the settlement of

3.1 Introduction

Carpentaria and Australasia's And Hunter
Lawn Hill and the Pleistocene Settlement of the Gulf/Lake
and others along the O'Shannassy River was completed, but no publications or reports were generated (Hiscock and Hughes 1984). At the time, plans were made to survey the length of the Gregory River, although it appears that such a fieldtrip never occurred, and after 1980, archaeological investigations of the region were concentrated at Lawn Hill by Hiscock.

![Map of Lawn Hill and surrounding areas showing Colless Creek Cave and Louie Creek Cave](image)

Figure 3.1: Hiscock's study location at Lawn Hill, northwest Queensland showing the survey area in yellow and the locations of Colless Creek and Louie Creek caves.

3.3 Hiscock’s Doctoral Research

The aims of Hiscock's PhD research were to examine the nature of material culture at Lawn Hill with particular reference to the manufacture and transport of flaked stone artefacts, stone raw material procurement strategies and developing technological approaches to explanations of assemblage variation (Hiscock 1988:2). One of the
Chapter 3: Lawn Hill and Cult / Lake Carpentaria

decriminations of ancient discards (Hiscock 1988:83).

importantly, the two factors appeared to be the primary environmental
relationships. Although stone sources, neither taken alone explained the nature of the
permanent water and stone sources, neither taken alone explained the nature of the
Hiscock’s surveys revealed that although stone artefacts were similarly associated with both
discredit dropped substantially but no consistent trend was evident in distance-decay curves.
within 200 m of these features. At a distance greater than 2 km, overall rates of stone
water sites were within 3 km of either water or a quarter, with almost all sites occurring
the study area were located within 3 km of stone sources, or within 3 km of permanent

gathered containing the maximum density of flaked stone artefacts. Over 80% of all sites in
gathered more frequently contained sites than those farther away. Those units closest to
Hiscock’s survey consisted of flint-chipper 1 km units spread across the Lawn Hill study area

3.4 Survey

selected sites.

main elements: an initial detailed survey of the region, and excavation of a number of
especially procurement and discard (Hiscock 1988:7). Hiscock’s research consisted of two
response to environmental change, achieved through analysis of the location of activities,
underlying theme of the study was to reconstruct how changes in material culture reflected
Figure 3.2: Hiscock's survey of Lawn Hill. Each 1 km² surveyed unit is shown in red. Dark grey shaded areas indicate plateau, and lighter shaded areas indicate mesas and sandstone hills (Hiscock 1988).

Hiscock concluded that the trends in stone artefact discard near quarries was most likely the result of occasional use over extended periods that “created an abundance of debris relative to activities of similar duration at other parts of the landscape” (Hiscock 1988:84). High artefact discard near to water is argued to be the result of activity locations centering on water, where material was transported, used, and discarded.

Hiscock also suggested that the way in which the landscape was used, that is the intensity of activities across the landscape, was differential. Secondary factors including seasonal water and shelter were found to influence artefact discard. Sheltered sites on rocky outcrops with extensive views across the landscape displayed higher discard densities than other locations, and the same was true of areas close to seasonal water and caves.

Along the river corridors differential rates of discard were also found. Areas on levee banks displayed higher concentrations than other areas. A variety of taphonomic explanations are offered for these trends including, hunter-gatherer preferences for flat

Chapter 3 Lawn Hill and Gulf / Lake Carpentaria
Chert is found at two locations in the region: Mount Fenner and the Bandy Planta.

Chert commonly made from two types of rock: chert and flint. Flint stone artifacts are mostly rockshelters and caves, and open sites in the region. Rockshelters are found on the surface of many formations common across Florida, and other stone artifacts are found within the surface of many formations.

Hiscock 1988:50)

The geology of the Lawn Hill region is such that the location of stone materials available across the landscape. A non-missionary reduction sequence was found between sites. The main focus of Hiscock's survey was to examine the nature of reduction sequences.

Stone artifacts reduction

In for all sites with evidence of occupation (Hiscock 1988:69).

Potentially habitation sites and was found to be 14 m with an average volume of 30 - 45

determinative. For such site use being available floor size. Floor area was recorded for 88

features displayed evidence that they had been extensively used by humans with the interior

Hill and Coles Creaks - included numerous caves, rockshelters and fissures. These

Survey revealed that the geology of some areas - most notably the large systems of Lawn

disconnected boulders of archaeological material.

sediment deposition on lower creek banks due to flooding that had effectively masked any

locations (Hiscock 1988:7). It was also suggested that there was probably greater

areas and where sediment, the presence of trees providing shade and food resource
As such, the Cambrian dolomites of the Barkly Plateau and the Thorntonia limestone represent the only sources of this material. Within the dolomites, chert occurs in two forms: (i) exposures in the parent limestone running in thin bands (Figure 3.3), or (ii) rounded nodules (up to 15 cm in diameter), cobbles and gravels in the beds of watercourses. Hiscock differentiated between two types of chert labeling them Q-chert (quarried) and R-chert (river), using a number of attributes. These are detailed in Table 3.1 below.

<table>
<thead>
<tr>
<th>attribute</th>
<th>r - chert</th>
<th>q - chert</th>
</tr>
</thead>
<tbody>
<tr>
<td>shape</td>
<td>angular and often cuboid</td>
<td>spheroid</td>
</tr>
<tr>
<td>cortex</td>
<td>thin and smooth</td>
<td>surrounded by dolomite</td>
</tr>
<tr>
<td></td>
<td>distinctive red and yellow suggesting oxidation</td>
<td>weathers to become grey or black</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rough and rilled</td>
</tr>
<tr>
<td>fracture</td>
<td>smoother more lustrous surfaces</td>
<td>greater effort to remove flakes</td>
</tr>
<tr>
<td></td>
<td>distinct banding</td>
<td>ventral surfaces are rougher</td>
</tr>
<tr>
<td></td>
<td>much greater variance in fracture quality</td>
<td></td>
</tr>
<tr>
<td>colour</td>
<td>wide range from white to yellow and blue to black</td>
<td>white to grey throughout</td>
</tr>
<tr>
<td></td>
<td>often banded</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1: Attributes of quarried and river cherts at Lawn Hill, northwest Queensland (after Hiscock 1988:51-2).
The fracture properties of greywacke are generally good but are subject to control by well
small inclusions of석전 flakes and quartz crystals set within the calcareous matrix. If these features
appearance with a dull and rough grey-green vesicular surface cortex. If other features
Greywacke can be generally described as having a medium green-grey or blue-grey

Figure 3.3: Greywacke in a limestone band near College Creek, Lawn Hill, northwest
Queensland.

Hand cores transmit force particularly well
does not produce pitting conducive to hanging. While over chert, with its thin and
knapping. Quartered material with a thicker and softer cortex transmits force poorly and
Of the two types of chert, the cobbles from here are by far the better raw material for
formed and weathered cracks. When the fracture plane passes across such cracks the direction of fracture is altered and step terminations are likely.

Suitable greywacke for use as flaking stone occurs as cobbles, boulders, and angular slabs. Within greywacke outcrops, cobble size was relatively uniform, but varied considerably between sources: 5,337 cm³ at Pages Creek, and 215 cm³ at Dinner Creek (Hiscock 1988:53).

Tensile and compressive strength of greywacke is far lower than that of chert. While less force is necessary to initiate fractures, the material is less easy to control. Hiscock determined that these attributes suited production of large, thick flakes and that the potential use-life of artefacts made from greywacke would be substantially less than those made from chert (Hiscock 1988:54).

Figure 3.4: Photograph of greywacke outcropping on a spinifex hill at LH9, Riversleigh, northwest Queensland.
concrete, and many of these cores were not transported far from their source. A rare deposit of redbeds removed, reduction of quartz cored chert initially showed only to remove
Quartz cored chert cores were generally reduced by reduction, with minimal initial reduction (as
specific and had thick cores that required platform preparation (Hiscock 1988:155)).
example, chert cores had been quarried rather than obtained from inset cavities. In other
platform preparation. Where cores were thicker, platform preparation occurred. For
were another with a thin cortex were often stuck on the natural surface with no prior
100–250 cm, and thin all were less than 400 cm (Hiscock 1988:153). Nodules which
be a critical factor in reduction. Hiscock noted that their nodules were mostly between
arthropleaquadont assemblies. The overall morphology of my material, nodules appeared in
of the stone raw materials available at Lawn Hill, chert and graywacke dominate the

3.4.1 Survey Results

transported from quarry sites to the south east and possibly as far away as Lake Mcobrrra
suitable raw materials sources are known in the region. This material may have been
flakes ground implements produced from mezodolite occur at Lawn Hill. Although no

the Poindley Mountain formation to the east of Lawn Hill (see Hiscock 1988:4). A quartzite of Maket Red cobbles at the edge of Lake Erkouron on
region. Quantities of Maket Red cobbles at the edge of Lake Erkouron on
Mezolite formations along Mezolite Creek are the most likely sources in the
outer components are composed of silcrete, quartzite and mezolite. Silcrete is
While chert and graywacke dominate stone raw materials suitable for making the other

Other raw materials
In contrast, the reduction of chert cobbles obtained from creeks (R-chert) was often undertaken with no core rotation. Hiscock found that R-chert featured prominently on the plains, and that the initial stages of reduction took place at gravel banks within the riverine areas at sources. Initially, ten flakes on average were struck from chert cores. Reduction was often aimed at producing large broad flakes with pronounced bulbs. Such flakes were often used for tula adze manufacture. At one site, LC2, Hiscock found that some of these flakes had been retouched in a burin-like way, with the removed spalls used to manufacture backed artefacts. River cobbles chert cores were also transported some distance onto the plains. With increasing distance northwards and away from sources, a greater amount of core rotation was noted.

Greywacke reduction was markedly different to that of chert, primarily due to the size of nodules and raw material qualities. On the plains, greywacke boulders size up to 5,000 cm³ were reduced by removal of between 70 to 100 flakes (chert flake removal was generally between 30 and 50). Often greywacke was heat treated late in the reduction sequence and immediately prior to retouching flakes. No evidence of bipolar flaking was found with greywacke, whereas chert flakes were sometimes struck using this technique (Hiscock 1988:157).

Different raw materials were used for particular artefact types and inferred uses. Chert, with a very fine grain and strong tensile strength is the only raw material used for artefacts where maintainability was of concern. Artefact types such as backed artefacts, tulas and scrapers are only known on chert from this region. Greywacke, in contrast, is of less tensile strength, coarser grain but available in larger nodules and was favoured for point production (Hiscock 1988:160).
Within the Collesses Creek Core, there are several perennial pools of water containing fish. Abundance of sandstone boulderites (Forschl 1988:164) on C2 which has been extensively quarried, and two archeological sites containing on the ground is bare rock. Close to Collesses Creek, there is a natural outlet of a creek (s) where there is no water on the plain and about 70% of the surface is a plain that consists of dissected flat-topped hills and varved flats.

A very season storms run along the south wall where layers of gravel and artefacts are exposed to the rear of the shelter to the front and from left to right. Water flows as a result of the water flow, and artefacts and features are left behind. The cave floor is a vertical face. The roof of the cave has a thin layer of gravel, below a 1.5 in vertical cliff. The rock is a limestone cap that is 7 m wide, 2 m high, and the cave is the 5 m above the creek at the top of a steep scree slope and the immediately below a cliff from the eastern ends of the Barley Plains. The entrance to Collesses Creek Cave (Figure 3.5) is located on a small perennial tributary of Lawn Hill.

3.5.1 Collesses Creek Cave

and two rockshelter sites, Collesses Creek Cave and Lawn Creek Cave.

Forschl paras, which has excavated a number of archeological sites including two open-middens sites, with a model of flaked stone artefact discard and reduction formulated for the study area.
fringing vegetation, and remnant species including *Livistona* *sp.* and cycad. Faunal species found here are less numerous within the gorge than on the adjacent plateau, and include small macropods, possums, echidnas, and bats. A gravel bank immediately outside the cave contains nodules of R-cherl.

![Image of Colless Creek and vegetation](image.jpg)

Figure 3.5: *Colless Creek showing the limestone gorge and vegetation adjacent to the creek, Lawn Hill, northwest Queensland.*

There are at least thirty known rock-art sites along Colless Creek (Walsh 1982, 1985; Border 1989; Slack 2002). Freehand painting accounts for almost all the motifs with a few abraded engravings and a couple of hand stencils (Walsh 1982:4). Most of the motifs in the gorge are schematized with smaller groups of figurative motifs consisting of bird tracks, human figures, snakes and boomerangs, almost all of which are mono-chrome. One humanoid consists of a polychrome figure in-filled with black, with decorative red internal lines and a perimeter white outline. Abrasion techniques have also been often used to enhance the outline of some older motifs. The art of the gorge seems to contain elements of the first and oldest (6) phases of art styles (Walsh 1982; Border 1989).
detected from root fill and a sandy matrix of pedocals of calcareous clay and quartz separated by a gravel lag deposit. The upper layer (unit V) consists of a dolomite gravel.

The stratigraphic sequence of Colless Creek Cave consists of two distinct horizons.

**Figure 3.6: Plan of Colless Creek Cave showing excavated squares, Lawn Hill, northwest Queensland. Square P6 which was used by Hiscock for his analyses is shown in red.**

Square within the cave and 66 squares on the escarp-slope. Ten test pits were excavated by the site (see Figure 3.6 below). Surface artifacts were also collected from a further four further ten 50 cm x 50 cm squares around the Hughes and Ahlin test pits at the front of the site. (see Figure 3.6 below). Hiscock's subsequent 1982 investigations involved excavation of excavations of Hughes and Ahlin consisted of four 50 cm x 50 cm test pits, two.
grains. The lower unit (Unit B) consists of a reddish brown dolomite gravel and secondary carbonates. The sediment of Unit B is argued to be similar to that of Unit A, but subject to a long period of in situ weathering. Most of the Colless Creek sediments have entered the site through fissures in the rear of the cave (Hughes 1983:60).

![Diagram of Colless Creek Cave section](image)

**Figure 3.7:** Section profile of square P46 at Colless Creek Cave, Lawn Hill, northwest Queensland (after Hiscock and Hughes 1984:12).

**Chronology**

Dating of the deposit was completed using radiocarbon determinations on freshwater mussel shell from Unit A, with no dateable material recovered from the Unit B deposit. A sample of living mussel shell was also submitted by Hiscock for analysis to investigate possible reservoir/secondary carbonate contamination of shell samples. If secondary carbonates were present then the living sample would be expected to return a radiocarbon date much older than its actual death age. The determination on this sample of 99.3 ± 1.0% (ANU 2444) showed that dating this material was unproblematic (Magee and Hughes 1982). Further testing of the mussel shell using x-ray diffraction did not show any...
Erosion of unit B and the lacustrine cap implies that the lacustrine cap must be in the realm of thousands of years, and therefore is likely that the accumulation and growth of the lacustrine cap are the result of sediment accumulation. However, it is likely that the lacustrine cap was formed during the last glaciation, and therefore is not possible to obtain a date for the lacustrine cap.

Figure 3.8 Age-depht curve for square P46 at Colless Creek Cave, Lawn Hill National Park, Queensland, the basal date of 17,790 ± 740 years BP (ANU1-2331) (20,740 ± 660 cal BP) during the deposition of the lacustrine cap.

The results of radiocarbon determinations for square P46 are shown in Figure 3.8 below. The results of radiocarbon determinations were obtained for the Colless Creek deposit from spits 2 and 3, and squares 1-10 of square P46, in 1979 and 1989 and from a spate of L39. In 1989, 1-10 of square P46, and samples from squares L39, L39, V, and Spits 2-5, evidence of carbonate re-carbonization (Hiscock 1988:168).
<table>
<thead>
<tr>
<th>phase</th>
<th>time period</th>
<th>geomorphic history</th>
</tr>
</thead>
</table>
| 5     | 4 000 - 0 BP | accumulation of mid-Holocene sediments  
no perceivable hiatus  
(thin at rear of cave, thicker at front)  
sedimentation rates decline during last 3000 years  
distinguished by presence of backed artefacts, increased charcoal, fresher shell |
| 4     | 8 000 - 4 000 BP | erosion of earlier unit A sediments  
(very little at rear of cave, almost total at front) |
| 3     | 18 000 - 8 000 BP | accumulation of unit A sediments during terminal Pleistocene |
| 2     | Prior to 18 000 BP | erosion of upper portion of Unit B  
removal of finer sediments from cave  
Formation of lags of gravel and artefacts in erosion channels |
| 1     | prior to 18 000 BP | accumulation and weathering of Unit B sediment |

**Table 3.2: Geomorphic history of Colless Creek deposit Lawn Hill, northwest Queensland (after Hiscock 1988:171).**

The rate of sediment accumulation within the P46 square from the lowest dated spit (spit 10) until the surface is shown in Table 3., where sediment accumulation is generally within around 1 kg of sediment per 100 years. Between the dates of 14,150 BP (17,480 ± 140 cal BP) (in spit 8) and 13,620 BP (17,040 cal BP) (in spit 6) sediment accumulation increases to almost nine times the rate of other periods.
occupation sequence for the site.

reveals a similar trend. On the basis of this analysis, Hiscock developed a three-phase

the late in Unit B. Artifact frequencies were extremely low. Pieces of artifacts by weight

drop in the upper layers, declining until sp 10 possibly due to an erosional feature. Below

artifacts per cubic meter. In Phase the frequency of stone artifacts was found to be very

in two ways: (a) number of artifacts per kilogram of sediment, and (b) the number of

679 from the lower undated Unit B). Vertical change in artifact frequency was measured

processes through time. The P4 test pit produced 3,020 artifacts (2,341 from Unit A and

Hiscock's excavation examined changes in stone artifact discard and manufacturing

| Table 3.1: Sedimentation Rate for square P4 at Coloss Creek Cave, Lawn Hill, northwest Queensland (after Hiscock 1988:66(6) |
|---|---|---|---|
| 0.1750 | 0.7000 | 0.1200 | P46/10 |
| 0.1380 | 0.7000 | 0.1200 | P46/9 |
| 0.2340 | 0.9000 | 0.1200 | P46/8 |
| 0.8380 | 0.8500 | 0.1200 | P46/6-7 |
| 0.6000 | 1.1850 | 0.1365 | P46/5 |
| 0.5000 | 1.1850 | 0.1365 | P46/4 |
| 0.0380 | 0.7900 | 0.11850 | P46/3 |
| 0.0260 | 0.7900 | 0.11850 | P46/2 |
| 0.0260 | 0.7900 | 0.11850 | P46/1 |

**Change in stone artifacts in square P4**
<table>
<thead>
<tr>
<th>Spit</th>
<th>Unit</th>
<th>Volume</th>
<th>number of artefacts</th>
<th>number / kg</th>
<th>number / m³</th>
<th>total weight (g)</th>
<th>average weight (g)</th>
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</thead>
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<tr>
<td>1</td>
<td>A</td>
<td>0.004</td>
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<td>35.6</td>
<td>54,250</td>
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<td>56,375</td>
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<td>49,400</td>
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<td>128</td>
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<td>10,667</td>
<td>588</td>
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<td>1.1</td>
<td>2,167</td>
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</table>

Table 3.4: Artefact frequency by sediment weight, volume and average weight of stone artefacts for all 23 excavation units for square P46 at Colless Creek Cave, Lawn Hill, northwest Queensland.

Chapter 3 Lawn Hill and Gulf / Lake Carpentaria
Figure 3.9: Average weight of artefacts for each phase in square P46 at Colless Creek Cave, Lawn Hill.

Analysis of changes in the abundance of stone artefacts did not reflect an observable trend during the period from 13,000 BP to 13,300 BP. The average weight of artefacts was 1.4 g and remained consistent over this period. In phase 1, Mean artefact weights were much higher than in phase 2 (16,400 to 13,300 BP). The average weight of artefacts was much higher, which is characteristic of the Colless Creek assemblage (Hiscock 1988:175).

However, it was difficult to address this issue as few archaeological reports made mention of the time, and stone artefact manufacture at Lawn Hill might be different to those sites. The phrase 1 artefacts at Colless Creek were probably older than most type sites known at the time. The phrase 1 artefacts at Colless Creek were probably older than most type sites known at the time. The phrase 1 artefacts are described as being Pleistocene Australian (Hiscock 1988:175).
The different classes of stone artefacts from P46 (cores, flakes, retouched flakes, and flaked pieces) were also compared. In Unit A, cores and retouched flakes were only present in very low percentages. Cores were absent in Unit B with retouched flakes found in very small quantities. Cores and retouched flakes were most common in spits 6 - 10 (13,600 BP - 17,640 BP). Comparison of retouched flakes with unmodified flakes showed that the retouched flakes were twice the weight of unmodified flakes between 13,000 BP to 16,000 BP, and were much larger at other times. This is considered to be the result of greatly varying sizes of unretouched flakes and constant sizes in retouched flakes in the assemblage.

Hiscock considered that the changes in artefact discard at Colless Creek Cave may have been due to a variety of mechanisms: methodological error, post-depositional modification, spatial differences in the location of discard areas within the cave, changes in the system of artefact manufacture and use, varying intensity of site use, environmental stress, and population increase in the region.

*Methodological error and post-depositional modification*

Methodological factors that might affect the interpretation of the P46 results include post-depositional changes in the radiocarbon activity of the mussel shells used for radiocarbon dating, breakage, and downward movement of artefacts through the deposit due to trampling (see Hiscock 1988:179-180). Changes in radiocarbon activity are unlikely as x-ray diffraction results for samples of shell showed no evidence of any re-crystallization of carbonates (Hiscock 1988:187). Age determinations obtained from squares beyond P46 also showed good stratigraphic correlation with the P46 samples.
Chapter 3: Lawn Hill and Gulf / Lake Carpentaria

Table 3.1: Frequency of artefact types in each split of P46 at Collers Creek Cave, Lawn Hill.

<table>
<thead>
<tr>
<th>Split</th>
<th>Tools</th>
<th>Points</th>
<th>Core Flakes</th>
<th>Core Knives</th>
<th>Window Flakes</th>
<th>Flakes</th>
<th>Retouched Flakes</th>
<th>Pieces Placed</th>
<th>Replaced Pieces</th>
</tr>
</thead>
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</table>

*Table continues*
Breakage of artefacts results in a greater abundance of small artefact fragments. If breakage acted as the mechanism creating the flaked stone assemblage an inverse relationship between artefact size and artefact number would be expected. In P46 this process cannot explain stone frequencies, particularly between spits 6 and 10 where both the largest pieces and the greatest density of material are found.

Finally, if vertical downward movement of artefacts had occurred in the P46 square due to a mechanism such as trampling, smaller more angular and thin artefacts should be moved further downwards than larger material. However, the reverse is true in P46, and there is no observable pattern of gradual change in the size of artefacts with depth (Hiscock 1988:189). Further testing of the ‘post-depositional hypothesis’ included conjoin analysis and examination of decay related changes in lithic material (smoothing and rounding of margins, luster of surfaces). All conjoints in P46 came from the same spits (Hiscock 1988:190), and the extent of weathering was not consistent with vertical displacement of material. Stone was categorized based on appearance as one of four classes of weathering: fresh, lightly patinated, patinated, or heavily weathered (see Hiscock 1988:191), and showed that there had been only limited displacement of material. The presence of a few patinated artefacts in more recent spits may be related to the re-use of old flakes rather than disturbance.

Spatial variation

Removal of large artefacts from the front to the rear of the cave during the period 13,500 BP – 17,600 BP could explain the frequency of larger flaked stone in square P46. Excavations to the squares S37, K39, T39, and U39 were conducted in order to determine if similar sequences to the P46 record were present. The excavations revealed that the front area of Colless Creek Cave had been extensively scoured and the antiquity of the deposit here was only considered to be in the range of 4,000 to 8,000 years (Hiscock
Techniques, raw material selection, the nature of reduction, and the length of reduction.

Phase 3 (Hiscock 1988:205), the sequence of micro-debitage in P46 showed that discard was analogous to the assemblage in terms of size and abundance of material in P46 were introduced in 1999. The gross trends of 1790 to 1999, the separation of Phase 3 and 2 was determined on the basis of the presence of artefacts in P46. Only one reduction decision was obtained for Phase 2, a basalt biface from 16,710 ± 260 BP (NPL-2508), from SPL 6, approximately half way down the core of 16,710-1999. The assemblage from Phase 3 showed for a comparison of artefacts with...
(a) Breakage patterns

Highest levels of breakage were found in phase 3 and the lowest in phase 1. Distal fragments occurred more often than proximal fragments, and longitudinally broken flakes were more common as proximal fragments than distal. Almost twice as many longitudinally cone split flakes occurred in phase 2 than in phase 3, correlating well with other data indicating less knapping at the rear of the site after during phase 3.

<table>
<thead>
<tr>
<th></th>
<th>phase I</th>
<th>phase II</th>
<th>phase III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of flakes broken</td>
<td>34.9</td>
<td>27.3</td>
<td>35.7</td>
</tr>
<tr>
<td>percentage of proximal fragments</td>
<td>10.5</td>
<td>4.7</td>
<td>9.2</td>
</tr>
<tr>
<td>percentage of medial fragments</td>
<td>1.4</td>
<td>2.7</td>
<td>2.1</td>
</tr>
<tr>
<td>percentage of distal fragments</td>
<td>12.7</td>
<td>8.2</td>
<td>14.7</td>
</tr>
<tr>
<td>percentage of longitudinally cone</td>
<td>8.6</td>
<td>9.0</td>
<td>6.7</td>
</tr>
<tr>
<td>split fragments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>percentage of fragments with</td>
<td>1.7</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>both transverse and longitudinal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>breaks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of transverse to longitudinal</td>
<td>2.9:1</td>
<td>1.7:1</td>
<td>3.9:1</td>
</tr>
<tr>
<td>breakage</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.6: Breakage of flakes in Square P46, Colless Creek Cave, Lawn Hill, northwest Queensland (after Hiscock 1988:639)

(b) Heating

Although many artefacts showed evidence of heat treatment, only three flakes in the uppermost spits of P46 showed evidence of controlled heat treatment. Almost all heated treated artefacts were subjected to uncontrolled and excessive heat after flaking took place (Hiscock 1988:208). It is most likely that heat alteration occurred as a result of fires lit on top of already discarded flakes.
During the Period (phase 3), cores were increasingly the source of decorative flakes. During Phase 3, the amount of decorative flakes on a predominately removed flakes. In the later post-decorative reduction, a much higher proportion of cobble-shaped decorative flakes, and/or the amount of cobble, from variations in cobbles, shape, decorative reduction, procedures, and/or the amount of more cores than during other phases. This may be related to the reduction of larger number of decorative flakes pecking strongly during Phase 2. In addition, the removal of the first procedure during reduction, as knappers prefer the core. Houston found that the Detailed analysis of reduction processes examined the force and location of blows, the

### Table 3.7: Changes in the Frequency of Raw Materials in Phase (from Hecox, 1986-96)

<table>
<thead>
<tr>
<th>Level</th>
<th>Percentage New-Chert</th>
<th>Percentage Local Stone</th>
<th>Percentage Non-Local Chert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>0.00</td>
<td>1.38</td>
<td>8.73</td>
</tr>
<tr>
<td>Middle</td>
<td>0.00</td>
<td>1.59</td>
<td>9.84</td>
</tr>
<tr>
<td>Lower</td>
<td>0.00</td>
<td>2.22</td>
<td>26.56</td>
</tr>
</tbody>
</table>

To Q-chert in the middle and late sequences, common throughout the deposit by Hecox, and a much higher proportion of Q-chert. Most of the analysed artifactuals were locally obtained chert. Q-chert was found to be more artifactual material in the site.

### Raw Materials (p) Knapping techniques

All flakes were produced using indirect percussion, with no evidence of direct percussion at the

### Chapter 3: Lawn Hill and Gulf / Lake Campmanu
2, decortication flakes that could be traced to more than one core platform became prevalent. However, the incidence of stone artefacts in P46 is highest for flakes with no dorsal cortex, indicating other technological strategies.

<table>
<thead>
<tr>
<th>Amount of Cortex</th>
<th>phase I</th>
<th>phase II</th>
<th>phase III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lower</td>
<td>lag</td>
<td>middle</td>
</tr>
<tr>
<td>% indeterminate</td>
<td>0</td>
<td>1.6</td>
<td>4</td>
</tr>
<tr>
<td>% flakes with 0 cortex</td>
<td>78.5</td>
<td>82</td>
<td>65.1</td>
</tr>
<tr>
<td>% flakes with &lt; 25%</td>
<td>9.5</td>
<td>8.2</td>
<td>9.4</td>
</tr>
<tr>
<td>% flakes with 26-50%</td>
<td>8.6</td>
<td>4.4</td>
<td>12.1</td>
</tr>
<tr>
<td>% flakes with 51-75%</td>
<td>3</td>
<td>0</td>
<td>3.4</td>
</tr>
<tr>
<td>% flakes with 76-99%</td>
<td>0.4</td>
<td>1.1</td>
<td>4</td>
</tr>
<tr>
<td>% flakes with 100%</td>
<td>0</td>
<td>2.7</td>
<td>2</td>
</tr>
<tr>
<td>number of flakes</td>
<td>232</td>
<td>183</td>
<td>149</td>
</tr>
</tbody>
</table>

Table 3.8: Changes in the amount of cortex on flakes from square P46, Colless Creek Cave, Lawn Hill, northwest Queensland (Hiscock 1988:642)

(f) Applied force

Attributes including platform size, prevalence of shattering, area of ventral surfaces, and termination types indicate the nature and intensity of applied force. At Colless Creek Cave differences in the area of ventral surfaces of flakes indicate that average force of blows was least in phase 1 and greatest in phase 2. This is supported by the greater occurrence of outré passé terminations during phase 2. The greatest frequency of platform shattering occurs during phase 2. Analysis of termination types examined the extent of control – feather and axial terminations indicating good control, whilst outré passé, step, and hinge terminations represent errors and lack of control by the knapper. Feather terminations were found to be highest during phase 2 and lowest during phase 3, indicating that forceful knapping in phase 2 was relatively successful in controlling fracture. In phase 3 decreases in applied force were accompanied with slight decreases in control as shown in Table 3.
From cores during phases 2 and 3 (Hiscock 1988:214), broken pieces recovered, taken in phase 1, which later changed to focus on removal of flakes by platform surfaces (Table 3). These trends are consistent with a focus on platform surfaces. The amount of unprepared cortical platforms were found to have never been prepared by pecking, but were most often prepared by removal of one or two flakes. The amount of unprepared cortical platforms were found to have never been prepared by pecking or grinding, but were most often prepared by pecking or grinding. The location of these changes in the platform surface relative to flakes on the core face, and (ii) selection of appropriate platform surfaces, were examined by Hiscock (Table 3). The location of the platform surface on the core face and (ii) the proximity of the blow to the core edge, is the piece. The location of the platform surface on the core face will greatly affect the size and shape of resulting flakes.

<table>
<thead>
<tr>
<th>Table 3.9</th>
<th>Changes in the termination stage on makes from square P46, Cowless Creek Cave, Lawn Hill, northern Queensland (Hiscock 1986:47).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Phase I</td>
<td></td>
</tr>
<tr>
<td>Phase II</td>
<td></td>
</tr>
<tr>
<td>Phase III</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>% single base</td>
<td></td>
</tr>
<tr>
<td>% step</td>
<td></td>
</tr>
<tr>
<td>% blunete</td>
<td></td>
</tr>
<tr>
<td>% other</td>
<td></td>
</tr>
</tbody>
</table>

(Hiscock 1988:213).
<table>
<thead>
<tr>
<th>Platform surfaces</th>
<th>phase I</th>
<th>phase II</th>
<th>phase III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lower</td>
<td>lag</td>
<td>middle</td>
</tr>
<tr>
<td>% indeterminate</td>
<td>10.3</td>
<td>3.8</td>
<td>3.4</td>
</tr>
<tr>
<td>% cortical</td>
<td>5.2</td>
<td>6.0</td>
<td>8.1</td>
</tr>
<tr>
<td>% incipient plane</td>
<td>0.9</td>
<td>1.6</td>
<td>4.7</td>
</tr>
<tr>
<td>% shattered</td>
<td>2.2</td>
<td>3.8</td>
<td>2.7</td>
</tr>
<tr>
<td>% single scar</td>
<td>72.8</td>
<td>76.0</td>
<td>72.5</td>
</tr>
<tr>
<td>% several large scars</td>
<td>8.6</td>
<td>8.7</td>
<td>8.7</td>
</tr>
<tr>
<td>% faceting</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>% ground</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>number</td>
<td>232</td>
<td>183</td>
<td>149</td>
</tr>
</tbody>
</table>

Table 3.10: Changes in platform types on flakes from square P4, Colless Creek Cave, Lawn Hill, northwest Queensland (Hiscock 1988:648).

The location of blows in relation to the core edge changed significantly through the sequence of occupation. In the earlier phase 1, blows were applied only a small distance from the core edge. During the lag and middle sample (phase 2) the location was significantly further into the core platform. Focal platforms (a result of locating the hammer close to the core edge) were least common in phase 2 and most common in phase 3, indicating that blow application was more precise during phase 2. Further corroboration is supplied by analysis of overhang removal from the core face which was shown to be more prevalent in the upper and lower phases. In simple terms this analysis shows that through time there was an increase and then a decrease in the distance from the platform edge struck by knappers. The increased flake size shown during phase 2 can therefore be directly attributed to this behaviour (Hiscock 1988:214).

Placement of blows relative to dorsal ridges showed differences through the P46 assemblage. During phase 3 flakes have far less pronounced dorsal ridges and are more irregular in cross section. Hiscock argued that this shows a tendency for the selection of

Chapter 3 Lawn Hill and Gulf / Lake Carpentaria
In order to test the above changes in the number of flakes struck from cores, Fischlock

[Summary of chronological changes in Reach 13, Fischlock 1988:214-15].

which in turn led to larger flakes in phases 2 and 3 (Fischlock 1988:214-15).
their dorsal surface surfaces measured against the number of platform removal flakes (supposing that only one platform removal flake was produced in each rotation of a core). The number of flakes of this type thereby indicated the number of flakes struck off between rotations (Hiscock 1988:217).

During the Holocene (phase 3) 20-30 flakes constituted the maximum number of flakes removed from chert cores (Hiscock 1988:216). Phase 2 (terminal Pleistocene and pre-LGM) reduction was of relatively short length and characterised increased transportation of cores to the site but with fewer flakes being removed (Hiscock 1988:217).

Changes in artefact manufacture between phases 2 and 3 are also related to raw material procurement. Phase 3 with light precise knapping, removal of greater numbers of small thin flakes, smaller more regularly shaped cores, features much greater reduction of Q-chert than during phase 2 [Hiscock estimates 24-40% of all stone during phase 3 was acquired at more distant sources (Hiscock 1988:218)]. During the earlier phase 2, knapping featured more forceful imprecise blows, little overhang removal and less reduction of cores (Hiscock 1988:218) reflecting less concern with conserving cores (Hiscock 1988:219). During phase 2 there was far less exploitation of the stone resources of the plateau than during phase 3, and was concentrated mainly on locally obtained R-chert from river cobbles from Colless Creek.

Changes in site use, environmental stress, and population increases

Simple functional measures of the use of Colless Creek Cave combined with the technological analysis described above document changes in the intensity of occupation occurring over the last 17,000 years. Four measures of the extent of site usage were examined by Hiscock including: (i) the use of fire, (ii) the intensity of trampling, (iii) the frequency of artefact use and (iv) the amount of food consumed. All of these measures were found to correlate well with the sequence established for technological changes in

Chapter 3  Lawn Hill and Gulf / Lake Carpentaria
BP as shown in Plate 3.10 (Hiscock 1988:222).

Creek cove readings were most intense in spins 6/7 and 8, between 13,500 BP and 15,000 BC. Any increase in regional population suggests that the site was occupied longer than was previously thought. The period between 13,500 BP and 11,000 BP is thought to feature the most intense use of the site. Between 11,000 and 10,000 BC, a greater number of oven holes were dug, and an increase in the size of the site is clear. This was done by examination of the number of oven holes created by increased heat within the assemblage (Hiscock 1988:222). This area is defined as an independent area around the site, and an increase in use, environmental stress forcing people to focus on the immediate area around the site, and more intensive use of the site. The increase in use is reflected in a change in occupation intensity of occupation between 13,500 BP and 11,000 BP.

The increase in occupation intensity is reflected in a change in occupation intensity of the site. The increase in intensity is due to changes in the pattern of resource use. The intensity of the assemblage is due to changes in the pattern of resource use. The intensity of the assemblage is due to changes in the pattern of resource use.
Changes in artefact use

There was greater edge damage on complete flakes than broken flakes throughout P46, indicating that such damage was the result of use rather than taphonomic factors. The prevalence of edge damaged artefacts during phase 2 mirrors the frequency of retouched artefacts (Hiscock 1988:224).

Examination of the number of retouched flakes within an assemblage will allow a rough measure of the intensity of stone use activities (Hiscock 1988:224). In P46 Hiscock found that the frequency of retouch increased from phase 1 to 2 and declined from phase 2 to 3, suggesting that phase 2 was a period of more intensive tool use (Hiscock 1988:224).

Changes in raw material procurement

The analysis of stone raw material focused on the division between local and non-local material, with local material (occurring within the gorges and less than 3 km from the site) including chert and limestone, whilst non-local raw materials (greater than 3 km) including greywacke, sandstones, quartzite’s and silcrete. Most of the P46 assemblage consisted of local material. However, quartzite occurred in phase 3 (spits 1, 2, 3) and phase 1 (spits 11,
Table 3II: Composition of vertebrate animal remains from square 56, Cockle Creek Cave, Lawn Hill, northwestern Queensland. Presence abundance has been calculated by number.

<table>
<thead>
<tr>
<th>Split</th>
<th>sample</th>
<th>mammal</th>
<th>bird</th>
<th>snake</th>
<th>fish</th>
<th>shark</th>
<th>whale</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>10</td>
<td>92.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>6.0</td>
<td>0.0</td>
</tr>
<tr>
<td>8</td>
<td>41.4</td>
<td>9.6</td>
<td>0.0</td>
<td>0.0</td>
<td>1.5</td>
<td>0.0</td>
<td>2.5</td>
</tr>
<tr>
<td>7</td>
<td>26.5</td>
<td>4.4</td>
<td>0.0</td>
<td>0.0</td>
<td>2.3</td>
<td>0.0</td>
<td>2.3</td>
</tr>
<tr>
<td>6</td>
<td>34.9</td>
<td>1.5</td>
<td>0.0</td>
<td>0.0</td>
<td>1.5</td>
<td>0.0</td>
<td>2.3</td>
</tr>
<tr>
<td>5</td>
<td>59.0</td>
<td>1.7</td>
<td>0.0</td>
<td>0.0</td>
<td>3.4</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>54.6</td>
<td>1.5</td>
<td>0.0</td>
<td>0.0</td>
<td>3.4</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>53.8</td>
<td>1.5</td>
<td>0.0</td>
<td>0.0</td>
<td>3.4</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>69.4</td>
<td>1.5</td>
<td>0.0</td>
<td>0.0</td>
<td>3.4</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>1</td>
<td>65.2</td>
<td>1.5</td>
<td>0.0</td>
<td>0.0</td>
<td>1.4</td>
<td>0.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Changes in faunal exploitation*

Despite mineral remains or the use of the cave during this time, however, it is equally possible that this represents a real decline in human occupation. In this, however, exploited due to increased environmental stress during phase 2 occupation. In a limited sample (13.5%0 BP to 17,600 BP). Hiscoc suggests that this indicates a real decline in human occupation and faunal remains are found only 3 km to the north. No non-local material occurs in the immediate area of non-local material does not strongly relate to distance, as quantities are 14. 15, 16, and 22, greater in split 14, and one faunal remain in split 4 (Hiscock 1988:225).
<table>
<thead>
<tr>
<th>spit</th>
<th>bone (g/100yr)</th>
<th>shell (g/100yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.58</td>
<td>4.04</td>
</tr>
<tr>
<td>2</td>
<td>1.32</td>
<td>3.25</td>
</tr>
<tr>
<td>3</td>
<td>4.44</td>
<td>8.60</td>
</tr>
<tr>
<td>4</td>
<td>1.86</td>
<td>2.95</td>
</tr>
<tr>
<td>5</td>
<td>2.42</td>
<td>8.36</td>
</tr>
<tr>
<td>6-7</td>
<td>36.13</td>
<td>330.23</td>
</tr>
<tr>
<td>8</td>
<td>1.79</td>
<td>100.81</td>
</tr>
<tr>
<td>9</td>
<td>3.45</td>
<td>59.19</td>
</tr>
<tr>
<td>10</td>
<td>5.62</td>
<td>8.75</td>
</tr>
</tbody>
</table>

Table 3.12: Estimated rates of bone and shell accumulation in P46, Colless Creek Cave, Lawn Hill, northwest Queensland. after Aplin n.d. (Hiscock 1988:663)

During phase 3 an overall reduction in discard of faunal remains occurs. Hiscock suggests that the change reflects a reduction in the amount of food prepared and consumed on site, and that the increase in shell and fish remains that occurs between spits 6 and 9 reflects a greater reliance on resources within the gorge. This is also a prevalence of locally available R-chert stone discarded during this period.

*Summary*

The Colless Creek data indicate an antiquity of occupation that predates the onset of the last inter-glacial. Assertions by Hiscock and others that occupation extends to 35 - 40 000 BP are hypothesized on the available data. It is uncertain how much time is represented by the lag deposit between units A and B. It is also uncertain whether occupation at Colless Creek extended to the LGM and OIS2, and whether the lag phase represents a hiatus in occupation. If this feature does represent a hiatus then the previously held model of Lawn Hill as a refuge is uncertain.
rock art was also recorded by Walsh on a part of this study of Lawn Hill (Walsh 1985). The excavations at Collless Creek (Hiscock 1988), Louie Creek Cave, with its large size of Lithofacial Limestone debris, and 400 m within an extensive Bole system along Louie Thompson Limestones cliffs, and approximately 2 km south of Collless Creek Cave at the commencement of the dolomite. Louie Creek Cave is a large Limestone rockshelter with a northwestern aspect located in the Burnt Cane Formation.

3.5.2 Louie Creek Cave

Second rockshelter known as Louie Creek Cave. Excavation of those changes in foraging and so to address this issue this study this year. The excavation area is located at Collless Creek Cave Excavated by Bole and lithic production at this time. At the time after 10,000 BP, including backed artefacts and blade production at this time. At the time after 10,000 BP, for example, deeply buried occupation of the Lower (e.g. 10,000 BP). The occupation of non-Hiscock’s analysis clearly shows a recognition of occupation in subsistence strategies and local stone raw materials correlate to an expanded foraging range in the period. The recognition of foraging activities at Collless Creek also supports this hypothesis and regional mobility. Both stone and local raw materials show a focus on the foraging area. Excavation of the site and a recognition of foraging activities at Collless Creek Cave during the period between 10,000 and 13,000 BP shows the most intensive occupation of the site. The last change in the Collless Creek Cave sequence occurs directly after the
Figure 3.11: The entrance of Louie Creek Cave at Louie Creek, Lawn Hill, northwest Queensland.

Location and environment

The cave is located on the southern side of the 50 m deep Louie Creek gorge, is approximately 15 m above the creek at base of scree slope and below a 20 m high cliff. At this location the creek flows southeast to northeast and a second smaller creek joins just east of the cave. Louie Creek is similar to that of Colless Creek, a shallow slow flowing course with numerous but small tufa dams. Hiscock (1988) suggested that the flow of Louie Creek may have been substantially greater in the past. It is known that the activities of European settlers have altered flow significantly in the last 200 years. Water flow in Louie Creek is permanent in most years and is partly fed by springs occurring in the middle of the watercourse. Several permanent pools of water near the cave contain fish, turtle, shellfish and edible plants. The banks of the creek are lined with water lilies (*Nymphaea violacea*), *Pandanus aquaticus*, *Melaleuca sp.* and *Ficus sp.* This local ecosystem supports a large range of animals and plant resources. R-chert is readily available in extensive gravel beds along Louie Creek.

Above the cave, the plateau has no water and is chiefly comprised of skeletal soils
(Figure 3.12). Large boulders at the entrance of the site have acted as sediment traps.

- 2 - 4 cm of silty except over the area is covered in sandstone breccia. The total estimated floor area is 1,400 sq m and much of this is covered in dolomite. The cave extends over 3 m into the cliff face and the entrance is 40 m wide.

Louve Creek Cave is comprised of both the sandstone and limestone geological units. It has been formed by weathering of Precambrian sandstone which is overlain by Cambrian limestone. The site has been dated by uranium series dating and is estimated to be approximately 2 km from the Louve Creek Cave, archaeological site density is reduced. The location of these sites shows the limestone gorge, rockshelters, caves and bluffs occur. At least four of these sites show archaeological evidence of Aboriginal occupation in the form of art, surface scatters of stone artifacts and indications of Aboriginal occupation in the form of art, surface scatters of stone artifacts and indications of Aboriginal occupation in the form of art, surface scatters of stone artifacts. Open sites are.

The Louve Creek Cave is hidden with rockshelters and open sites. Open sites are.

...
A low intensity scatter of flaked stone artefacts occurs on the floor of the cave and on the scree slope below. A large sandstone grindstone features in the northeastern entrance and a slab of roof fall further within the cave contains two ground pits. Extensive rock art occurs within and around the cave featuring freehand painting and drawings in a variety of colours. The largest of the motifs is a snake in white ochre that weaves its way around most of the entrance of the site. Other art includes hand stencils, baskets, and two spiral designs. The art contains examples of all of the proposed sequence for the region (Border 1988; Walsh 1985).

**Excavations**

In 1981 Hiscock excavated a series of test pits within Louie Creek Cave (Hiscock 1988). A total of six 50 cm x 50 cm squares were excavated (BL26, BL27, BL30, BL31, BJ29 and AS33). Five of these test pits were located in northwestern entrance area of the site where sediment was deepest, and a further square (AS33) was located 12 m to rear of the other
Horizons were identified (Figure 3.13). Excavations in thirteen pits of varying depth, and within B129, six different stratigraphic horizons were identified. Square B129 was selected for detailed analysis. Square B129 was one of the deepest squares contained within described hearths (NH1, BH30, BH26). One of the deepest squares contained within a hearth was 4.3 cm. The stratigraphy of the lower part in Lone Creek Cave varies considerably and three squares in order to provide a stratigraphic correlate (see Figure 3.13).
Chronology

Three radiocarbon determinations were obtained on freshwater mussel shells from spits 5, 8 and 12 - 14. A bulk sample was submitted for the lower excavation levels of BJ29 due to low shell quantity. Spit 5 returned a date of 8,810 ± 130 BP, spit 8 was dated at 14,210 ± 230 BP (17,580 ± 220 cal BP) and the sample from spits 12 - 14 was dated at 18,600 ± 900 BP (19,820 ± 1,140 cal BP)(Hiscock 1988:670). An age - depth curve for square BJ29 is shown below in Figure 3.14.

![Age-depth curve for square BJ29 at Louie Creek Cave, Lawn Hill, northwest Queensland (after Hiscock 1988:670).](image)

The radiocarbon determinations from BJ29 show increasing age with depth and sediment accumulation rates varying. In the upper levels there is a pronounced slower sediment accumulation rate relative to the lower units. In Layer 3 (Spit 6 at a depth of 8 - 9.75 cm) which represents the period between 8,000 and 10,000 BP Hiscock argues that deposition was probably much faster than the subsequent periods as there is an absence of roof fall. The lower spits, from 8 to 14 (from 14,000 BP) feature rapid sedimentation, which Hiscock argued, mirrors the sedimentation at Colless Creek Cave, and documents the effects of the Glacial Maximum aridity (i.e. increasing soil erosion on the plateau).
between 14,600 BP and 17,250 BP (Hiscock 1988:237) (Table 3.14). These are said to reflect some working intensity which was greatest at the foot of the cave. The variations in discard rates in this section of loam deposits. The reoccurrence of greater intensity in artefact manufacture, and is also supported by similar between 14,600 BP and 9,100 BP (spit 3) and significant increases between 9,100 BP and 17,250 BP and 8,350 BP and 9,100 BP (spit 5). Hiscock argued that these periods of increased discard levels, a moderate increase in discards in the last 1,100 years, modern increase between per 100 years (Hiscock 1988:237). There are three periods when artefacts disappear before 11,000 BP. These artefacts are very low, varying between 1 and 4 artefacts per 100 years. Halsey (1979) took a sample of the upper loams over 2 m in size and recorded the most in 1979. The samples represent the area of excavation units in BP, 23.7°S, 141.1°E. The emissions are given in the caption to the table.

**Table 3.14: Radiocarbon age range of excavation units in BP, 23.7°S, 141.1°E.**

<table>
<thead>
<tr>
<th>He (m²/year)</th>
<th>Sediment Deposition</th>
<th>Time Span (years)</th>
<th>BP Years</th>
<th>Depth Approximate (cm)</th>
<th>Depth Below Surface (cm)</th>
<th>Spot Depth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.06</td>
<td>0.00</td>
<td>1900 - 20,000</td>
<td>32.0 - 35.0</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td>0.00</td>
<td>1800 - 1900</td>
<td>28.5 - 25.0</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>0.00</td>
<td>1750 - 1800</td>
<td>25.0 - 28.5</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.25</td>
<td>0.00</td>
<td>1725 - 1750</td>
<td>22.0 - 25.0</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.35</td>
<td>0.00</td>
<td>1550 - 1600</td>
<td>18.0 - 22.0</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.90</td>
<td>0.00</td>
<td>1400 - 1500</td>
<td>14.0 - 18.0</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.50</td>
<td>0.00</td>
<td>1300 - 1400</td>
<td>12.0 - 14.0</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.25</td>
<td>0.00</td>
<td>1200 - 1300</td>
<td>10.0 - 12.0</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>1.00</td>
<td>0.00</td>
<td>1000 - 1100</td>
<td>8.0 - 9.0</td>
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<td></td>
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<tr>
<td>0.50</td>
<td>0.00</td>
<td>750 - 850</td>
<td>5.0 - 7.0</td>
<td>5</td>
<td></td>
<td></td>
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<td>0.25</td>
<td>0.00</td>
<td>4250 - 500</td>
<td>2.0 - 3.0</td>
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<td></td>
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<tr>
<td>0.15</td>
<td>0.00</td>
<td>3500 - 400</td>
<td>1.0 - 1.5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spit</td>
<td>layer</td>
<td>volume</td>
<td>number of artefacts</td>
<td>number / kg</td>
<td>number / m³</td>
<td>total weight (g) *</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>--------</td>
<td>---------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>1</td>
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<td>0.003</td>
<td>124</td>
<td>16.3</td>
<td>41333</td>
<td>78.1</td>
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<td>2</td>
<td>0.007</td>
<td>131</td>
<td>16.8</td>
<td>18714</td>
<td>70.7</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>0.010</td>
<td>225</td>
<td>18.4</td>
<td>22500</td>
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</tr>
<tr>
<td>5</td>
<td>2</td>
<td>0.002</td>
<td>79</td>
<td>20.3</td>
<td>39500</td>
<td>36.4</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>0.003</td>
<td>36</td>
<td>25.7</td>
<td>12000</td>
<td>5.8</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>0.007</td>
<td>89</td>
<td>15.3</td>
<td>12714</td>
<td>118.6</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>0.006</td>
<td>104</td>
<td>13.5</td>
<td>17333</td>
<td>79.5</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>0.009</td>
<td>151</td>
<td>17.4</td>
<td>16778</td>
<td>115.3</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>0.011</td>
<td>172</td>
<td>16.5</td>
<td>15636</td>
<td>57.5</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
<td>0.007</td>
<td>111</td>
<td>24.7</td>
<td>15857</td>
<td>24.2</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>0.008</td>
<td>59</td>
<td>20.3</td>
<td>7375</td>
<td>22.7</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>0.008</td>
<td>52</td>
<td>8.6</td>
<td>6500</td>
<td>7.8</td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>0.009</td>
<td>80</td>
<td>11.3</td>
<td>8889</td>
<td>2.7</td>
</tr>
</tbody>
</table>

* chert artefacts only
numbers from original

Table 3.14: Artefact densities for each spit of BJ29, Louie Creek Cave, Lawn Hill, northwest Queensland (after Hiscock 1988:673).

The size of flaked stone artefacts is greater in the upper parts of the BJ29 deposit. However, the change in artefact size at Louie Creek Cave does not simply relate to a change in raw material selection from Q-chert to R-chert as was the case at Colless Creek. No Q-chert material was identified in the deposit. Size comparisons show that between spits 7 - 9 (10,200 BP - 15,500 BP) artefacts were generally larger than at any other time in the rest of the sequence. Between spits 9 and 14 (14,600 BP - approx. 20,100 BP) flaked pieces were very uncommon, and retouched flakes and cores were completely absent. In fact discard prior to 14,600 BP was comprised of unmodified flakes. In addition to the R-chert, flakes made from limestone occurred infrequently in all spits of BJ29.

The most likely reason for the relationship between change in size of artefacts and the rate of discard from BJ29 is changing technology. After 14,600 BP a greater range of stone working activities were carried out within Louie Creek Cave, with the last 4,000 years
Hiscock argued that there was a much higher frequency during the period 14,600 BP and
and 11 indicated much higher transverse breaks in relation to settlement dates.
and occupation. Spits 9 and 14 showed very low rates of transverse breaks, contrary to the
interruption, broken flakes to complete flakes was calculated as a measure of the intensity of
All untouched flakes larger than 6 mm from P129 were examined, and the ratio of

The intensity that peaks in archeological dates,

These periods of increased
between 8,320 and 9,100 BP, and that there was a period of sustained increase in hearth
and concluded that this increase in frequency in hearth sizes over the last 1,100 years and
per 100 years) higher rates occurred in Spits 1, 5, 6, and 7 than in other spits. Hiscock
them, and although the frequency of such pieces was small in Spits 1 and 3,

Chronological changes in the use of fire were evident from hearth shaped fragments of

The material procurement, and (v) hand-held explanation.

at Louise Creek to investigate simple functional changes: (i) use of fire, (ii) transverse, (iii)

As with his analysis of the College Creek site, Hiscock examined four aspects of behavior

Functional Changes

and rules occurring (Hiscock 1988:238).
Figure 3.15: Comparison of sedimentation rates in BJ29 and the rates of transverse flake breakage Louie Creek Cave, Lawn Hill, northwest Queensland (after Hiscock 1988:683).

(c) Changes in raw material procurement

All local stone consisted of R-chert, limestone, and sandstone, whilst non-local material consisted of greywacke, quartzite, and silcrete. Within square BJ29 the great majority of stone artefact raw material is of local origin. Additionally, the discard of R-chert increases through time, peaking between 13,100 BP and 16,650 BP and subsequently decreasing up to the present (Hiscock 1988:241). Local limestone was used prior to 17,250 BP and after 9,100 BP, but between 17,250 and 9,100 BP R-chert was preferred. Flakes of non-local material were most commonly made on imported greywacke, and these account for a very small percentage of the assemblage (1.5 - 3% of the assemblage before 17,250 BP and after 14,600 BP respectively), and only occur in small numbers in just over half of the spits. No non-local material is found between 17,250 BP and 14,600 BP.
The faunal assemblage from Louie Creek Cave is small and largely unreported. Changes in the condition of faunal material exploited at Louie Creek Cave are largely explained as a result of anthropogenic factors. High levels of fragmentation are largely attributed to burning. Partially burnt and calcined bone increases with depth possibly due to the lack of preservation of unburnt bone in lower levels. Greater frequencies of bone relative to shell are evident in the lower units and parallel each other generally throughout the deposit.

From 17,200 BP there is an increase in faunal material and then a steady decrease for the next 2,500 years (Table 3.15). These results suggest greater food preparation and consumption within the site during the period between 17,250 and 14,600 BP (Hiscock 1988:242). In fact, all the functional studies (artifact discard, burning, trellage, and faunal exploitation) indicated more intensive occupation during this time, followed by a steady decrease a few thousand years later.

<table>
<thead>
<tr>
<th></th>
<th>Time (years)</th>
<th>Bone (g/100yr)</th>
<th>Shell (g/100yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26.5</td>
<td>12.0</td>
<td>1.1</td>
</tr>
<tr>
<td>2</td>
<td>46.8</td>
<td>21.1</td>
<td>0.7</td>
</tr>
<tr>
<td>3</td>
<td>77.6</td>
<td>47.5</td>
<td>1.8</td>
</tr>
<tr>
<td>4</td>
<td>28.4</td>
<td>12.6</td>
<td>1.1</td>
</tr>
<tr>
<td>5</td>
<td>28.4</td>
<td>12.6</td>
<td>1.1</td>
</tr>
<tr>
<td>6</td>
<td>47.5</td>
<td>12.6</td>
<td>1.1</td>
</tr>
<tr>
<td>7</td>
<td>27.1</td>
<td>11.0</td>
<td>0.8</td>
</tr>
<tr>
<td>8</td>
<td>19.6</td>
<td>11.0</td>
<td>0.8</td>
</tr>
<tr>
<td>9</td>
<td>22.6</td>
<td>15.0</td>
<td>1.3</td>
</tr>
<tr>
<td>10</td>
<td>88.7</td>
<td>90.0</td>
<td>2.5</td>
</tr>
<tr>
<td>11</td>
<td>31.5</td>
<td>60.0</td>
<td>2.7</td>
</tr>
<tr>
<td>12</td>
<td>26.3</td>
<td>8.6</td>
<td>0.9</td>
</tr>
<tr>
<td>13</td>
<td>25.2</td>
<td>4.8</td>
<td>0.6</td>
</tr>
<tr>
<td>14</td>
<td>17.0</td>
<td>11.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 3.15: Discard rates of bone and shell in BJ29, Louie Creek Cave, Lawn Hill, northwest Queensland (Hiscock 1988:687).
Summary

Although the excavations of Louie Creek Cave are not as detailed as those at Colless Creek Cave, it is clear that similar themes occur during the occupation of the site. The basal date of 18,600 BP is coincident with the extreme climatic conditions of the LGM, and the period immediately following this mirrors the changes to foraging that were observed at Colless Creek Cave.

Between 18,600 BP and 14,000 BP Louie Creek Cave appears to have been more intensively occupied than at any other time. Stone artefact discard is high, and there is increased use of fire and treading. After 14,000 BP a greater variety of stone related tasks were completed on-site. It seems however, that occupation after 14,000 BP was much less intensive. Sedimentation rates are reduced for the period post 14,000 BP, and although stone discard is higher than for other periods, between 8,000 and 13,000 BP discard declines indicating a possible reconfiguration in settlement/subsistence activities. In addition, the discard rates of faunal material are meager for the entire deposit, prohibiting detailed modeling of the nature of foraging range and diet breadth at any time.

3.6 Chapter Summary

This chapter has summarized the results of Hiscock’s previous research in the study area, detailing the analysis of flaked stone artefacts from Colless Creek and Louie Creek Caves. Hiscock’s analysis revealed changes in the pattern and intensity of site use at these sites and suggests intensive use correlates with a contraction of range and territory during periods of climatic stress. This data provides for a model of fluctuating occupation of the Lawn Hill region.

Hiscock’s Lawn Hill refuge model is based on observations concerning the use of local raw materials and emphasis on river resources during the LGM. This model relies heavily on (i) the presence and absence of greywacke at different times in the regional chronology; and
Chapter 3. Lawn Hill and Gulf / Lake Carpentaria

This endeavor

In order to test the end of the prehistoric conditions, we used the permanent settlement of human settlements in areas for which people were from the area, or the first occupation of human settlements in areas for which people might have been able to support a population for a period of time, which still allowed for a sustained settlement (Hiscock 1989). However, the model does not adequately explain how a population

Although small (Hiscock 1989:20), was able to support a population of 20-30 people for a 4,000 year period

The fluctuating settlement model developed from Lawn Hill suggests that this area

Lawn Hill more produced over conditions.

Accumulation might represent opportunistic harvesting of a temporary and coastal post - 13,800 BP, a period of just 175 years. It is equally reasonable to suggest that this

Table 3:2 shows that Site 6 and 7, where most shell discarded remains occur between 13,625 BP and a range of 100 - 300 B.P. in Site 6 and 8, this also occurs between 14,000 and 13,600 BP. Significant component of the assemblages at these sites and their associated shell discard is at its

(n) Increased discard of mussel shell. However, it must be noted that glacial ice is never a
Chapter 4

Evolutionary Theory Part 1:
Human Behavioural Ecology, Optimal Foraging Theory, and
Stone Artefact Studies

4.1 Introduction
This chapter discusses the theoretical approach that has been applied to this research. It provides the background, and presents the concepts and models that are implemented to interpret the Riversleigh/Lawn Hill archaeological record. Anthropological and archaeological case studies, where similar approaches have been taken are discussed in relation to the present study.

This research utilises human behavioural ecology to develop a settlement model for the Lawn Hill/Riversleigh research area. There are a variety of reasons for using this approach including: (i) the application of evolutionary theory to an archaeological problem highlights the role that reproductive strategies and human decision making have on adaptation; (ii) the important premise that adaptive behaviour will often relate to changes in environment; and (iii) the models of human behaviour derived from this body of theory are testable against the archaeological record.

4.2 Human Behavioural Ecology
The first studies of Human Behavioural Ecology (HBE) emerged in the 1970s, borne from evolutionary ecological studies in the biological sciences (see Bird and O'Connell 2006; Charnov and Orians 1976; Dunnell 1980, 1996; Hutchinson 1965; Krebs and Davies 1978; Winterhalder and Smith 2000). Initially these studies focused on foraging theory with the aim of setting human oriented research within a wider cultural ecological approach
Chapter 4 Evolutionary Theory: Part I

the more immediate needs of an organism. Optimal foraging theory (OFT) is the most

Finally, optimal foraging is considered more middle-range theory, with models focused on

remains with a bias to those who control more resources (see Pink and Latham 2003).

qualities, the polygyny will be favored. Polygyny will affect the choice of mates by

incurred are less than the benefits gained from polygynous mating (in terms of breeding

multiple pair-bonding rather than monogamy) will occur in a population. When costs

Simms 1994; Leahy et al. 1973). The Polygyny Threshold Model predicts when polygyny

investments toward offspring generation the greatest fitness return (see Alten Smith and

Hawkes et al. 1988). Sex Allocation theory holds that parents will bias reproductive

for example, the optimal timing of fledgling retention in humans (see Hawkes 2003; 1993).

mutualistic and reproductive characteristics (Chamorro 1993; Kappel and Robinson 2002),

physiological needs and behaviors of an organism are determined by fundamental

most often applied in studies of the very long term. If a Hare model poses that the

ecological theory. The first three approaches are essentially first order theoretical tests and

human behavioral ecological community use four main theoretical approaches: (i) theoretical

in a particular culture.

for archaeological studies to investigate how food (and other material) procurement might

spend on other fitness-enhancing activities (Simms 1998). HBE models provide one avenue

important even if food is not scarce or hard to get, as it allows time and resources to be

effective in their food quest (Bird and O’Connell 2006, Wiseman et al 2005; 1996). Efficiency is

and assumes that certain human groups, especially hunter-gatherers, are skilled and

The basic premise of HBE is that all behavioral ends toward optimization (see Foley

studies as it relates directly to food procurement and preparation.

Whithalde and Simms 2001:1). The approach is particularly valuable to archaeological
simple form argues that organisms (including people) concentrate on procurement and consumption of resources (usually food), that provide the greatest rate of nutrient return (usually expressed as energy returns) while using the least amount of effort in acquisition (Bird and O'Connell 2006; MacArthur and Pianka 1966; Emlen 1966). OFT often presents generalized but realistic mathematical models relating to subsistence and social behaviour from which testable hypotheses may be formulated (Winterhalder 1981). It is related to the other longer temporal theories in that organisms are expected to switch between different strategies over variable time scales in order to maximize returns that have long-term pay offs in terms of reproductive success. That is, selection will only favour the best of feasible existing alternatives (Broughton and O'Connell 1999; Kaplan and Hill 1992:168). It is this approach from HBE that is directly applied to this research.

This thesis utilises the theoretical framework provided by HBE as it offers a robust theoretical basis based on functional explanatory frameworks, that is readily applicable to archaeological analysis. In particular, it provides a theoretical link between behaviour and fitness in populations, with known and measurable constraints.

4.2.1 Optimal Foraging Theory

Application of Optimal Foraging Theory has been applied to archaeology and anthropology over the last 20 years, particularly in North America. In Australia however, the approach has only recently been explicitly applied to archaeology (see Barton 2001; Clarkson 2004; Cosgrove 1995, 1999; Cosgrove and Allen 2000; Edwards and O'Connell 1992).

The OFT models have one basic premise: that hunter-gatherers aim to maximize the rate of nutrient return from foraging activities (Bird and O'Connell 2006; Mithen 1990:123).
Chapter 4 | Evolutionary Theory: Past, Present, and Future

and handling a resource, which is then measured against the nutritional return the resource provides. This production is based on the costs involved (usually expressed in terms of time and energy). The dear abundance model predicts the types of food that a forager will target. This

(2002).

time. This can then be tested through analysis of archaeobotanical assemblages (see Brigham et al).

predicted time spent acquiring resources and food procurement strategies as a function of present time as a component of handling time. The strength of this model is that it can present data and a component of hunting time. The strength of the model is that it can

activities such as de-stalking, butchering, cooking, and carrying. Other studies confirm the period required to obtain the energy from the resource once acquired, including the period required to obtain the energy from the resource once acquired, including

resource, and might include activities like stalking and chasing a prey animal (e.g., handling time). This period is the period that it takes to secure the location of a resource; (iv) pursuit time — which is the period that it takes to secure the location of a resource; (v) search time — which is the period that it takes to secure the location of a resource; (vi) pursuit time — which includes all the activities that take place until the initial direct phases; (vii) search time — which includes all the activities that take place until the initial

resources they require (Lynam and O'Brien 2000). Acquisition of a resource falls into

Hunter-gatherers are constantly faced with decisions regarding the types and quantities of

Diet breadth model

are: (a) diet breadth, (b) patch choice, (c) habitat choice, (d) nutritive value of the diet, and (e) the central place and the location of some foods within this landscape. These four OF models used here

and the location of some foods within this landscape. These four OF models used here

hunting, their fluted and local communities' demographic and geological histories, some foods. Such models are based on an understanding of local and more distant

products foraging behavior can be developed by posing questions relating to these

in their search for some food or reproductive goals. Detailed but simple models of

Hunters, not unlike any other organism, will exploit a range of areas in the landscape

settlement can provide important insights into human mobility and patterns of landscape

With this in mind, archaeological OF studies of hunter-gatherer subsistence and
offers. The model is based on an optimal diet, predicting what resources will be harvested against those that will be overlooked (Edwards and O’Connell 1995; Hawkes and O’Connell 1992:63; Kapland and Hill 1992).

The diet breadth model holds that foragers will choose to handle resources that yield the highest rate of nutrient return upon encounter, irrespective of the encounter rate for that particular resource. When higher ranked resources are not available, those resources of lower value are pursued, resulting in an increase in diet breadth (Bettinger and Richerson 1996; Bettinger 1983; Bettinger et al. 1996, 2006; Winterhalder 1986).

Figure 4.1: Diet Breadth Model (after MacArthur and Pianka 1966:606; Bettinger 1991) showing the relationship between energy acquired and diet breadth. Resources will be added to a diet according to the net energy return rate (as indicated on the y-axis) until the optimal point is reached (where the curve of overall foraging time is lowest). In this example an optimal diet breadth of four resources would be targeted.

Under the principles of the OFT model, it is expected that a foragers diet will be restricted and specialised where handling costs are low. If the time spent processing the highest ranking item available is low and the item is readily abundant, then there is no incentive to broaden diet. In contrast, diet becomes broader in environments where resource

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The concept of ecological niche in archaeology, time averaging (Cayton and Debenham), was expanded from the Upper Paleolithic site of Les Langueux in France, the study applied generally to Middle Paleolithic. This type of analysis of seven analogous sites in use in ethnographic applications, which were built on results of activities that are approached using the der breack model. They noted the strength of this model was in providing one of the few examples of an archaeological approach to a detailed study in the natural habitat, which were not explored due to their high husbandry times.

...resources of high rank were taken, while grass seeds, which were readily available in the desert of Central Australia. During most Aboriginal trips, they noted that only a detailed study of the Aborigine people...
1998:1119). Time averaging was shown to potentially change archaeological explanations of diet breadth significantly, where a maximum diet breadth and the number of taxa (NTAXA) of an assemblage might appear the same. With differential time-averaging, the longer an assemblage takes to accumulate, the greater the chance that the assemblage would incorporate a low-ranked food resource (Grayson and Delpech 1998:1123). This result presents a very important constraint upon relying too heavily on diet breadth in archaeological applications, especially when great time depth is involved.

*Patch Choice Model and Marginal Value Theorem*

Landscapes are not homogenous units and resources are not spread evenly through space. For this reason, the diet breadth model also considers the geographical distribution of resources. The Patch Choice Model predicts those areas a forager will search in order to maximize the rate of nutrient returns from resource when such resources are spread unevenly (MacArthur and Pianka 1966:607-9).

In its simplest form this model conceptualizes the landscape as a series of patches (areas with resources). Hunter-gatherers move around a landscape harvesting food in a predictable way. The Patch Choice Model specifies the areas where foragers should search in order to obtain the maximum return for expended effort (MacArthur and Pianka 1966:607-8). The extent to which patches are distributed homogeneously or heterogeneously within the landscape is commonly referred to as habitat grain (see Winterhalder 1980). In a habitat with a homogeneous distribution of patches, foragers will tend towards generalized use of patches, whilst in a habitat where patches are more varied, specialization will occur (Horn 1968).

Where patches are varied, those with high ranking resources spread in a predictable and evenly dispersed way will be exploited first. However as the higher ranked patches become depleted with resulting decreasing returns, lesser ranked patches will be targeted. If
environmental conditions get worse, and higher ranked patches become depleted then the patch choice model predicts that progressively fewer patches will be encountered by the forager, where once they may have targeted a more distant but better resource area.

Along with the benefits the hunter-gatherer obtains from each patch exploited, are associated costs. These include the time it takes to get to a particular patch (travel time), the time spent searching or pursuing the goal (for example prey), and the amount of time that is needed to prepare the resource for use or consumption (handling time). All of these costs will affect how many and how geographically spread out the patches are that the hunter-gatherer will exploit.

The dispersal of patches and resources sources will directly influence the location of forager settlement, principally in minimising costs of travelling to resource locations.

Where food is evenly dispersed, foragers are also expected to disperse themselves across the landscape. Where food is clumped or where foragers are more mobile, settlement is more likely to aggregate (Figure 4.4).

![Geometric model of optimal dispersion](image)

Figure 4.2: Geometric model of optimal dispersion. Settlement locations are represented by triangles and are predicted for different environments. In A and B, solid circles represent stable, evenly dispersed patches. In C and D, patches are clumped/moblie. The mean round-trip travel cost to the forager is given by d in each example. Travel
costs are minimised in stable patches by dispersing settlement (A), and in clumped or mobile patches by centrally locating settlement (see Horn 1968).

As different patches have different levels of productivity, so will harvesting returns. In some cases continual harvesting of a patch will have no effect on prey within the patch. If this is the case the forager will be expected to continue to exploit that patch until resource availability declines. In other instances there might be no change in prey density until the last individual is harvested, and at this point the hunter-gatherer moves on to another patch. However, these situations are rare and most commonly prey density in any given patch will decline over time with constant harvesting. The result is diminishing returns for time and labour spent exploiting the patch, which can be both graphically and empirically illustrated by Marginal Value Theorem.

Marginal Value Theory examines the optimal allocation of time spent foraging in a set of different patches where resources are assumed to be gradually declining as harvesting continues. There are two basic premises to this model. The first is that a forager should leave a patch when diminishing returns in that patch render overall foraging returns lower than those which might be achieved from other patches (see Charnov 1976; Stevens and Charnov 1982). Secondly, the forager will only add new patches to their harvest if the rates of return from these patches are above those for the patch currently occupied (Figure 4.5).
sessment period, the inland patch was more favored for resource acquisition and people.

Nagasaka's analysis shows that such a division has been too simplistic. In the initial
historic divide between early period non-hunters and the later farmers (see Davidzon 1994),
existing trends - the slope to broad resource base, are attuned to be a feature of a culture
extinct bird - the teams to broad resource base, are attuned to be a feature of a culture

Studies of diet change in New Zealand, such as documented shift from the large now

strategies of N. T. X. M. (of Greyson and Defesh 1998)

rather than generalized foraging behavior.

model were the humans in landscapes of every grain will have towards specialization
exchange and learned behavior. In their model, conclusion was based largely on information
very specific in their hunting behavior. Specificity was based largely on information
reality the Grue were

research of the Grue people from Omo, Canada provides

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Figure 4.3: Marginal Value Decrement (After Charnov 1976). The distance along the x-axis is the

The data is presented in the respective curve pattern to - K. The

shown for the patterns. Optimal habitat selection is each patch occurs at the dotted
the x-axis represent distance between patches. The curve of energy return (E) is

be seen from A to B and C. The base from A to B represents the total mean energy

of the y-axis represent distance between patches. The curve of energy return (E) is

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may have even specialized in hunting moa. However, as the Moa became depleted, diet breadth increased. Similar trends were observed in the coastal patches, but with evidence of even broader resource exploitation than occurred inland. Lastly, as use of both the coastal and inland patches decreased, use of the offshore patch increased. Nagaoka's results both challenge the dominant culture historic divide but also show the complex nature of foraging behaviour as settlement became more mobile, dispersed and seasonal (Nagaoka 2002:438).

In Australia, Cosgrove has successfully used the patch choice model in exploring Late Pleistocene foraging behaviour in Southwest and Southeast Tasmania (Cosgrove 1995, 1999; Cosgrove and Allen 2001; Cosgrove and Pike-Tay 2002, 2004). Cosgrove's diet breadth model is based on ranking prey animals plus hunting strategies. Patterns of species distribution, element frequencies and body part representation in sites were examined as a way of determining subsistence strategies on a site and wider landscape basis. Pursuit time, ease of capture, ease of field butchery, transport and preparation; nutritional return; and incidental benefits such as raw material by-products, were all considered in this model.

Bennett’s Wallaby (Macropus rufogriseus) and wombat (Vombatus ursinus) were found to be important components of the late Pleistocene economic resource base in southwest Tasmania. Both species are considered to have had similar distribution patterns throughout the region (Cosgrove 1999:387). In the southwest, stable grassland patches effectively clumped animal resources in predictable ways within valleys, and these populations were systematically exploited by humans. In contrast, the southeast local ecology resulted in the same animal resources being more scattered and distributed unevenly across the landscape (Cosgrove and Allen 2001:401).

Season-of death and skeleton-chronological studies have indicated that people were selecting particular animals of size, sex, quality and condition (Cosgrove and Pike-Tay

**Chapter 4** Evolutionary Theory: Part 1
Figure 4.1: Deterministic definition of foraging behavior in Southwest and Southeast Tasmania.

Planning that aimed to lower risk and uncertainty (Cosgrove and Pfeifer, 2002:138). Occupied during summer. Foraging behavior was focused towards logical and systematic foraging activities foraged animals in peak condition, with upland access more intensively. Concerns however, the archaeological evidence from Southwest Tasmania shows that the prior to transport and that younger prey may have been consumed at that time. Similarly, hunting has also been considered as a process that might have occurred at a hill. While female wallabies do not occur in great numbers in assemblies, it is possible that differential transportation is recognized as a mechanism that might skew those results. Over two years in age in order to obtain optimal returns (Cosgrove and Pfeifer, 2002:137). Hunter preferences were found to have selected larger animals, particularly those...
Central Place Foraging

The consumption of resources does not necessarily take place within the patch from which they were harvested and optimal foraging theory needs to account for this complexity. The Central Place Model (CPM) examines the cost of bringing the consumer and resource together in time and space. CPM is based on the same marginal value theorem as described above, but adds in the cost of completing a return trip from the central place (where consumption will take place) to the patch where the resource is harvested. The cost of return trips directly effects the optimality of exploiting different patches. As the time taken to travel to a patch increases, there is a corresponding increase in the amount of time that is spent in the patch foraging and the optimal prey ranking will also increase (Figure 4.5) (Orians and Pearson 1979). Distant patches will only be exploited in two instances: when it is dictated by diminishing returns, and when the availability of higher ranked resources is greater than patches closer to the central place. It is predicted that lower ranked resources will only be targeted in proximal patches.

![Diagram](image)

Figure 4.5: The central place foraging model (Bettinger 1991). If travelling time is constant (T) the amount of time spent foraging in patches of different value will decrease (F) and the minimum size of resources taken will increase (C).

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High utility loads to be collected, and the cost of transport was incurred for the exploration of the area. Their study specifically examines how a trade-off between field processing (allowing animals to travel further) and the Central Place Model has received some attention in archaeological studies, including

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To the right, the population of resources available.

In the push of the prey, different patches will be explored based on the density and away from the central place will occur, since those closer are depleted (last the movement away from the central place will occur, since those closer are depleted (last the movement

behaviour) (Brownson 2003; Brownson and O'Connell 1999). Use of patches further

example in the encounter rates of prey, leading to modifications to human foraging

by patching the resource. All resource exploration will potentially cause decreases, for

reduction in the behaviour of prey, over exploration, and changes in the local

reduction can take a variety of forms, including prey

deforestation. Decisions will need to be made concerning when to abandon a patch for those

as with the push of the prey, Central Place Model further will ultimately result in resource

then field processing times the forager would be predicted to transport the resource.

the threshold of field processing time then it is the most efficient, conversely if it is less

2002; Bennett et al. 1997; MacEachran and Parham 1992; Rhode 1990). If travel time exceeds

patch (field processing), or a combination of the two (MacEachran and Parham 1992; Peck et al.

resources will occur. Processing and consumption may occur at the central place in a

number of tips (Bennett et al. 1997); (ii) the selection of the location where processing of

will become necessary more problems with greater travel distances as it reduces the

patches. These extra costs may be overcome by exchanging (i) carrying of large loads

Central Place Processing results in greater travel time costs than foraging within local
of pinyon pine and pickleweed nut resources. (Metcalf and Barlow 1992). Predictions were made where a trade off point between field processing and transport occurred and it was assumed that the threshold variable (z) was a graphical point on a transport-time axis where field processing would become economically profitable (Metcalf and Barlow 1992:344). The model shows that when travel time is greater than z, field processing will occur (Figure 4.8).

For pinyon pine and pickleweed, best gains would result when foragers located camps near to the resource. However, the Californian archaeological assemblages were dominated by pickleweed. Rather than a simple preference of hunter-gatherers for pickleweed over pinyon nuts, the Central Place Model showed that it was more likely that pinyon nuts were field processed, whilst pickleweed was brought back to the central base. This finding has significant implications for analysis of site contents and settlement patterns, particularly as collection strategies and transport distances may not be accurately reflected in the archaeological record.

Figure 4.6: Graphic example of the field processing/transport trade off (Metcalf and Barlow 1992:343). The area to the left of the y axis measures time taken to reach and return from patch, and the right of the y axis measures procurement of field processing time. U(t) represents the relationship between the utility of load and the time spent

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Likely to be under-represented in residential deposits, whereas lower ranked species in situations where resources have high cover yields and low handling time, they are

 Hidden assemblage composition may vary independently of prey choice. In

The archaeological implications drawn from this study were:

Scores and held processing occurred only at short distances from the central place.

Transported to a central location (Bird and Breeze-2, 1997-52). Large clan had low-

The amount of edible flesh that would be

transported per to transport in order to maximize the amount of edible flesh that would be

The Wenam collected different species and the best options of held processing. They found that the Wenam culled

Birds and Breeze-2, Breeze-2, and Breeze-2, all-based on the time required to collect

Shelly which is harvested from near Pares and sub-humoral figures as well as rocky shore

behavior of the Wenam. Kinship people from the Iroquois group. The Wenam, the Wenam, the Wenam

Birds and Breeze-2 (Bird, 2003) have applied a Central Place Model to their research into the fishing

Birds and Breeze-2 (Bird, 1997; Bird & Breeze-2, 2002).

In Northern Australia, Bird and Breeze-2 (Bird and Breeze-2, 1997).

Shells were abundant (Beringer, 1997: 887).

Melanistic led to reposition of residential bases to locations related to patches where food

reposition of residential bases was generally preferred. In this example, repositioning in residential

procurement inventory held processing is costly, local procurement, followed by processing

and ethnoarchaeological observations of harvesing (for the mussel shells). As logistical

the field. The study is based on analysis of possible local sites of banks (for the areas)

been consumed on-site, transported to a central place as a new resource, or processed in

North America. The authors investigated whether those two resources were likely to have

two second example of a practical application of central place foraging theory is Beringer et

occurs, and in situations where travel time is less than "n," no held processing will occur.
(in this case *Nerita sp.*) will be over-represented irrespective of their dietary importance (Bird and Bliege-Bird 1997:54);

(ii) Where sites are near shellfish habitats, and shellfish have low \( z \) values, then these sites are likely to become processing or 'dinner time' camps. Sites near inter-tidal areas containing shellfish with high and low \( z \) values were considered to represent residential bases. Sites yielding shellfish with high \( z \) values some distance from collection areas might also represent residential bases.

Recently, Barton utilised a human behavioural ecological approach to his study of the surface archaeology of the Simpson Desert (Barton 2001). Barton's study aimed to determine the factors that caused hunter-gatherers to vary behaviour, the characteristics of the local ecology (and then behavioural expectations). It also attempted to establish the aspects of foraging behaviour that would be detectable in the archaeological record (Barton 2001:325).

The Simpson Desert study incorporated a number of models. A *Diet Breadth Model* was developed based on modern faunal data. Differences in resource density and location throughout the study area were compiled for a *Patch Choice Model*. Predictions for land use for individual landscape units were then made based on their structure and composition. Given the nature of the study area - surface scatters in arid Australia - sampling and analysis were necessarily confined to the stone artefact record.

The Simpson Desert artefact record was typified by expediency in design and use. However, stone artefact manufacture is argued by Barton to be a part of a broader strategy of resource use where hunter-gatherers selected technological solutions appropriate to their needs. Notably, expediency was considered as related to more than just raw material availability and reduced logistical mobility (Barton 2001:354).
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be aimed at short term rate maximising, and sometimes their behavior appears fully at
The foraging behavior of the East African Hadza and Panamanian Ache do not seem to
anthropological examples described above have illustrated that this is not always the case.
fixed variances and that a forager seeks to maximise net returns. The archaeologist and
further complexities that require attention. The HBE models discussed above assume
In order for optimal foraging models to accurately reflect real-world situations there are
processing, and other tasks.
food
foraging activities against the time spent producing and maintaining tools, fire,
arbolecologies to hypothesise about time management, and how hunter-gatherers balanced
subsistence, and technocological strategies through time. They also allow
The foraging models described so far allow for predictions concerning hunter-gatherer

4.2 Risk

Planning in locational and scheduling of artefact manufacture and maintenance.
distribution of resources, but rather in targeted management of raw materials
(Paton 2001:329). These strategies were not viewed as opportunistic reactions to the
acquisition and raw material provisioning within a patch, resource poor environments
assemblages were the product of residually mobile forager solving problems of resource
farming on a large scale that was driven by habitat gain and patch densities. Ancestors
archaeological patterns in the Simpson Desert was the result of an inherent or inherent
breeders and that this was reflected in dated stone technology (the grundios). The
study concluded that low densities of high nutrient resources had led to expanding der
evidence of seed grinding was common and was indicative of low residential mobility
mobility was much higher (Paton 2001:332). In patches near to permanent water
diverse range of subsistence and economic activities, while away from these areas, group
sites located at permanent springs and within sand plains of the Simpson Desert featured a
odds with optimal foraging models. Also, as uncertainties exist in the real-world, the foragers’ knowledge of patches and landscape not necessarily complete (Stephens and Charnov 1982). The uncertainty will cause foragers to develop a range of solutions aimed at managing risk (see Winterhalder 1986; Winterhalder et al. 1999). As Elston and Kuhn have commented, elements of foraging behaviour including the type and extent of mobility, diversification in subsistence, and the general notion of risk minimization are really just facets of the same general phenomenon. (Elston and Kuhn 2002:4)

**Risk Minimisation**

Foragers can respond to uncertainty through either risk ‘sensitive’ or risk ‘prone’ subsistence behaviour. Risk sensitive decisions aim to reduce variation in returns, whilst risk prone decisions attempt to benefit from variation. Foragers will seek to minimize the chances of falling short of resources by adopting strategies that will always yield returns that are above a critical level and with the least variance - known as the ‘Extreme Variance Rule’ (Stephens and Charnov 1982:258). Foragers will usually choose risk ‘sensitive’ behaviour over risk ‘prone’ as these strategies are more likely to be successful over a longer period. Strategies include changes to prey and patch choice and usage, optimal group sizes and the time spent on foraging (see Caraco et al. 1980; Stephens and Charnov 1982; Winterhalder 1986). Only after all available minimising strategies are exhausted are foragers expected to choose a strategy that has more variance and is risk prone (e.g. stealing resources from another foraging group).

The types of strategies that foragers will employ to combat risk are varied, but six in particular have gained attention in archaeological studies (Clarkson 2004:58): (i) changes to mobility, (ii) intensification, (iii) diversification, and resource sharing strategies including (iv) storage, (v) exchange, and (vi) group foraging (see also Bamforth and Bleed 1997).

**Mobility**

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Productivity of each patch rather than increases the availability of patches explored. Only
investigation is to reduce variance in the supply of resources. If efficiency increases the
investigation is an overall increase in real time and effort spent foraging. The effort of


transport costs whereas to become less important and allow more stable residential groups
previously high residential mobility is considered in the context of the ability to minimize
or foragers in the Southern Levant. The adoption of microscopic technologies by foragers with
Neeley's work examines the introduction of microscopic technologies and residential mobility


microbiological cores which appear to have functioned as multipurpose tools (Cocker.

facial mobility: assemblages are characterized by high frequencies of formal tools, and
The name of the baked stone assemblages indicates that technology was organized to
frequent movement of foragers and periods of improved animal resources were available.
Cocker (2002) and Neeley (2002) have examined the relationships between residential

(Cizzeron 2004:59).

encounter rates within and between patches, and greater sampling between patches
the abundance of resources. They involve reduced costs in terms of travel time, increased
close to people. Both strategies compensate for risk by reducing the spatial uncertainty in
about by moving people to resources; and logistical – where the resources are brought
mobility is exhibited in two forms: residential – where changes in mobility are brought
those resources that yield high returns will be targeted within patches. Resources need to be relatively resistant to suppression and should not affect changes in the relative abundance of other resources (Larson 1996; Larson et al. 1996; Winterhalder 1986).

Winterhalder and Goland (1997) applied an expanded diet breadth model to examine the reasons for intensification in eastern North America during the late Holocene. They included the complexities of resource dispersion and the concepts of risk reduction through information sharing and exchange. Intensification took the form of prehistoric foods that displayed morphological indications of being domesticated from c. 4,000 BP. Two explanatory mechanisms are: (i) more disturbed habitats were necessarily utilised during the late Holocene, with domesticates starting as weeds; and (ii) plant domestication was due to changes in settlement patterns that led to local patch depletions, in turn causing increased transport distances and ultimately a decreased foraging efficiency. The consequence was an expansion in diet to include lesser ranked resources, and domesticates (Winterhalder and Goland 1997:147).

In Sub-Saharan Africa, Ambrose (2002) examined the intensification of exotic stone raw material use for manufactured for use as microliths which occurred at the end of the Middle Stone Age. Ambrose considers that this might reflect social strategies of adaptation to increased risk through “a system of reciprocal obligations mediated in part by gifts of fine-grained exotic lithic raw materials” (Ambrose 2002:10).

Diversification

Diversification enables expansion of diet breadth to include lesser ranked resources, resulting in maintenance of minimum dietary requirements. However, acquisition of lesser ranked resources will involve greater time in acquisition, handling and processing. This risk minimizing behaviour could also be coupled with risk ‘prone’ activities, as has been shown
Exchange in procurement of certain resources is more prevalent in sedentary groups than semi-sedentary, often implying a certain degree of prestige (Cashdan 1987; 1990: 1ow 1990). Long term storage implies a certain degree of large investments in terms of time and effort expended in acquiring and processing the resource. Storage will effectively counter periodic resource shortages but involves forces may harvest greater amounts of resources than are required in order to store them.


The South American Ache, and Northern Australian Melanesian Hawks and Blege Bird 2002:65, are demonstrated ethnographically for the African Kung, the Turanaro, the Haida, and Lem, costly signaling as means for competing for social advantages. Hawks and Blege-Bird large and dangerous game. These activities are an example of what Hawks and Blege-Bird (1990), Hawks (2001), and Hawks and Blege-Bird draw attention to.

by Hawks, Blege-Bird, O’Connell and others (see Hawks 1990, 1991; Hawks and
Establishing relationships with people outside of the immediate foraging group may also aid in minimizing risk. Exchange creates obligations for both groups, though it may provide assistance when local shortages occur. It exists in a variety of forms: (i) direct trade (balanced reciprocity); (ii) generalized exchange through the pooling of risk between larger groups; and (iii) theft (non reciprocal exchange). Non reciprocal exchange is a risk prone behaviour, as the ultimate consequences of taking without giving may result in negative impacts upon the foraging group. In addition to exchange of resources hunter-gatherers might exchange information, particularly if the foraging efforts might be undertaken by a group rather than an individual (Stephens and Charnov 1982).

**Group Foraging**

A shift from individual to group foraging will also reduce risk. Group foraging allows for greater knowledge sharing thereby reducing uncertainty in resource location. It may increase encounter rates, and reduce handling and processing times.

There are numerous benefits in group foraging. Immediate practical foraging benefits include faster patch detection time, reduced sampling time of the quality of a patch, and decreased variation in returns. There is also less chance that the group will abandon a patch prematurely. On a larger scale there are also evolutionary benefits that are associated with group foraging, including enhanced predator detection and avoidance, and increased prey capture rates. However, as Winterhalder has also noted, group foraging might not always assist all members of the group as averaging effects that reduce variance and the standard deviation of returns, can be at the expense of potential lower net return rates for the individual (Winterhalder 1986).

The relative effects of group foraging will be largely dependent upon the type of resource, i.e. frequency, dispersal, and habitat grain. For example, in ephemeral patches hunter-gatherers that forage as a group will have higher rates of return than the individual (Clark
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Foraging theory. The assumptions operate in these models: technologies are needed to
and their available, productivity, maintenance and use can be modeled using optimal
2004, 2005, Hiscott et al. 1994; Larson et al. 1996. As with other resources, stone artefacts
risk of (ii) acquiring the user with an increase in utility (Barnard and Bledsoe 1997; Clarkson
changes in foraging Stone technology systems are related to two primary goals: reducing

provide valuable insights into the processes of transmission in evolutionary terms,

provide technological developments and the timing of their introduction and proliferation can

subsistence activities. While at a higher theoretical level, the relationship between new

allow anthropologists to investigate the neps of decisions human-groups make regarding

modest, At a basic level, higher improvements are a tangible residue of human behavior and

studies of stone artefact technology readily lend themselves to testing optimal foraging

4.6 Stone Artifacts and Optimal Foraging Theory

Learning

human production, hazardous prey hunting, technological and opportunities for social

mobility. Other factors that will affect optimal group size include predator avoidance,

in the foraging activities of large groups, there will be a corresponding increase in group

R.L. Bartram et al. 1999; Larson and Goldsmith 1993; (ii) as prey becomes depleted, the

distance between patches increases group size becomes smaller (R.L. Bartram et al. 1992.

resources. There are two general principles that regard the optimal group size as

be determined by the spatial distribution of patches and the density and richness of

the efficiency of group foraging depends greatly on group size. Optimal group size will

and Pusey 1997)

influencing increased competition for resources, acquisition, and dominance effects (Parker

and Mangel 1996). Where there is increased partisanship, there might be disadvantages

extract resources from the environment; (ii) the context and nature of the use of patches places constraints on technological design; and (iii) the production of stone implements takes place within limited time and energy budgets, largely dictated by subsistence demands (Clarkson 2004:51).

With increasing foraging pressure brought about by unfavourable changes, as people modify their behaviour, pressures will also be placed on existing stone technologies and toolkits. As the objective of optimal foraging strategies is to minimize risk and maximize utility, changes to technology can greatly aid in attaining these goals. More elaborate technologies, use of different raw materials, and alternative material procurement strategies may all be implemented in order to improve success in prey capture, travel time, and in processing and harvesting (e.g. Torrence 1989).

Recent archaeological studies have been concerned with the concepts of stone raw material procurement, and tool use and discard in explaining how humans have sought to achieve gains particularly in terms of utility. The focus of these studies has primarily been on different reduction sequences and between curated and expedient tool design and function (Bamforth 1986; Parry and Kelly 1987). However, Clarkson has noted that the differentiation of technology into simple categories conflates ideas of artefact variability. Technological innovations incorporate planning and design, and lot of variability reflects emphasis on different performance characteristics aimed to enhance utility for specific roles (Bleed 1997; Clarkson 2004:66; Kuhn 2002).

Clarkson (2004) has described how the organisation of stone artefact industries can built into foraging models in terms of different provisioning and organisational strategies. These consist of: (i) time budgeting; (ii) organisation under mobility constraints; (iii) utility increase through design theory; and (iv) technological investment and gain rates (Clarkson 2004:66 and see also Caraco 1979; Kuhn 1995; Schiffer and Skibo 1987; 1997).
Havens 1984).

Manufacture will be most profitable (Bouchardon and O'Connor 1999; O'Connor and
now useful). It follows that a deeper breadth increases investments in tool design and
in design can increase chances of prey capture or make previously unattainable resources
modifications to design can aid in solving technological problems. In this way investments
improvements in the design of stone artifacts will itself often increase utility, as

4.6.3 Utility increase through design theory

logistical mobility increase there will be an increase in tool diversity (Clarkson 2004:69).
when logistical mobility increase there will be an increase in tool diversity, (a) when
rather than from the base. Generally, mobility constraints can be summarized as follows:
has noted that when mobility increases, raw materials will be acquired at distant locations
be predicted to hunt alone, or to specialize in multiple and multiple-purpose hunting (Kuhn
Mobility constraints will also constrain technology. If mobility is higher, then foragers would

4.6.2 Mobility constraints

rockshelter and re-use of artifacts could be expected at certain places.

greater amount of manufacture and manufacture in anticipation of foraging pursuits,
different raw materials may reflect patch viscosity, and in circumstances where there is a
variations. In general, these are the same for all major technological and tool
building may have specific consequences in terms of assemblage
done separately. These building may have specific consequences in terms of assemblage
and when and where specific tasks are undertaken all become important. For example, it is
such activities that achieve goals, or enhance fitness (see Torrence 1983). How,
we once is true, humans have to pursue activities in different ways to allow for these non-

4.6.1 Time budgeting
4.6.4 Technological investment and gain rates

Stone artefacts have a limited use-life and investments which ensure that implements are more reliable and maintainable, and prolong this period will also effectively minimize risk. As a tool is used, its performance level is steadily reduced (many tools work better shortly after manufacture, and steadily decline in performance over time). Selection of appropriate raw materials and improved design are effective methods for extending the use-life of a tool (the gain rate), by producing tools which retain sharper edges, are durable, and are easily formed into artefact designs (Gould and Siggers 1985; Torrence 1989). The use-life of an artefact is also increased by tool maintenance (such as re-sharpening) performed between use periods. Different design criteria will benefit utility including: standardization, hafting, portability, versatility, and flexibility (Clarkson 2004:73-77; Fitzhugh 2001).

Standardisation of assemblages reduces maintenance time. By standardizing the features of composite tools, the costs involved in manufacturing one component will be reduced, for example stone projectile tips (Hayden 1979; Torrence 1989). Hafting of a tool is designed to enhance performance through utility gain, and is achieved by allowing increases in the amount of force that can be applied in the use of the artefact. The process of hafting will allow the tool to be used in a manner that would not be possible if it was not hafted. It would also increase precision and conserve stone, as fewer edges are exposed that may suffer damage (see Keeley 1982).

When mobility constraints are present hunter-gatherers will adopt strategies that are aimed at enhancing the ease of transport (portability), and increase the range of tasks (versatility). In a group with high residential mobility, a small number of larger tools would be expected. If there is high logistical mobility, the number of smaller tools would increase. Simply stated, if a hunter-gatherer has to travel farther to get food, then it is more advantageous to limit toolkits to a small number of less diverse but more complex artefacts. If mobility
Chapter 4: Evolutionary Theory

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spatialization in tool manufacture, a greater diversity in tool forms, each with
multifunctional tool types. If there is high logistical mobility then there might also be
advance of use. If this is the case then tools will remain small, lightweight,
portable, versatile, flexible, multifunctional and replaceable, and planned and manufactured in
diverse patterns to be employed with lower encounter rates. To be effective, tools should be
individualized provisionally usually occurs when there is resource depletion causing more

Individual provisioning can be on an individual and place specific basis.

Provisioning provides insurance against famine resource vulnerability and availability.

Provisioning provides insurance against famine resource vulnerability and availability.

include both provisioning of people and of places. When human communities are planned,
these costs will contribute to the establishment of provisioning strategies. These strategies
when, where and how activities will be used. The results of their decisions in terms of
Hunter-gatherers are faced with a range of costs concerning technological investments.

4.6.5 Provisioning Strategies

2002,

important that are easily re-sharpened without losing too much of their edge (Kuhn

improvements that are easily re-sharpened without losing too much of their edge (Kuhn
to repay their initial investment. Generally, use-life will be improved by designing
the manufacture of the artifact, utility gain will occur only when the use-life is long enough
where effort expended in procurement and manufacture. Where time costs are high in terms of
Sherow 1996). The greater the use-life, the greater the utility gain as it reduces the time and
are portable, where activities can be employed for a variety of different uses (Nelson 1994).

Rather than designing specific tools for specific tasks, foragers may develop tools that

multipurpose tools. Consequently, versatility will be higher when tool diversity is low.

For specific resources then tools should be comprised of specialized tools rather than
chances then we should also expect changes in toolkit diversity. If foragers make long trips

Place provisioning will occur when there is greater predictability in the location and timing of future activities (as high ranked resources are abundant and variance is low), when mobility is low, and resource patchiness is high. Place provisioning will occur when resource procurement occurs from a central place, and will be evident in transport of raw materials into the residential site and also through stockpiling of raw material with little pre-processing.

4.6.6 Archaeological Application

Clarkson (2004) provides an example of a study of technological analysis of the flaked stone was used to test utility and risk reduction models. The analysis of assemblages from four rockshelters and 293 open sites in Wardaman country, in the central area of the Northern Territory, has shown that changes in stone technology were targeted at increased utility gains and were related to effective time budgeting and embedding of activities in other tasks. People in Wardaman Country organised procurement activities during both foraging and during down-time. For example, if utility increases were to be achieved, raw materials used for artefact manufacture needed to be located and procured in patches that were being exploited, and toolkit manufacture and maintenance should have taken place in residential locations. Both features proved to have always been a feature of subsistence strategies in the region but particularly so during the last 5,000 years (Clarkson 2004:269).

Increasing technological diversity in stone artefacts also proved to be a feature of hunter-gatherer subsistence over the entire settlement period in Wardaman Country. New technological sequences of artefact types gradually appeared over the last 15,000 years, though many of these were introduced and proliferated during the last 3,000 years. Clarkson’s study also found a close relationship between weight of flaked artefacts and distance from stone source evident in transported cores. Raw materials procured at distance from consumption locations were processed more intensively prior to transport.
as residential locations. A trade-off between reliable and maintainable technologies was
in assemblies from rockshelters and large open sites in the upper hand systems that acted
were all features of the subsistence strategies in Westernmost Canada. Stoolchairs were evident
Schedule's needs covered reliability and innovations in technology and tool performance

which diversely, specialized roles and longer ancient use-lifes.

physical technologies and invasive technologies after 3'000 BP may reflect an increase in
8'000 BP, and very few cores at all after 3'000 BP. The inception and production of
yielded small reduced cores after 12'000 BP, larger, less reduced cores between 7'000 -
reduction sequence. An increase in flexibility is suggested by a shift from expedient use
suggested to enhance portability. Versatility was characterized by a decrease in the
increase in the size of recovered implements over the last 3'000 years was
Clarkson also examined portability, versatility, flexibility in design, and use-life of artifacts.

means of metalization in order to halt the implementation

complexed, however the low variation in production width of points was suggested as a
Although initial observations of this behavior were made, no use-wear studies were
enhancing efficiency, minimizing tool edge damage, and reducing the loss of small tools.
increase utility gain, expanding function, increasing the possible force of application.
During the last 3'000 years (Clarkson 2004:269), Haling was also used to partially
was a strong reduction in variation in all aspects of shape and size of recovered implements
manufacturing core associated with haling and tool-bit replacement. For example, these
During the Late Holocene Foreages used standardised artefact forms to reduce
and subsequently transported.
when cores becameselection transporsted, with hance that produce spesifically produced preformes
Additionally, field processing of stone become an important feature again after 3'000 BP
also noted. Reliable tools included tulas and bifacial points which occurred after 5,000 BP. Their introduction appears to have replaced scrapers (marginally retouched flakes) which were considered to be maintainable implements with short use-lives. Scrapers dominate retouched assemblages before 3,000 BP. Scrapers are also considered flexible technologies indicating investment in risk reduction prior to this time (Clarkson 2004:273). Technological investments in tool design occurred after 5,000 BP and appear to have peaked between 3,500 and 2,000 BP. This indicates a technological strategy of tool design aimed to provide better performance over a limited range of functions.

Clarkson found that changes in the abundance and structure of resources placed strong constraints on human behaviour. The differences in abundance of critical resources of water, stone raw materials, shelter, and the diversity and ranking of food resources were found to limit the time spent in patches and the range and type of technological activities.

Temporal changes in subsistence and provisioning in Wardaman Country were closely linked to changes in climate and the subsequent changes to the structure of resources. Subsistence responses included several reversals between individual and place provisioning, and major shifts in logistical mobility over time. For example at 12,000 BP there was high residential mobility, provisioning of retouched flakes and heavily reduced cores – interpreted as a low investment in manufacture (Clarkson 2004:279). During the Holocene there was a steady increase in occupational intensity with provisioning of shelters with large, less reduced cores, less reduction, and a decline in raw material diversity. Changes in climate from 5,000 BP attributed to ENSO variability, led to patchier resources and coincided with increased mobility and the development of new technologies. This period featured a massive investment in tool design, diversity, standardization and use-life. Retouched implements became more portable and were likely to have been hafted (Clarkson 2004:279-80).
behaviour and this will involve a range of responses. The deep-breath and patch choice
produced and some goals. As environmental change, so too will the forests.’
Future-foresight groups want to maximize their efficiency and success in achieving both

**4.7.2 Optimal Foresight Theory**

The Optimal Foresight Theory provides a robust theoretical framework for developing

replacement.

Replacing existing technologies and reduce damage thereby reducing time spent on repair and
be standardized and quick and easy to repair/replace. Reliable technologies will be easier
efficient, designed to withstand stress, and easy to repair. Minimizing technological systems will further reduce the
utility gain of tools over time. Effective technological systems will combine tools that are
Developing tools that are reliable and/or maintainable are crucial to maximizing the

**4.7.1 Stone Technology and Risk**

Chapter Summary
range of return maximising and risk minimising responses will follow. These responses will include changes to the patch choice and subsequent changes to mobility and transport.

The distribution of resources across the landscape will have important implications in reconstructing foraging behaviour. Resources may be evenly distributed, clumped or be in-between these two extremes. For example the 'geometric model of optimal dispersion' attempts to gauge both residential and logistical mobility in terms of the evenness of resources (see Horn 1966). Foragers are predicted to select an optimal settlement location that reduces travel time to resources, and thus the expected encounter rates of resources. If resources are evenly spread, foragers will exploit resources by moving their residential base frequently over short distances whilst foraging in small dispersed social units (see Cashdan 1992; Clarkson 2004:56; Smith 1983). If resources are more mobile or clustered in particular areas aggregation at a central location is predicted (Harpending and Davis 1977). Furthermore, a mixture of one or more risk minimizing strategies may be implemented such as which resources are harvested and the diversity of diet. These changes relate to somatic goals, not only food but also raw materials utilised in attaining food.

Having discussed the theory that underlies Human Behavioural Ecology and Optimal Foraging, and explained the various models and how they are applicable to archaeological studies, the next step is to develop a settlement and subsistence model for the research region that incorporates the principles of OFT and risk.
30 m in places, the plain is generally flat and featureless. In contrast, the topography of the
consists of slope, alluvium, patch soil, and sloping colluvium. With hills and mesas up to
The topography of the plain and plateau contact markedly. The sediment of the plain

differences in the parental morphology where cliffs and slopes rise up to 30 m
around 100 m higher. Around the south, the intersection is less pronounced due to
Cul de Carpentaria and end abruptly in the northern and central regions with vertical cliffs
southwest and plains in the northeast (see Figure 5.1). The plains are associated with the

The study area can be divided into two physiographic units: a dissected plateau in the

5.2.1 Topography

5.2 The Research Region

models presented in Chapter 2

A series of hypotheses are proposed, based upon both terrestrial theory and the Australian
presumed. The discussion presents a synthesis of the data in light of the HBB approach
occur within these patterns, and the distribution and quality of raw materials are also
habitats and resource patches. Economically important vegetation and fauna expected to
how the geology, topography, and hydrology of the region have combined to produce the
River. The Carpentaria basin study area and the wider Cul de Carpentaria. The chapter discusses
human behavioral ecology (HBE) approach to the physical landscape data for the
This chapter builds upon the theoretical background presented in chapter 4. It applies the

River. The Carpentaria basin study area and the wider Cul de Carpentaria. The chapter discusses
human behavioral ecology (HBE) approach to the physical landscape data for the

Introduction

River. The Carpentaria basin study area and the wider Cul de Carpentaria. The chapter discusses
human behavioral ecology (HBE) approach to the physical landscape data for the

Chapter 5
plateau is directly associated with the underlying geology of Cambrian dolomites and is far more rugged. Here, karst topography featuring fissures and sink holes is common, and in many places there is little residual soil with surfaces of sharp limestone rocks created by carbonate removal during rainfall. Water flow through the plateau has created deeply entrenched rivers, creeks and gorges in many places and has also fashioned caverns, caves, and rockshelters.

Figure 5.1: Topography of the study area. Areas that rise above 20 m in elevation are shown shaded in grey.
Chapter 5, Evolutionary Theory, Part 2

...found either as cobbles or nodules within the dolomitic...

...forming technologies. These include: chert, greywacke, silcrete, quartzite, limestone, and sandstone. All of these...

...are only a few known stone types that are suitable for the manufacture of artefacts.

F. Rose Kau-Madden

...the dominant geology of the Riverstick area...

...and consist of grey massive friable crystalline limestone and dolomite. This formation...

...formations overlie the Constance sandstone and Law Hill formations in this area...

...the Rainbow peninsula of the Bally Shambles and associated Gwydyr River gorge systems...

...Cambrian dolomite and Thomastown limestone, occur within the main commercial area of...

...the south of Law Hill and Riverstick, middle Cambrian period rock consisting of...

(From and Moore 1994).

...formations are found combined with silstones and quartzites occurring as outcrops...

...Riverstick, Cambrian limestone domalites, while in the north immense sandstone...

...north of Riverstick, that run for about 80 km. In the south of the research region at...

...Constance sandstone. This feature forms a north-south trending scar of dipping beds...

...formation is again unconformably by a cross-beded conglomerate named...

...of shale, silstone, mudstone, carbonate and dolomite overlie the Constance formation. The Law Hill...

...sequence of interbedded sandstone, quartz-wacke, greywacke, silstone and shale varies...

...sandstone, silstone, and mudstone, and shales. To the east, the Lower Range formation, a...

...of sandstone, silstone, and mudstone. At the top of the Cambro-Ordovician strata, which are...

...Middle Cambrian, and Late Tertiary formations (see Figure 5.2), Proterozoic, Middle Cambrian, and Late Tertiary formations (see Figure 5.2), Proterozoic...

...between Mussilbrook Creek, Law Hill and Riverstick, the main rock types consist of...

...Geology
limestone of the plateau. Greywacke, silcrete and quartzite occur in the northern and eastern regions of the study area where dolomite is absent, and the sandstone formations dominate. Sandstone suitable for grinding occurs as slabs of variable size along the Constance formation and areas to the east (Figure 5.2).

Figure 5.2: Locations of knappable stone sources within the study region. Dolomitic limestone is shown in shades of grey, silcrete sources as green, greywacke as red and sandstone is shown in orange.
Chapter 5: Evolutionary Theory: Part 2

Evolutionarily disparate as springs and seeps that become rivers. At their points of origin
to their permeability, water is able to gradually make its way through pores and
to rock. Due to their permeability, water is able to gradually make its way through pores and
during the Triassic, Jurassic, and Cretaceous periods and covered by marine sedimentary
basin are composed of layers of gneiss sandstone and clay by erosion of higher ground
southeast corner of the Northern Territory. The underground aquifers that make up the
island in the world, underlying 27% of Australia, including most of Queensland and the
and 50-100 km distance from the study area. The basin itself is the largest and deepest of
and 50-100 km distance from the study area. The basin itself is the largest and deepest of
underground aquifers of the Great Artesian Basin (GAB) deep below the Bundy Tableland
underground aquifers of the Great Artesian Basin (GAB) deep below the Bundy Tableland
these, the southern Cretaceous and Oligocene Rivers are the most substantial, rising from
these, the southern Cretaceous and Oligocene Rivers are the most substantial, rising from
Seven perennial water courses run in a north east direction across the study region. Of
areas of the Lawn Hill Formation (Figure 5.3)

Dramatic changes. On the plain, drainage is sub parallel, semi-circular and rectangular
Dramatic changes. On the plain, drainage is sub parallel, semi-circular and rectangular
has led to the development of a dendritic drainage pattern with entrenched gorges and high
has led to the development of a dendritic drainage pattern with entrenched gorges and high
The Underlying Geology and Topography of the Region. On the plain, rainfall infiltration
The Underlying Geology and Topography of the Region. On the plain, rainfall infiltration
The location and relative abundance of fresh water sources are the greatest driving factor

Rivers and Springs

The water courses of Lawn Hill/Riverleigh flow northwards into the Gulf
Although arising well south of this basin, and very close to the Lake Eyre catchment, all of
Although arising well south of this basin, and very close to the Lake Eyre catchment, all of
difference of up to approximately 2 km (see Rodolfo and Jackson 1982: HILL 1994).
of the Gulf of Carpentaria is less than 70 m in depth, and in the south there is a rapid
of the Gulf of Carpentaria is less than 70 m in depth, and in the south there is a rapid
350,000 km² with over 2,500 km of coastline including every coastal drainage basins. Most
350,000 km² with over 2,500 km of coastline including every coastal drainage basins. Most
of Carpentaria is a large semi-enclosed, nearly rectangular embayment occupying over
of Carpentaria is a large semi-enclosed, nearly rectangular embayment occupying over
The study region is wholly within the drainage basin of the Gulf of Carpentaria. The Gulf

Hydrology

5.2.3
the Gregory and O'Shannassy Rivers are at the southern extreme of the Gulf of Carpentaria drainage basin. For the first 50 km or so, these rivers constitute little more than small streams, but by the time they reach the entrenched gorge system associated with the junction of plateau and plains, they are up to 40 m wide and about 6 m deep. Once leaving the plateau at Riversleigh, the O'Shannassy River has a confluence with the Gregory River approximately 10 km into the plain. The Gregory River continues its course through the Late Quaternary alluvium and black soil plains for another 200 km until intersecting with the salt flats of the Gulf of Carpentaria near Burketown.

In central Lawn Hill there are three permanent aquifer-fed water courses: Lawn Hill Creek, Colless Creek and Louie Creek (Figure 5.3). Lawn Hill Creek commences within the Northern Territory as Carrara Creek and like the Gregory River, when it has reached the junction of plateau and plain it is wide, deep, and has created entrenched gorges. Whilst the Gregory flows only through limestone geology, at Boodja Boodja (in central Lawn Hill), Lawn Hill Creek reaches its greatest depths around the eastern most fringing sandstone cliffs before developing into a slow moving watercourse interspersed with deep waterholes. Only 5 km upstream within the limestone escarpment Lawn Hill reek is little more than a shallow stream. Both Colless Creek and Louie Creek commence at a short distance within the plateau at Boodja Boodja, and are essentially tributaries of Lawn Hill Creek. Colless Creek rises within the limestone plateau approximately 20 km north of Lawn Hill Creek and flows south east, joins the Gregory River just prior to the fringing Constance Sandstone Range. Louie Creek located 10 km south of Lawn Hill Creek, has a confluence with the Gregory River approximately 15 km onto the plains. Both creeks are shallow streams. Lawn Hill Creek joins the Gregory approximately 175 km northeast of the study area. A fourth watercourse known as Widdallion Creek, a tributary of Lawn Hill Creek splits off the main channel just beyond the transition of plateau to plain, rejoining near the Lawn Hill Creek confluence with the Gregory River. In the early 1980's

Chapter 5 Evolutionary Theory: Part 2
Head 1994, 1998, Taylor et al. 2004 (Table 5.1).

...some of the tuba sequences have been carbon dated (Dygalale 1999, 2001; Dygalale and Both Outline Creek and the Gregory River have been investigated geomorphologically and are substantially cutting shallow pool areas of up to 1,200 m². The outcrop formations along...}

...effectively interact with water flow, following the development of pools, waterfalls, temporary streams and adjacent inter-set lakelets (Carthey et al. 2003, 2006). In many places the inter...temperatures and ambient inter-set lakelets (Carthey et al. 2003, 2006) below water formations of pools have active water flow. These inter outcrop formations are the result of calcium carbonate deposition and are strongly influenced by physiogrupham, warm water formations of pools that affect water flow. These offer formations at the calcarious limestone, alluvial watercourses of the central and southern areas and creeks (Colless's Law). Along the upper watercourses in the calcarious, alluvial and creeks, the calcarious limestone...lengths up to 40 km wide.

...Creeks cease to flow and are reduced to a series of large waterholes, averaging 2 km in...confluence with the Gregory River. During the dry season Musseldrook and Elizabeth...km from the junction of Plan and Plan and how into Lawn Hill Creek near to its...km north of Lawn Hill Creek respectively (Figure 5.7). Both creeks commence above...the north of the study area, Musseldrook and Elizabeth Creeks, occur at 40 km and...difficult to gauge, but the presence of Lawn Hill Parsons in the north of the study area,...except for a few months during the wet season. Estuaries of water flow prior to this are...passageless creeks a very stoppering water flow into Windjana and the creek is now dry...
<table>
<thead>
<tr>
<th>Sampling Site</th>
<th>Sample Code</th>
<th>Age (year BP) (uncorrected)</th>
<th>Age (year BP) (corrected)</th>
<th>Sample context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carl Creek</td>
<td>OZ1F88</td>
<td>3,150 ± 40</td>
<td>505</td>
<td>shells from sedimentary fill upstream of fossil dam series</td>
</tr>
<tr>
<td>Carl Creek</td>
<td>OZ1F860</td>
<td>3,410 ± 40</td>
<td>765</td>
<td>shells from sedimentary fill located between fossil dam series</td>
</tr>
<tr>
<td>Carl Creek</td>
<td>OZ1F861</td>
<td>3,880 ± 40</td>
<td>1,265</td>
<td>shells from sedimentary fill on the downside side of a fossil dam sequence, underlying a fossil tufa dam</td>
</tr>
<tr>
<td>Armchairs</td>
<td>OZ1F859</td>
<td>11,940 ± 70</td>
<td>9,295</td>
<td>shells from sedimentary fill upstream from fossil tufa dam</td>
</tr>
<tr>
<td>Armchairs</td>
<td>OZ1F862</td>
<td>45,000 ± 1200</td>
<td>42,355</td>
<td>shells from sedimentary fill directly behind fossil tufa dam</td>
</tr>
</tbody>
</table>

Table 5.1: Age data for fossil tufa sequences at the Carl Creek site and the Armchairs site at Riversleigh (from Carthew et al. 2006:94)

In addition to permanent rivers and creeks, permanent and semi-permanent springs occur within the study region. These are particularly prevalent at the edges of the Constance Sandstone in the central and northern study areas. Resistant sandstone commonly forms a natural barrier across watercourses, where the localized springs often fill substantial pools of fresh water. Such springs include Hartness, Gorge, Edith, and a number of unnamed springs. To the south of the Constance Range a single spring known as Jirringirri (Lilydale Spring) is known.

*Ephemeral creeks and streams*

The region's variability in weather conditions means that during the 'dry' season water is generally not available on either the plateau or plain, other than from the permanent rivers and creeks. Unseasonable rainfall may result in small pools, which soon dry out. In

**Chapter 5** Evolutionary Theory: Part 2
Waterholes may occur along such streams, but they too are soon dry.

Most large ephemeral streams cease to flow within a few weeks. For a month or so, however, when the wet season's rains increase and the ephemeral channels fill with water and create distinct channels, the ephemeral creeks overflow their banks, creating waterfalls in the limestone and sandstone gorges.

Contrast, during the wet season heavy rainfall fills abandoned pools, small creeks and...
5.2.4 Climate

Regional

The regional climate plays a crucial role in location and predictability of resources. The climate of the Gulf of Carpentaria region is strongly seasonal and is dominated by the Northern Australian – South East Asian tropical monsoon, characterised by marked seasonal variations in prevailing winds, temperature, and rainfall patterns. Between December and March there is a pronounced short wet season due to the effects of tropical monsoons originating in South East Asia and in Northern Australia. Generally dry conditions exist during the rest of the year due to the Inter-Tropical Convergence Zone (ITCZ) moving north of the equator and resulting in dry south east trade winds dominating the weather of the Gulf of Carpentaria. However the El Niño Southern Oscillation (ENSO) effect can result in large variations in the timing and amount of seasonal rainfall in the wet season. The onset of ENSO can vary, from the failure of the wet season to a very strong rainfall and tropical cyclone activity. Between October and November a transitional period occurs and is characterised by thunderstorms at irregular intervals prior to the onset of more general rain systems.

Study area

Although the climate of the tropical north and Gulf of Carpentaria greatly affect the local climate, there are pronounced regional differences. Intraregional variations would have been far more pronounced at different times in the past. In general, average rainfall decreases with increasing distance from the coast of the Gulf of Carpentaria. Within the research region rainfall levels vary considerably. In the Lawn Hill central area the climate is better described as semi-arid rather than monsoonal. Mean rainfall is about 350 mm at Lawn Hill station during the peak three month period of November to February and is less decreases further south. During the ‘wet season’, thunderstorms and tropical depressions
surface water available is from the perennial rive systems. During the dry season, evaporation exceeds precipitation and the only drop below 10°C. During the dry season, evaporation exceeds precipitation and the only

with an average maximum temperature of 25°C. Temperatures do not usually

During the remainder of the year (March – October), temperatures remain generally high.

Tolerable place to be at this time. Humidity and sometimes heavy rainfall makes lawn HILL/Paved/paths an isolated and barely

experience temperatures between 40-45°C. High temperatures combined with decreased

season with an average daily maximum of 38°C for January, although it is not uncommon

V as with rainfall, average temperatures vary greatly during the year, peaking in the wet

stream although flow may slowly after storms, dry out within weeks.

shallow pools of free water on ridges only last about a week after rain, and ephemeral

but extensive pools of Billabong) occur on Muswellbrook and Elizabeth creeks. Any

permanent trees of the Crape my O'Crab and Oxnamass Riviers, and Lawn HILL Creek. Significant

that any precipitation will occur, yet this time the only available water is found in the

During the long and pronounced dry season between March and October; it is unlikely

Typically dehydrated rocky areas

experience strong flows and flooding at this time, and pools of water are present on low

and in some areas, flooding can also occur. On the plains numerous ephemeral streams

gorges in a very short time. As a result, there is scarring of sediments adjacent to gorges,

pluvial/landslides can also result in significant increases in stream flow throughout

other areas (Davies and Xooor 1994). Due to the name of the entrenched gorges of the

originating in the northwestern can effectively soak a few hectares while no rainfall occurs in

(Continued from the northwest)
5.2.5 Vegetation Communities

Given the immense size, geology and hydrology of the study region a number of distinct vegetation communities occur. The primary factor determining the type and extent of such communities is proximity to permanent water. The region is generally classified as consisting of a mix of low open woodland, grassland and riparian vegetation communities. However, a number of additional local vegetation communities occur within these broader units. These communities consist of riverine and riparian corridors, woodlands and grasslands (see Dames and Moore 1994; Milson 2000a, b).

Within areas like the gorges and on the plain close to permanent rivers vegetation is dense and diverse. In such areas, a combination of parent rock, alluvial sediments, and water-flow determine biodiversity. It is not unusual to have areas of low open woodland, open forest, closed forest and patches of rainforest within only a few hundred metres of each other.

Community 1 - Riverine and riparian corridors

Riverine and riparian corridors are found along the course of each of the main permanent rivers and creeks of the study region. They are also a feature on intermittent creek lines, although vegetation is less dense than along permanent creeks. Within the gorges, fringing riparian forests line all of the main water courses. The presence of permanent water and much deeper soils than any other vegetation community, allow trees to grow up to four times larger than elsewhere. *Livistona* palms and *Pandanus* dominate the river banks.

Along the intermittent streams and waterholes, vegetation is dominated by *Eucalyptus camaldulensis* (River Red Gum), which grow to 10 m in height. Away from waterholes *Terminalia canescens* (Winged Nut Tree) dominates. Some of these areas also feature dense stands of *Acacia farnesiana* (Mimosa) and *Melaleuca*. Along the banks and within the water of the most substantial rivers (and particularly within gorges) there is a diverse vegetation
the Capricornia sandstone formation. It is dominated by *E. hystaphyllum* (snappy gum) and community occurs specifically in association with steep and lower dissected foot slopes of the ground layer consists of mixed grasses, herbs and vines. A further sub-group of this *Baulinna*, and *Lepidium angustatum* (Wid Peanut) also occurs (James and Moore 194:5-55). and southern dominant layer of *Zea phillinius* (Silver Cassia), *L. hystaphyllum* (Ausphitum) and *E. hystaphyllum* (Snappy Gum). A *I. dunnii* (Kunzea), *Grevillea cordata* (Helmecoper Tree), and *E. hystaphyllum* (Snappy Gum) forms the under-layer. A community usually consists of an upper layer of *E. hystaphyllum* (Snappy Gum), *Western Bloodwood*, *Combina hominids* (Western Bloodwood), that open woodlands dominated by *Combina hominids* (Western Bloodwood) cover most of the area distant from water at Boodjamulla. Woodlands occur on both the plain and the plains, but are most dominant on the plain up to about 1 km from permanent water. This plain is the area distant from water at Boodjamulla. Woodlands occur on both the plain and the plains, but are most dominant on the plain up to about 1 km from permanent water. This

**Figure 5.4: Bighami community along the Gregory River, northwestern Queensland.**

*Palms Tree* and *Nymphoides aquatica* (Canyon Water Lily). *Narrow leaf Nardoo*, *Olea melanodes* (Lily), *Pandanus aquatica*
T. aridicola subsp. Aridicola (Arid Peach) and an understorey of Triodia pungens (Soft Spinifex).

![Image of woodland community](image)

Figure 5.5: Woodland community, Gregory River, northwest Queensland.

Community 3 - Grasslands

Beyond the open woodlands, black soils and rocky outcrops associated with the underlying geology have created sparsely vegetated areas of grassland. This community is dominated by groundcovers of grasses especially Triodia pungens (Soft Spinifex). In some places even this is absent, such as in areas of exposed parent rock, and particularly on the plateau within the Thorntonia limestone where skeletal soil and barren rocky ground are found, and do not permit the growth of much vegetation. In these areas small Acacia (Wattle)
Figure 5.6. Grassland community, Kynuna, northwestern Queensland.

Trees.

The ground rock, there is only open *T. maudii* (spotted) hummock grassland with isolated

However, there are considerable bare areas at ground level. Where the soil is shallow and

clumped and spreading marram of these grasses provide a continuous low-level canopy.

*Queensland Bluegrass* and *Perthia gaudichiana* (Northern Kerosene Grass).

*Deschampsia caespitosa* (Whitfield Grass), *Calopogon flexus* (Ribbon Grass), *Deschampsia scabra* are dominated by very tall grasses with occasional emergents, dominated by *Perthia*

exposures of rock occur. The deep cracking soils and weak alluvium development of the plain

On the plain, grasslands occur on head to head undulating areas where poor soil quality and

consisting of various spinifex grasses.

*E. dichromophila* (Bloodwood), and *E. aphylla* (Desert Bloodwood) with ground cover.

Vegetation is also very sparse on the tops of the range and sandstone ridges, consisting of

trees are the only plants present including *L. hastata* (Soap Bush) and *P. hakea*.
5.2.6 Faunal Communities

The faunal communities of the study area are closely linked to the geology, topography and hydrology of the region. Previous environmental surveys have identified seven different faunal communities that are broadly coincident with particular vegetation communities: riverine/riparian, alluvial flats, boulder outcrops, limestone, woodland, grassland, and spinifex hills (Dames and Moore 1994:59). Habitats have been defined with respect to vegetation, topography and soils, and are also affected by the distance to permanent water, the presence of flowering trees, fire regimes and ground cover. In some areas human activities such as pastoral industry, the construction of weirs, and introduced species (cattle, pigs and cats), have also created artificial habitats.

Birds constitute the most diverse and abundant fauna for the region (135 species). Of these 72 species are considered residents, 53 are nomadic and 7 are migrants. Although about 65% of birds are widely distributed, the population densities are highest in the woodlands, riverine/riparian corridors and on alluvial flats. Numbers increase during the wet season, especially when local flora such as *Eucalyptus pruinosa* are in bloom attracting many species of honeyeaters. Populations of the fifty most common resident birds vary between 200 and 5,000.

Nineteen species of mammals have been recorded within the study region - fifteen native and four introduced species. Greatest mammalian diversity is found on the plateau and within the gorges, largely due to the numerous species of bats. Some mammals have particularly restricted habitats (*i.e.* water rats), whilst others can be found in all environmental communities. Desert dwelling mammals such as the Western Hare Wallaby are only located on the plateau areas, whilst the Agile Wallaby which occurs in great numbers on the plain and riparian corridors, is not found at all on the plateau. In total, five species of macropod have been identified in the region including *Macropus rufus* (Red

Chapter 5 Evolutionary Theory: Part 2
Table 5.2: Percent coverage of each of the different vegetation zones for the research region.

<table>
<thead>
<tr>
<th>Year</th>
<th>68</th>
<th>77</th>
<th>78</th>
<th>79</th>
<th>101</th>
<th>109</th>
<th>Total</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>14</td>
<td>44</td>
<td>99</td>
<td>50</td>
<td>24</td>
<td>78</td>
<td>77</td>
<td>birds</td>
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<tr>
<td>14</td>
<td>11</td>
<td>52</td>
<td>25</td>
<td>18</td>
<td>21</td>
<td>12</td>
<td>12</td>
<td>reptiles</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>13</td>
<td>13</td>
<td>amphibians</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>10</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>mammals</td>
</tr>
</tbody>
</table>

The research area includes numerous lakes and ponds, the largest of which is Lake Hart (40 ha). Lake Hart supports substantial populations of Crocodile Coot, Freshwater Bird, and numerous species of reptiles. Limestone and boulder outcrops also sustain numerous populations of reptiles. Permanent wetlands are located at the edges of the research area. Other species include 49 species of reptiles: nine eels, four leaches, six dragons, three monitors, 17 skinks, 3 pythons, and 7 venomous snakes (Djiru, 1994:16). The wildlife includes six dingoes, three carnivals, and seven echidnas. The study area is located in the drought zone (Webber, 1994:16). The area is characterized by low rainfall, and the study area is located in the arid zone (Webber, 1994:16).
5.2.7 Ethnohistory

Early ethno-historic observations describe the nature of settlement and subsistence around the time of first contact between Europeans and Aborigines 1865-1880 (Slack 2002).

Details of the size of Aboriginal groups and the places where they were encountered by Europeans in the study area show a strong correlation with archaeological evidence. In almost all instances, early accounts state that Aborigines were observed along the creek banks and always within close proximity to permanent water. For example, an article in The Queenslander newspaper described Edkin’s Lagoon in the north of the study region as “a favourite camp of the blacks, judging by the great heaps of mussel shells piled up on its banks” (anon 1878). Caroline Creaghe, an early explorer of the region described the construction of wet season shelters: “There were four humpies made of coarse grass growing all around, bound together with strips of bark. They are built in a semi – circle, all open. It is only during the rainy season they inhabit them, in fine weather they lie in open country under trees…” (Creaghe 1883).

Details of subsistence activities include descriptions of Aboriginal hunting and gathering technology. Creaghe described holes cut out of trees from which she assumed possums and native bee honey (sugar-bag) were obtained (Creaghe 1883). At the junction of the Gregory and O’Shannassy Rivers she also described in detail the remains of a deserted camp site where “large heaps of ashes were also everywhere along the banks; also large quantities of kangaroo’s and emu bones, fish and freshwater crocodile bones etc” (Creaghe 1883). A scientific correspondent named Sutherland who lived near to Burketown observed hunting technology that consisted of elaborate large nets “long and wide, very neatly made and strong, the fibre being chiefly from the bark of the Kurrejong (sic)” that were placed at significant tracks leading from the edge of the rivers in order to catch kangaroos and emu. Dilly-bags and fishing lines were also made from bark of the flax.
women with spear and stone tipped spears (Gough 1897:47). The throwing stik orulla.
spans were known for the region, including a century and a half.
spans, recorded carnelian, and crucible (Tourinfluential) and plain. According to Rohal, a variety of wooden
domestic, and ceremonial implements. At least three different types of boomerangs were
region to the north-east of the study area. These artefacts include fishhooks and hunting
Rohl (1897) describes both wooden and stone implements from the Lenchhund-Serwil

Adapted

sources and the technique of production for the whole of north-west Queensland.
commanura, trade networks, and ceramic types. Rohal carefully described artefact types,
people described hunting and food preparation, domestic implements, the sickle, farming,
Rohl specifically details material culture of the neighbours Kalkadoon and Indjimbal.
A synthesis of the practices and material culture of the north-west Queensland Aboriginal
reference to the people of this area is made in this book, and although no specific
Central Queensland Aborigines (Rohl 1897; see also Rohal 1904) are described. In 1987
shortly before their arrival, and that local Aboriginals practiced intermittent burning (see
subistence. Explorers often described large areas of the region as having been burnt
landscape to encourage the landscape appears to have been an important part of Aboriginal
1913).

swimming in the water during the dry season worked well, where they were clubbed (Sunderland
from grass, then once stretched across the river was used by Aboriginals to secure fish by
method for fishing involved construction of a thick rope, "about as thick as a man's
of a bush passed on one side to a sharp point and barked (Sunderland 1913). Another
plan twisted in either one of three stands, with a hook usually made from the wishtone
nulla’ was also observed by Roth close to the study area (Roth 1897:256). Other artefacts noted by early ethnographers include edge-ground stone axes and a variety of stone knives made from what is referred to as blade flakes hafted into ‘cementing substance’ to form a handle.

Domestic artefacts included storage and transportation vessels, woodworking, and food preparation implements. Coolamons are well known throughout the study region both ethnographically and observed in the field. Used to carry water or food they were manufactured from a piece of concave bark cut from the trunk of a tree or branch. A great diversity in coolamon size and shape exists as they were often cut at the time of need to perform a specific task. Aboriginal informants note today that coolamons could be up to 2 m in length, with attached handles and carried by several people (J. Diamond pers. comm. 2004).

Another tool Roth specifically refers to is the ‘native chisel’ describing it as being “one of the most useful tools in the possession of the aboriginals, and universal throughout North-West-Central Queensland” (Roth 1897:149). Consisting of a ‘flint’ flake hafted at either end of a short smoothed piece of timber, it is used for a variety of tasks including the maintenance of wooden spear tips, as a cutting implement and to prepare hides. Roth’s ‘native chisel’ is essentially a retouched flake, hafted and subject to regular re-sharpening.

Grindstones have been noted consistently across the semi-arid/arid region of northwest Queensland. They consist of a flat sandstone slab - a lower stone slab and a smaller upper stone, often referred to as a muller which can be round or flat. Also noted by Roth were ‘baking ovens’ (Roth 1897:156). Baking involved a large fire to heat stones, moving the hot stones into a hole, and then placing the meat on the stones. Another layer of hot stones would be placed on top of the meat, followed by a skin and final covering of mud.
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Section: Prehistoric Cultures

Figure 5.7: Aboriginal settlement, northwest Queensland. 1910 Showing habitation.

Headresses worn by males with shields and swords (see Figure 5.7).

The only record of Aboriginal ceremonial practices and adornment. They show elaborate body (Krom 1897: 109-113). Photographs taken at Riversleigh at about 1905. Provide the description of the practices of the ceremonial upper insertors, and some of the described are the practices of adornment of the ceremonial upper insertors, and some of the described are the use of feathers, bones, and glass as other ceremonial ornamentals such as beads and headresses, or as decorative semi-permanent jewellery with pleasure. Also described are the use of feathers, bones, and glass as other ceremonial ornamentals such as beads and headresses, or as decorative semi-permanent jewellery with pleasure.
trade item with Aboriginal groups up to 250 km away (S. O'Keefe pers. comm. 2003). It is likely that trade was an important part of Aboriginal social life at contact, especially to the southwest and northwest. An exception is the Kalkadoon People of the southeast where oral history only makes mention of hostilities with the Waanyi people (E. King pers. comm. 2002). However, in contrast to the ethnographic explanations of a lack of trade with the Kalkadoon, hundreds of edge ground axes are commonly found in Late Holocene contexts throughout the study area. Hiscock has previously suggested that the closest raw material suitable for manufacture of such artefacts comes from Kalkadoon country at Lake Moondarra near to Mount Isa (see Hiscock 1988:55).

Early ethnographies sometimes detail important observations concerning the methods of prey capture (e.g. the methods of fish capture discussed above). These observations may have implications in respect of search, handling and capture times for prey. This in turn will effect the development of prey rankings when developing expected diet breadth models.

5.3 Riversleigh / Lawn Hill Model of Subsistence and Settlement
This section outlines a model for human foraging behaviour developed for the research region. It incorporates the environmental data discussed above, current knowledge concerning climate changes over the last 50,000 years (see Chapter 2) and expected foraging behaviour stemming from the theoretical predictions of human behavioural ecology (Chapter 4). The model includes predictions emanating from the diet breadth and patch choice models, but includes other elements of HBE including marginal value theorem and central place foraging theory. The responses to risk and uncertainty are then explored in respect of both resource use and lithic technology through time.

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compelled from various sources (Table 5.2).

Austrian prehistoric foragers for the Central Northern Territory, and the model was
dissertation provided the only recent attempt at a comprehensive diet breadth model for
observation and analysis of the caloric values of many specific resources. Charlton's (2004)
and handling times. Development of prey rankings requires a detailed level of field
returns of any given resource in terms of the energy required to harvest (search, capture
costs) and an assessment of prey rankings. Rankings are usually based on a combination of the energy
in relation to fauna material, the development of a diet breadth model requires

may provide valuable supplementary data.
not be visible, though investigations of microfossils such as pollen, search or phylogenetic
organic remains recently survive in the archaeological record, many of these plants would
variety of plant foods were probably targeted by foragers in the research region. However,
applicable generally to the study region is detailed below in Table 5. The lists imply that a
addition to local fauna. A list of observed Aboriginal plant foods are rich in honey, nuts, seeds, and
the region was visited and included seed and fruit vegetables, honey, flowers and nuts. In
loads by traditional owners has been noted. Aboriginal diet in the Northern Territory in
years of fieldwork in the study area. During fieldwork, the location and suggested uses of
Northern Australia. Personal observations have been made throughout the course of six
personal observations, vegetation surveys, ethnographic literature and previous research in
examine diet breadth. Diet breadth for the study area is based upon a combination of
The first stage of developing a model of foraging behavior for the study region is to

5.3.1 Diet Breadth Model
<table>
<thead>
<tr>
<th>Taxa</th>
<th>Common Name</th>
<th>Aboriginal Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livistonia rigida</td>
<td>cabbage palm</td>
<td>growing bud eaten raw or cooked</td>
</tr>
<tr>
<td>Vitex gloriosa</td>
<td>black plum</td>
<td>fruit eaten raw or cooked, wood used for fire sticks</td>
</tr>
<tr>
<td>Lysiphyllum auronii</td>
<td>bauhinia</td>
<td>sap eaten, drink made from flowers</td>
</tr>
<tr>
<td>Brachychiton collinus</td>
<td>kurrajong</td>
<td>seeds roasted, tap root and gum eaten raw, bark for string</td>
</tr>
<tr>
<td>Ficus sp.</td>
<td>fig</td>
<td>figs eaten, leaves as sandpaper, medicinal</td>
</tr>
<tr>
<td>Fluegga virosa</td>
<td>white berry bush</td>
<td>seeds eaten raw, ground to paste, cooked as damper</td>
</tr>
<tr>
<td>Cyperus vaginatus</td>
<td>rushes</td>
<td>fruit eaten raw, medicinal, tuber starch</td>
</tr>
<tr>
<td>Ipomoea sp.</td>
<td>bush potato</td>
<td>eaten raw, tuber</td>
</tr>
<tr>
<td>Pandanus aquaticus</td>
<td>pandanus</td>
<td>edible tubers</td>
</tr>
<tr>
<td>Eucalyptus terminalis</td>
<td>western bloodwood</td>
<td>seeds roasted, leaf base eaten raw, medicinal, leaves for fibre, trunks for rafts</td>
</tr>
<tr>
<td>Grevillea striata</td>
<td>grevillea sp.</td>
<td>galls eaten, drink made from flowers, sugar bag, sap medicinal</td>
</tr>
<tr>
<td>Haakea arborescens</td>
<td>corkwoods</td>
<td>drinks made from flowers, seeds eaten, medicinal</td>
</tr>
<tr>
<td>Carissa lanceolata</td>
<td>konkerberry</td>
<td>berries eaten</td>
</tr>
<tr>
<td>Carissa ovata</td>
<td>current bush</td>
<td>berries eaten</td>
</tr>
<tr>
<td>Triodia pungens</td>
<td>hummock grass</td>
<td>resin used for hafting stone artefacts</td>
</tr>
<tr>
<td>Cockspertum fraseri</td>
<td>kapok bushes</td>
<td>flowers and roots eaten</td>
</tr>
<tr>
<td>Santalum lanceolatum</td>
<td>sandalwood</td>
<td>fruits eaten, medicinal</td>
</tr>
<tr>
<td>Grevillea mimosoides</td>
<td>grevillea sp.</td>
<td>drinks made from flowers, seeds eaten</td>
</tr>
<tr>
<td>Boerhavia sp.</td>
<td>tar vine</td>
<td>taproot eaten (tuber)</td>
</tr>
<tr>
<td>Cissus rubiformis</td>
<td>native grape</td>
<td>fruits eaten</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>pigweed</td>
<td>seeds, stems and leaves eaten</td>
</tr>
<tr>
<td>Marsilea exarata</td>
<td>nardoo</td>
<td>Toxic starchy sporocarps ground with water and cooked into damper</td>
</tr>
<tr>
<td>Owenia acida</td>
<td>emu apple</td>
<td>fruits eaten</td>
</tr>
</tbody>
</table>

Table 5.3: Aboriginal Plant Use for the research region (after Wrightman and Andrews 1991).

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The diet breadth model (like Table 5.) charts the relative rankings of food resources from highest to lowest. The highest ranked foods are generally those that are easily obtained and require little preparation. For example, Clarkson's diet breadth model predicts that edible fruit is the highest ranked and most preferred resource. Foods that are either difficult to obtain or are of low caloric return are lowest in diet ranking. For example, both grass seeds and palm hearts have extensive time costs for processing, while freshwater mussels are of comparatively lower energy return compared to most other resources.

There are a few concerns with establishing a diet breadth model as per Clarkson's example. Firstly, is the issue of applicability of data. Many of the studies that have been used to formulate the data in Table 5.4 are based on short term observations of forager behaviour drawn from environments that do not always provide effective parallels for Australia generally or this region. Secondly, some rankings are based on very old research (i.e. McCarthy and McArthur 1960; Jones 1980). A third and even more crucial concern is that some of the measurements of the rates of energy returned do not reflect the data obtained from studies. For example, the energy return rates and subsequent placement of edible fruit in Clarkson's model appears to exaggerate its value. According to discussion by O'Connell and Hawkes (1981) it is more likely that fruit would return about 5,000 kcal/hr.

This same paper details a higher value for arboreal animals of approximately 6,000 kcal/hr.

Use of ethnographic literature provides a more robust resource ranking system, as well as greater understanding of resource acquisition technologies that may not be visible in the archaeological record. For example, the ease of prey capture and the travelling time to resources are important factors in the relative value of resources. Technologies that reduce either of these factors might shift lower ranked foods higher up in a diet breadth ranking system. For example, fish are relatively low in resource preference in Table 5.4; however techniques such as netting and poisoning that are not visible archaeologically involve far
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120

 Attributes and Analyses. Foods such as fruit have a lower ranking at this initial stage.

31

(309) are preferred. These are followed by medium and smaller mammals and reptiles.

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(309) are preferred. These are followed by medium and smaller mammals and reptiles.

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(309) are preferred. These are followed by medium and smaller mammals and reptiles.

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(309) are preferred. These are followed by medium and smaller mammals and reptiles.
<table>
<thead>
<tr>
<th>Ranking</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>large mammals and reptiles</td>
</tr>
<tr>
<td>2</td>
<td>medium mammals and reptiles</td>
</tr>
<tr>
<td>7</td>
<td>honey</td>
</tr>
<tr>
<td>4</td>
<td>large birds (turkey)</td>
</tr>
<tr>
<td>5</td>
<td>turtle</td>
</tr>
<tr>
<td>6</td>
<td>fish</td>
</tr>
<tr>
<td>7</td>
<td>medium birds (only a few species)</td>
</tr>
<tr>
<td>8</td>
<td>fruit</td>
</tr>
<tr>
<td>9</td>
<td>eggs</td>
</tr>
<tr>
<td>10</td>
<td>mussels</td>
</tr>
<tr>
<td>11</td>
<td>tubers</td>
</tr>
<tr>
<td>12</td>
<td>seeds</td>
</tr>
</tbody>
</table>

Table 5.5 Prey Ranking for general classes of food at Lawn Hill/Riversleigh based on personal observation and discussions with Aboriginal survey members.

Male Aboriginal survey team members were clear that they favoured large mammals and reptiles to eat. However, as noted previously, these foods often involve less frequent encounter rates and lengthy capture times. In contrast, some foods that the diet breadth model in Table 5.4 rank highly were not favoured at all by Waanyi informants. These included arboreal animals (mainly bats), tubers and seeds. Aboriginal people had an attitude that these foods might be eaten only when everything else had been exhausted. Some foods were considered either taboo to consume or not worthy of the effort, as with bats and seeds. Another complexity is that most food collection is historically known to have been done by women. Today most of these foods have been replaced by European items in the Waanyi diet making it difficult to gauge their prior importance. However, during survey 'down time' it was noted that women frequently used this time to either fish, or to collect fruit and berries.

A basic diet breadth model was developed after the nature of foraging, including capture rates and ease of resource handling, incorporating the first stage of prey rankings (Table 5.5). The top three resources in this model (honey, fruit and eggs) would be predicted to
Table 5.6

<table>
<thead>
<tr>
<th>Prey Rank</th>
<th>Resource</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jog</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Lizards</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Large aquatic animals (turtle)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Large birds (few species)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mammals and reptiles</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Eels</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Fish</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Medium birds (only a few species)</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Turtles</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>Reptiles</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Large mammals and reptiles</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Seed</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>Fruit</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>Honey</td>
<td>1</td>
</tr>
</tbody>
</table>

Harvest quantities and are time consuming in terms of processing. Exhaustive digging to obtain and large quantities to satisfy hunger. Seeds also require large quantities to yield fruit. \( \text{medium}\) from other active resource procurement. \( \text{Judges} \) and \( \text{hikers} \) then involve other aquatic resources require skill and patience (but might be conducted during down time). The lower ranking foods in the \( \text{HHH/Reysmith}\) are breads model AOLOx2A model and ranking those that have engaged people would between large, medium, and small game. It is more likely that Aboriginal people would have engaged the distinction and success as indicated in ethnographic accounts, would have eliminated the distinction model acknowledged that many technological innovations (including complex weaponry) hunting activities. Unlike Charles's inversion between large and small mammals, this inversion using no more than a thin stick placed into a bee - hole on the side of a tree. Provide very high calorie returns for minimal effort. In the case of money it is common to be harvested every time they are encountered during foraging. All are easy to obtain and
5.3.2 Stone Artefacts and Foraging

The previous chapter discussed the ways in which stone artefacts can be imbedded into foraging models and earlier in this chapter descriptions of raw materials and their location were outlined. By far the most dominant raw material in assemblages is chert, which is available as river cobbles or as nodules in limestone in either the gorges or on the plateau. The location of chert corresponds positively with the location of the primary sources of water and the high productivity patches (woodlands and riparian). In contrast, raw materials including greywacke and silcrete are located in areas that are further away from permanent water and within less productive patches, specifically the grasslands and plateau.

Investigating the relationship between flaked stone technology and foraging activities at Lawn Hill/Riversleigh involves examination of: (i) levels of raw material procurement and transportation relative to availability and quality of materials; (ii) changes in discard rates in archaeological sites within different patches; (iii) changes in the type and intensity of reduction through time; and (iv) the level of toolkit diversity over time.

*Stone Procurement*

The patterns of stone raw material procurement are indicative of the foraging strategies of a population. Diversity and relative abundance of raw materials provides information concerning patch visitation and the overall mobility of foragers. Differential transportation of raw materials, distance decay and the relative occurrences of field processing are also significant.

Within the study area there are two main types of raw material procurement that are expected. Local chert is expected to have been acquired predominantly from river cobbles and to a much lesser extent from quarry areas on the limestone plateau. Although chert sources are very close to areas that are predicted as residential bases for a population, it is considered likely that initial reduction of stone took place at the sources and cobbles or
Differences in reduction sequences are therefore more likely to directly relate to the
settings. Different reduction sequences are therefore more likely to directly relate to the
settings. In need to conserve raw materials at least in areas in proximity to water (and within
environmental limits) given that access to raw materials is not uncommon or difficult, these
settings are as a pay-off for costs associated with design and manufacture. Therefore,
reduction sequences are examined in order to focus on use-life as an indicator of
Reduction

breakage (due to treads).

In other independent measures of occupation intensity including sedimentation rates and
Diseased trees are quantified by weight, number, area, classes and then assessed relative
density and intensity. The more intense/recent the occupation, the more intense/frequent the occupation.

may be a desirable measure of the intensity of the site occupation. Assuming a low
front of the main productive efforts, the level of attention/disregard in terms
and charged. Notwithstanding agronomic efforts, the level of attention/disregard in terms
of attention/disregard throughout the region. Occupations in intensity is measured by the level of attention/disregard throughout the region.

David R. Alley

place at the source location. hunting in marginal parts. It is expected that most reduction of hearths would take

also occurred during, down - time (Torrence 1987), 1988:157-60). Examination of charcoal is likely to have been emplaced into other areas and

guaranteed stone brought back to a site might already be quite heavily reduced (see Hiscock

prehistoric specialists. All rights reserved
manufacturer or users solutions to problems concerning both environmental uncertainty and selective pressures.

Reduction sequences utilised in stone artefact manufacture and maintenance were assessed by analysis of all types of debitage, cores, flakes and retouched flakes. Cores were quantified by assessing the extent of core reduction. The attributes of this analysis included the number of rotations, the prevalence of parallel flake scars and the incidence of single or cortical platforms. The frequency of different retouched artefact implement types was also used to evaluate whether extensions to tool use-life were related to greater levels of foraging stress brought about by less stable environments (Hiscock 2001a, 2002a, 2006). Lastly, given their dominance in assemblages, unmodified flakes have received detailed study including changes in overall average dimensions, *i.e.* pointedness, length – width, and weight. The types of terminations, the proportions of flake platform types and the extent of their preparation were also recorded (see Andrefsky 1998; Dibble 1997, 1998; Dibble and Whittaker 1981; Flenniken and White 1985; Shott 1996, 2003; Shott *et al.* 2000; Speth 1981).

**Technological diversity**

The level of technological diversity in hunter-gatherer societies is directly associated with subsistence strategies. Diversity is limited by transportation and mobility costs and the relative levels of task specificity that lithic material might be used for. Technological diversity will be lower where there is high residential mobility. However, if there is a high level of logistical mobility, specialized tools will occur, thereby inferring greater technological diversity. Increased logistical mobility is one solution to greater resource patchiness, and more mobile resources. If technological diversity increases then it is expected that the increase in the number of tool types will also provide utility gain rates. Recent research has documented increasing levels of technological diversity in the

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5.3.3 Mobility and archaic assemblages

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... while the archaic assemblages at these locations (Nicholson and Cane 1994, Cane 1996) and the park's residential mobility (Nicholson and Cane 1996). These sites will be common during periods of high residential activities, occurring as a higher percentage of overall camps (average 2001:162, Cane 1984, 1987; Short term camps are located away from residential bases, e.g., communities hunting...)

... artifact, larger assemblages of flake debitage and excised cores reduction.

... residential, residential bases, should also feature high frequencies of worn and broken grinding stones (Blum 1979, 1980). Given the amount of time that is spent in these... some material types and qualities, and possibly large heavy items of the hunting fauna... subsistence system; then we would expect residential bases to contain a wide variety of... (see Nelson 1992). As stone raw material sourcing is embedded in the foragers' assemblages that are large and coarse-grained with high levels of variation and complexity where hunter-gatherers focused their lives. These sites will contain diverse... residential bases are locations where a full range of subsistence activities took place and... model of residential mobility; both spatially and temporally, and are directly related to the parish... short term camps, and (ii) limited activity areas. Each of these site types reflects strategies... three types of sites are produced in locations within the study region: (i) residential bases, (ii)...
places will be similar to the larger bases, they will feature limited diversity and complexity. Assemblages at short term camps are largely determined by the amount of material that foragers are able to carry, and as such, it is likely that there will be evidence for curation of tools, and that debitage will relate more to maintenance activities rather than tool production. It is also predicted that short term camps will feature task specific items such as backed artefacts.

*Limited activity sites*

Limited activity sites are places where resource extraction took place, e.g. butchering locations or stone raw material sources. Unless these places were often visited, they are expected to be of very low archaeological visibility consisting of small lithic assemblages of broken, or retouching debitage in places where tools were used for resource extraction (Binford 1980; Thomas 1983). Such materials may also feature prepared cores that were use to manufacture ‘expedient tools’ on site.

5.3.4 **Riversleigh/Lawn Hill Patch Choice Model**

Based on the above descriptions of environmental units, and the location of critical resources within them a patch choice model for Riversleigh/Lawn Hill has been formulated. This model operates on both a local and regional basis.

*Local Patch Choice*

The study area has been divided into four different local patch types based upon a synthesis of the vegetation, contemporary faunal communities and the geology of the region: *(i)* Riverine and Riparian; *(ii)* Woodlands; *(iii)* Grasslands; and *(iv)* Limestone Plateau.

Each patch type occurs as an uneven environment, though they are spatially predictable. The level of predictability may have varied considerably over long and short timescales. In

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The inverse-fluvial patch may also be present within semi-permanent watercourses.

In addition to the primary role of acting as a bank for fish, it may provide a refuge for aquatic animals and serve as a breeding ground for fowl and other birds. The inverse-fluvial patch is also an important habitat for terrestrial animals, providing food and shelter.

The inverse-fluvial patch is typically found in areas where there are large expanses of shallow water (e.g., ponds and lakes). The patch is usually associated with areas that have a high water table, which keeps the soil moist and encourages the growth of aquatic plants.

The inverse-fluvial patch is a critical habitat for many species of fish, as well as other aquatic animals. It provides a refuge from predators and helps to maintain a healthy aquatic ecosystem.

The inverse-fluvial patch is also important for the survival of many terrestrial species, as it provides a source of food and shelter. It is particularly important for species that are unable to survive in more permanent water bodies, such as those found in ponds and lakes.

The inverse-fluvial patch is an important ecological feature that needs to be protected and managed to ensure its continued existence and the health of the associated ecosystems.
however during periods of increased aridity, the patches in these environments would have soon become depleted.

The riverine-riparian patches would have provided a focus for human settlement and subsistence throughout the occupation of the study region. Evidence of human occupation will be concentrated within this patch type as residential bases. However, within the gorge areas it is expected that a range of site types occur including rockshelters, shell middens, and art panels will occur. Evidence of stone artefact procurement and manufacture is expected to be manifested as quarried riverbanks and shallows, small chert quarries along limestone ridges and scatters located on the periphery of the patch.

As the riverine and riparian patch is expected to have been a focus for extended residential base camps it also follows that it would have been a place from which central place foraging trips would have been made. Due to the richness of the patch, long distance foraging is only expected to have been made for high ranked or rare items.

Lithic assemblages from sites within the riverine-riparian patch will feature extended core reduction, evidence of tool production, maintenance and repair with high ratios of flakes to tools and broken tools to complete tools, with provisioning of some locations with raw material. It is likely that artefacts with evidence of use reflect expedient tool use for on site tasks, as evidenced by a large number of unretouched flakes. Where curated items do occur it is likely they will be heavily curated and discarded by the forager replacing worn items in toolkits.

Woodlands

Woodlands occur along primary permanent watercourses on the eastern plains of the study region and on smaller alluvial plains located within the periphery of gorges associated with the plateau. Woodlands contain the highest levels of biodiversity and are directly
area they are unlikely to be of any great antiquity. Occur within this period. However, due to the harsh environmental conditions of the study evidence of food consumption at either residential bases or at single events might also 10'000 BP based upon lithic warfare patterns (see Hiscock 1989). These data include breaking-down use. Such sites have been shown to have a possible antiquity of over somewhat. During this use, instances of protein and manganese locations as well as instances of artifacts discarded due to ecological and hydrological conditions, but are expected to include stone artifact. The types that will occur within this period tend will be strongly correlated with local permanent water.

Overall, the woodland sites expected to show evidence of a mixed mobility strategy. A particular period becomes dry, higher levels of group mobility would have resulted. During wet periods central place foraging may have occurred from these places then when drier and wetter, occupation is likely to have been short term. It is quite likely that extended periods of occupation during phases of enhanced rainfall. During phases of woodland, similar to the innovative and impact areas, would have provided a focus for to have been significantly greater during such periods. Significant with minor excursions to the innovative corridor. Habitations grain is expected habitation. During extended periods of activity, woodland patches would have contracted over time. During periods of high annual rainfall the patch was extensive with a fine grain. The location, extent and richness of the woodland patch would have been highly variable communicating with proximity to permanent water, beginning at the transition from open

0.001 1'000 m. This patch type associated with proximity to permanent water, beginning at the transition from open.
The lithic assemblages in woodland patches will show evidence of extended core reduction in areas near to water and raw material sources, and will depend on the extent of nearby riverine patches and the location of Woodlands with respect to water, stone sources and natural shelter. Where woodland patches are near to these resources they should feature high rates of tool discard, moderate levels of tool diversity and perhaps higher frequencies of grindstones around areas close to free-standing water. It is also possible that certain locations may be provisioned with stone raw materials. Where woodlands are situated in regions that are further removed from critical resources, the expectations are that site frequency, size, richness and diversity will be far lower.

**Grasslands**

The grasslands patch type is a combination of boulder outcrops, spinifex hills and black soil plains, which occurs predominantly on the eastern plains of the study region beyond woodland patches. It also occurs on the limestone plateau abutting the limestone plateau patch, and at great distance from permanent water.

Grasslands contain low levels of biodiversity and are a coarse grain habitat. Fauna consists predominantly of reptiles, birds and larger mammals. During periods of increased rainfall this patch might have offered temporary enhanced richness as other local species expanded their range. However, in all but the wettest of conditions these patches exhibit low richness. It is unlikely that foragers utilised this patch with any intensity, and that use was limited to resource extraction and foraging during periods of wet weather. Archaeological sites that are expected within the patch include stone quarries including greywacke, isolated artefacts discarded during hunting trips, and isolated art in boulder outcrops and on the more significant mesas that outcrop in the northern area of the study region and are closer to permanent water (see Border 1988). Except at quarry locations, the predicted stone

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Some of the creeks are seasonal and by the middle of the dry season they disappear. In the north at Lawn Hill, Muswellbrook and Elizabath Creeks water flow is less than their streams. In the south there are fewer, longer-lasting rainfalls in their subsurface size and are permanent water which remains for hundreds of years. As result of this stable water flow the Creek or River are physically and create large dune-like areas of floodplains

the Creek or River are physically and create large dune-like areas of floodplains and a permanent water source. A result of this stable water flow is the Creek or River are physically and create large dune-like areas of floodplains

Rangeland Pasture Model

Besides these localized areas, the low use patch is expected to only be a few frequency. The plains may have been used as grasslands to extract stone for maritime, particularly in the large size anomalies and larger fields. Some areas near to the edge of the plains may have been very similar to the grasslands patch and would have primarily been used for dependence in resources. The proportionate use of the plains area is expected to

This patch is of low biodiversity and therefore low habitat gain and is generally the plains area is expected to have had little effect on the patchiness or richness of these areas.

diversity and be comprised primarily of grassland or wooded and broken agriculture.

assumptions of this patch will display little or no evidence of cool temperatures, low
cease to flow and exist as a series of billabongs. In the north, patch composition is different in terms of extent and grain, and resources are more scattered and less predictable. In addition, stone raw material sources are more distant.

Figure 5.8: Diagram of ecosystems of Riversleigh (a.) and Musselbrook (b.) showing the extent of each of the local patches. Note that limestone plateau does not occur at Musselbrook and that orange shading indicates sandstone escarpment areas.

5.4 Settlement and subsistence at Riversleigh / Lawn Hill through time
This section describes a model of subsistence and settlement for the study region. It combines the models of expected forager behaviour stemming from Human Behavioural Ecology, the data concerning local resource availability (modern patches and diet breadth) and how considers these might change through time. This model provides a series of expectations in foraging behaviour that will be tested against the archaeological data presented in the next two chapters.

The settlement and subsistence model for Riversleigh/Lawn Hill is based on the current best knowledge concerning climate changes over the last 50,000 years. It consists of six
species through time. This model is presented below in Table 5.6.

5.4.1 Diet Breeding Model through Time

Foregoing pattern through time

Dietary patterns and the predicted nature of occupation and dominant
species and density of resources and the predicted nature of occupation and dominant
in the past. For each phase of the study area predictions can be formulated on the
predicted patterns. For each phase of the study area predictions can be formulated
are comparable. The model relies upon the assumption that human behaviors suggest to minimize

Table 5.6 Illustrates the relationship between resources as expressed as a diet breadth table.

In availing themselves of woodlands and prairies, pastures became depleted and reduced in size.
During periods of increased animal resources such as horse and corn would have decreased
periods of animal. Lesser ranked invasive resources might have remained fairly constant
produced and animals, were reduced in abundance and density in most prairies during
pluvial, and to the large-scale climatic changes. High ranking resources, including plant
by reference to patch sizes (e.g. trees/forested, woodland, grassland, and horticulture).

The model relies upon the assumption that human behaviors suggest to minimize

Table 5.6

Diet Breeding Model through Time

<table>
<thead>
<tr>
<th>Phase</th>
<th>2,000 BP to 4,500 BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Colonization Phase (50,000 to 30,000 BP)</td>
</tr>
<tr>
<td>2</td>
<td>the Last Glacial Phase</td>
</tr>
<tr>
<td>3</td>
<td>Holocene Phase (18,000 to 10,000 BP)</td>
</tr>
<tr>
<td>4</td>
<td>Postglacial recovery Phase (10,000 to 5,500 BP)</td>
</tr>
<tr>
<td>5</td>
<td>Short and phase (5,500 to 2,000 BP)</td>
</tr>
<tr>
<td>6</td>
<td>the Recent epoch (2,000 BP to C. 50 BP)</td>
</tr>
</tbody>
</table>
Similarly, other highly ranked resources like eggs would have become far more scarce due to reductions in birthing rates due to stress and increased competition.

The model also predicts large changes in the structure of large and medium mammal and reptile populations. At present high to medium frequencies of animals like kangaroos can be found in woodlands and riverine/riparian areas (usually at watering times). During periods of increased aridity (periods B and E) these animal populating numbers would be expected to show a shift in abundance from high to low as well as becoming more dispersed or clumped. The relative abundance of kangaroos might decrease during the LGM (period B) though it might only reflect clumping around more permanent water. Increased resource clumping might actually make for better rates of resource acquisition, despite the lower abundance. It also follows that clumping of lower ranked resources like mussels in deep slow moving pools of water is significant, rather than their location within a particular stretch of river.

Whilst the effects of periods of greater aridity are likely to have had great impacts on resources with a high ranking in the diet breadth model, the same is not expected for those resources lower on the table. Medium mammals, fish and medium birds are thought to have remained relatively static (although effected by reductions in patch extents) whilst lower ranked resources such as mussels, tubers and seeds are thought to have changed very little through time.
Table 5.7: Diet breadth model for Brachyptychus and Host. The number of occasions expressed for each of the reported prey examined across the study period. The number of species is indicated.

<table>
<thead>
<tr>
<th>Species</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass Seeds (P größer)</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Insect larvae</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Spiderlings</td>
<td>Fleece</td>
<td>Fleece</td>
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<td>Frenshoer Mites</td>
<td>Fleece</td>
<td>Fleece</td>
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<td>Xyloc Manhattan</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Large blue butterflies</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Large brown butterflies</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Large moths and butterflies</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Bees</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Ants</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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<tr>
<td>Honey and leaves</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
<td>Fleece</td>
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The values in the table represent the number of occasions on which each species was observed in the diet of Brachyptychus over the study period.
5.4.1 Phase 1 – Colonisation (50,000 to 30,000 BP)

The colonisation period is when the first hunter-gatherer groups entered the study region. The timing of first settlement of the region is argued to have been contemporary with first settlement of Australia. If colonisation of Australia occurred prior to 50,000 BP then we might expect an initial colonisation date from the study region close to this time. If however, the shorter chronology is the better reflection of the antiquity of Aboriginal settlement then we might expect an arrival date in the study region of closer to 40,000 BP.

Humans traversing the study area probably followed permanent watercourses like the Gregory River from the southern area of Lake Carpentaria after colonisation through present day New Guinea. A second, less likely route into the study region is from the west. People may have arrived in the study area after entering Australia from Timor into the Kimberley region, or through Arnhem Land, crossing the arid zone and subsequently the study region, but this is considered less likely. Evidence for the most likely route will come from the location of sites from this initial period and material culture that may or may not be associated with desert adaptations.

If humans arrived in the study region sometime prior to 30,000 BP, they would have faced a landscape possibly colder, but wetter than today. Resource patches would have mirrored the patches discussed above: riverine and riparian, woodland, grassland and limestone plateau.

The first population of the study area is expected to have been small. The preferred migration route from Lake Carpentaria would imply that this population had a high level of residential mobility, as they sampled the landscape along their route. This might have involved seasonal visitation to the study area initially from residential bases at the south of the lake. Foraging behaviour is predicted to have reflected a broad based economy using a combination of patches as almost an exploratory system, testing patches and resources and
Chapter 5 Evolutionary Theory Part 2

Importance/Influence of Factors on Resources and other Resources Become Dependent

eXpect that the population was subject to high levels of resource risk at any distance from materials. If people continued to inhabit the region or visited regularly, then we would

expect that the population was subject to high levels of resource risk at any distance from

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materials. If people continued to inhabit the region or visited regularly, then we would
Increased uncertainty in foraging success would have had extensive and observable effects on behaviour. There might also be accompanying significant changes in group territoriality and a reduction in residential mobility. This might be observed in increases in the intensity of cave occupation near to permanent rivers. It is also expected that resource depletion and increased patchiness would lead to increased diet breadth to balance increased risk through lower encounter rates of prey. Under pressure, foragers would be expected to increase their diet breadth to include lesser ranked prey items that are argued to have been more readily available than those of higher value. An alternative or complement to this argument is that foragers may also have acted to improve their level of foraging success by specialization in certain resources, for example riverine foods, such as mussels.

During this extreme period, it is hypothesized that there will be accompanying changes in lithic technology including an increase in the extent of reduction. These changes will be observable in the frequency of cores and small flakes present in archaeological sites. Debitage might also display characteristics consistent with greater control and precision in knapping so as to minimize waste (as argued by Hiscock 1988). It would also be expected that only local raw materials would be exploited at this time. As the Riversleigh and Lawn Hill parts of the study region have a different configurations of water availability and location of good knappable lithic raw material, these technological traits may be different in the two areas. At Riversleigh it is predicted that the lithic assemblage displays characteristics of general expediency in stone tool design and use as part of a broader strategy of resource use, whilst at Lawn Hill there might be evidence of greater curation. In both areas it is expected that any changes to reduction strategies would reflect technological solutions appropriate to specific needs.
transport but given the short duration might be difficult to detect archaeologically.

this particular time might be reflected through changes discards rates and raw materials.

with possible impacts on population levels and mobility. The archaeological signature for

without the direct support of higher, forensic uncertainties.

Current palaeoenvironmental data indicates a small peak of activity at 10,800 BP (The Younger

of increased size and density compared to other periods.

residences would be present along watercourses and their associated assemblages would be

places, with associated low residential mobility. If is expected that sites that were

were aggregated around large standing bodies of water, within forges and on the castrum

were due to higher patch productivity. It is likely that while settlement locations gained they

Given these circumstances is likely that a resident population would be able to increase in

Musselbrook Creek would also be evident.

invasive patches along smaller perennial and semi-permanent water courses such as

were present along smaller perennial and semi-permanent water courses such as

more marginal areas such as the grasslands. Residential expansion to the other lesser

expand residential settlement locations, and exploration of greater areas of patches and

During this phase higher levels of patch productivity would have allowed foragers to

channel availability.

lower levels of risk associated with resource acquisition and enhanced vegetation and

During this time, foragers were now presented with opportunities associated with the

hypothesized that a third major recognition in forager use of the landscape occurred

animal and terrestrial and a more homogeneous distribution of resources. It is

greater than today. During this phase, these was increased resource abundance, stability in

between 18,000 and 5,500 BP the climate of Northern Australia recovered significantly

Phase 3 and 4 - Recovery Phase (18,000 to 5,500 BP)
Towards the end of phase 4 (between approximately 8,000 to 5,500 BP) we would expect that the study region was supporting larger populations who were able to live far more sedentary lives with fewer constraints on subsistence and technology. Archaeological evidence of this pattern should be reflected in larger and more complex residential base sites and greater complexity in temporary camps. Greater artefact reduction and an increase in debitage in sites and in the percentage of debitage with little or no cortex should feature.

5.4.4 Phase 5 – El Nino Aridity (5,500 to 1,500 BP)

During this phase climate deteriorated significantly, with a peak in the severity of arid conditions considered to have occurred between 3,500 and 2,000 BP. ENSO driven aridity would have increased foraging uncertainty through changes in vegetation range and density leading to increased patchiness. Under these conditions foragers are expected to have adapted to a subsistence strategy featuring higher mobility once again. It is also possible that population declined at this time due to changes in resource availability.

Changes in foraging strategies that were aimed to reduce foraging risk are expected to be reflected in changes in toolkit design and the general organization of technology. Possible changes might include the introduction of new technology, higher levels of tool diversity, evidence of individual provisioning and greater reliance on maintainable and reliable technologies. Technological innovations aimed at reliability might include redundant elements, and easily replaceable parts such as spear barbs or points (see Bleed 1986).

5.4.5 Phase 6 – Recent (1,500 to 50 BP)

Over the last 1,500 years the Australian climate has improved significantly from the phase 5 El Nino period. It is expected that during this time the Aboriginal population of the study area increased significantly and that residential settlement locations expanded as an effect of this, to a level that encompassed most rivers and with them most patches of the
Chapter 5: Evolutionary Theory Part 2

Reversed/4: Law/Hill the date of which will be used to test the current model.

The following chapters present the results of archaeological investigations at
the site of which have occurred over the last 5,000 years. With this established,
expectations regarding former behavior within the study area landscape and related these
settlement and subsistence model has outlined specific

Conclusion

of increased sample size:

During this phase as a result of hereditary increase in ancient manuacture and by the nature
mobility and sensuality in landscape use, Technological diversity is expected to be higher
and semi-permanent camps, representing a combination of both logistical and residuary
components, would occur in greater numbers along lesser permanent water courses
higher visibility, in all prehistoric, historic and modern periods. It is also expected that
higher frequency of residential base sites (this is also due to topographic reasons, their is

The archaeological evidence of the last 5,000 years is therefore expected to consist of a

sought to minimize foregone uncertainty.

have had predictable provisioning strategies shifting from their previous strategies that
study region became well utilized. With reduced subsistence challenges foregears would

Counterpart: A robust and resource use and knowledge
(in terms of ecology, topography, hydrology), known patchypes, fauna survey and
region correlations (e.g. Barton 2001; Clarkson 2004), in understanding of landscape units
physical models and expected foraging strategies, and has been developed based on other
This model for the study area is based on a composite of the patch choice and the Diet
Human Behavioral Ecology (HBE) and evolutionary anthropologists have been presented
A model of settlement and subsistence for the study region based on the framework of


Chapter 6

Survey and Excavation in the Southern Study Area - Riversleigh

6.1 Introduction
The next two chapters report on the results of excavation of archaeological sites spread across the study area. Open sites and rockshelters were investigated, focusing on the different river systems and on different local resource patches.

Chapter 6 presents results of excavations and survey in the Riversleigh area of the research region. Riversleigh provided the main focus of research between 2002 and 2004, and where five archaeological sites were excavated. These consisted of open scatters, middens and rockshelters at varying distances from permanent water. The results of the excavation program at Riversleigh are compared and contrasted with the results of Hiscock's' study at Lawn Hill to develop an overview of the region.

6.2 Surveys
The Riversleigh fieldwork had two aims: (i) to undertake detailed archaeological excavation of sites discovered along the Gregory River.

Investigations at Riversleigh consisted of survey along the course of the Gregory River from approximately 3 km on the eastern plain to a distance of approximately 10 km west of the commencement of limestone gorges. Other areas in the region also surveyed, including an ephemeral tributary of the Gregory River called Verdon Creek, and the lower
Chapter 6: Southern Study Area

The initial survey identified the number of rockshelters that have potential cultural deposits of the Geogary River has led to the creation of extensive cave systems. Very few of these archaeological sites were recorded during the survey, some of which already known. The surveys identified rockshelter and cave sites and areas that have been previously been recorded (Figure 6.1). Shown below is the location of sites recorded during the survey for this project. Sites that have been excavated are labeled by name.

Figure 6.1: Riversleigh, northwest Queensland showing the location of sites recorded during survey.
these were of sufficient size and accessibility to have afforded shelter. Where caves of suitable size for occupation were found, most were in locations that were subjected to scouring during the high water-flow of the wet seasons. Consequently very few rockshelters featured sediment accumulation greater than a few centimetres, and as such were unsuitable for excavation. However, four sites did have potential for excavation: two rockshelters on the Gregory River, one on Verdon Creek and one at the junction of the Gregory and O'Shannassy Rivers. Of these sites only the Verdon Creek shelter (site LH23) and the GRE8 site located along the Gregory River were excavated.

Continuing and inclusive consultation with the Waanyi community resulted in visits to known sites of cultural importance. These sites included large shelters and cave complexes that occur over 2 km from permanent water and within different geological and environmental units to the previously targeted locations. Two sites were identified with potential for archaeological investigation: (i) the ‘Grotto’ (GRE13) and (ii) ‘Gamanyi’ (Carrington’s Cave).

In total, five sites were excavated in the Riversleigh section of the study region - the open sites O'Shannassy Hearths (H3), and Old Lilydale Midden (OLH), plus the rockshelter and cave sites GRE8, Gamanyi and GRE13 rockshelters.

6.3 Riversleigh - Sites close to permanent water

6.3.1 O'Shannassy Hearths

The O'Shannassy Hearths are located on an erosional Holocene floodplain adjacent to an unnamed ephemeral tributary, east of the O'Shannassy River. The site consists of a complex of hearths, artefact scatters, isolated finds and a burial in an area of approximately 800 m x 300 m. Approximately 60 hearths have been recorded, and over 20 artefact scatters at these locations. Twelve ground stone axes manufactured from non-local raw
permanent water is only available from the O'Shaunessy River. 250 m west of the site. The river drain Revine springs, medium density woodlands. During most of the year, the O'Shaunessy River has a number of seasonal channels of sandsone composition and is associated with an ephemeral stream of the O'Shaunessy. Vegetation cover over the site area. A thin band of woodland occurs between the site and the O'Shaunessy. Heaths are located in the grasslands patch type where there is low.

The O'Shaunessy Heaths are located in the grasslands patch type where there is low.

The O'Shaunessy Heaths are located in the grasslands patch type where there is low.
Figure 6.3: O'Shannassy Hearths site, Riversleigh, northwest Queensland. Showing location of exposed hearths and the excavated H3.

Description and Dating

One of the hearths from the O'Shannassy Hearth site was excavated to investigate structure, content, age, and the associations with the transported axes. The H3 location consisted of a large intact hearth feature measuring approximately 40 cm x 50 cm comprising a mixture of loosely packed sandstone, and charcoal. Excavation of the H3 feature was limited to the eastern half of the feature, and undertaken in 5 cm excavation to approximately 20 cm below the surface. Charcoal from the hearth returned a radiocarbon determination of 375 ± 40 BP indicating the site may have been used until close to European settlement. Another interesting aspect of this site is the prevalence of sandstone grinding stone fragments within the oven feature. It appears that several may have originated from larger sandstone grinding dishes, many of which litter the O'Shannassy Hearth site.
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1.98

To the northeast of the Old Labydon Homestead, a pastoral station which was
conscientious of the local Homestead (Figure 6.4). The site is in close proximity
Crecons River on the eastern portion of the study area, and 500 m from the

The Old Labydon Homestead Midden (OTH) is located 150 m from the north bank of the

6.3.2  Old Labydon Homestead Midden

season when local resources were abundant enough to support large numbers of people.
The site represents the remains of a residential base which was occupied during the wet
the homestead adjacent to the O'Shanassy Heath. Site is an operational stenam, it is likely that
the mound was processed and removed. Also included are examples of small-scale
O'Shanassy Heath. These include indicative of people with a broad resource base probably
numbers of locally obtained grinders and many non-local artefacts. The

The overall assemblage at the O'Shanassy Heath includes flakes stone artefacts, large

Summary

Figure 6.4: Profile of the H1 Feature showing location of Ch sample
occupied by European settlers in the late 19th century. Underlying the historical ruins and extending for over 500 m further east and west, is a prehistoric Aboriginal shell midden complex.

Adjacent to the OLH site, the Gregory River forms a slow moving body of water, over 5m deep and approximately 50 m wide. A shallow, tufa dam located 1 km downstream provides an abundance of riverine resources and acts as a crossing point. The midden itself is approximately 5 - 8 m above the wet season level of the Gregory River and as such is not subject to any seasonal flooding. At this location extensive erosional features (gullying) have been created by erosion caused by stock with channels also developing from rainfall runoff.

![Diagram showing the location of OLH midden site, Riversleigh northwest Queensland. Map a. shows the regional setting of OLH. Map b. shows the location of midden site, the relationship to local patch types, and the historical site.](image)

The OLH midden is situated in a woodland patch within 50 m of riparian vegetation. The vegetation is dominated by eucalypts with an understorey of scattered shrubs and grasses. A band of what is best described as grasslands occurs only 200 m north of the site, extending only a few hundred metres before terminating in Cambrian limestone outliers.
Preliminary analysis of the OTH middens indicated several significant features:

- **Figure G.6**: OTH middens at Riverine, northeastern Queensland. Map indicates the location of middens and shell accumulations.

Four samples of middens were selected, one area was selected for excavation. The depth, density, and composition of the middens were recorded. Exposed shell and excavation details were documented throughout the survey. The location of the middens was recorded using differential GPS, which placed the location of the site on the central map. The extent of the visible scatter is approximately 500 m x 300 m. In June 2002, the location of the site was mapped using EDM survey. The OTH middens consisted of an expansive shell exposure, visible in section in the erosion trench created by erosion due to historical pastoral activities.

These grasslands are considered a relatively modern
Excavation

Investigation of the OLH midden involved preparation of a section profile in an erosion gully to gauge the depth and stratigraphy of the midden, followed by excavation. The section profile revealed that adjacent to this location that the depth of the shell deposit was c. 1.1 m.

OLH Test Pit 1 (TP1) was located on a narrow spur created by gully erosion of the OLH site. Excavation involved removal of surface vegetation of light grass cover and surface finds followed by excavation in 5 cm spits within stratigraphic units to a depth of approximately 90 cm below surface. At this point archaeologically sterile sediments were encountered. Below this point a further 50 cm x 50 cm square in the northwestern corner was continued for another 20 cm. A total of 20 spits were removed in the OLH TP1 trench terminating at a depth of approximately 1.1 m below the ground surface.

Stone artefacts and complete shell valves were recovered and bagged during excavation. All other excavated material was sieved on site using 4 mm and 2 mm mesh and some preliminary sorting of the finds was also completed. The upper units of the trench were dry sieved (spits 1 - 9), however due to the consolidating sediments in the lower units (spits 9 - 20) these units were wet sieved in the Gregory River. All material that was wet sieved was dried prior to being placed in plastic bags. At the completion of test excavations the OLH TP1 trench was backfilled.

Chapter 6 Southern Study Area
were identified by examination of shell weights and NISP counts recorded for each cubic
be more complex than first noted in the field. The distinct stratigraphic layers of shell
Subsequent analyses of material from OTH Li revealed that the stratigraphy of the site to
10 cm of this unit.

sandy sediment with stone artifacts recorded in association with shell only in the upper 10
concentrations of stone artifacts. Unit 3 (110 cm - 76 cm) consists of a layer of sterile
concentration of stone artifacts. Unit 2 (75 cm - 25 cm depth) consists of a dense accumulation
and a few stone artifacts. Unit 1 (25 cm - 0 cm depth) consists of yellow-brown sandy sediment containing a low concentration of shell
Three primary stratigraphic units were identified in OTH Li. Unit 1 (25 cm - 0 cm

Andrew Ponder are in the foreground.

Figure 67: The OTH Li excavation. Members of the Waimate community were present and were
activity involved in excavation, sorting and sorting of finds. Richard Fulcher and
metre of sediment. Subsequent examination of stratigraphic drawings, excavation records, and photographs support a division of the stratigraphy into eleven depositional units (Figure 6.1, Table 6.1).

![Section profile](image)

**Figure 6.8: Section profile of OLH TP1, Old Lilydale Midden, Riversleigh, northwest Queensland**

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Depth below surface</th>
<th>Unit type</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>0 - 7 cm</td>
<td>Sandy soil</td>
</tr>
<tr>
<td>2</td>
<td>7 - 15 cm</td>
<td>Shell lens</td>
</tr>
<tr>
<td>3</td>
<td>15 - 16 cm</td>
<td>Sandy soil</td>
</tr>
<tr>
<td>4</td>
<td>15 - 27 cm</td>
<td>Shell lens</td>
</tr>
<tr>
<td>5</td>
<td>27 - 30 cm</td>
<td>Sandy soil</td>
</tr>
<tr>
<td>6</td>
<td>30 - 46 cm</td>
<td>Shell lens</td>
</tr>
<tr>
<td>7</td>
<td>46 - 52 cm</td>
<td>Shell lens</td>
</tr>
<tr>
<td>8</td>
<td>52 - 55 cm</td>
<td>Shell lens</td>
</tr>
<tr>
<td>9</td>
<td>55 - 76 cm</td>
<td>Shell lens</td>
</tr>
<tr>
<td>10</td>
<td>76 - 88 cm</td>
<td>Sterile unit</td>
</tr>
<tr>
<td>11</td>
<td>88 - 110 cm</td>
<td>Sterile unit</td>
</tr>
</tbody>
</table>

**Table 6.1: Depositional history of OLH TP1 site based on post fieldwork analysis**

Chapter 6 Southern Study Area
The age range for the OTH TIP deposit falls between 11,916 and 13,765 Cal BP, based on dates obtained on living shells was applied for a local Channel River Reservoir. A correlation of 2,500 years (Meyers and Read, 1994; R. Dyer, pers. Comm.) overlaps at 7-8BMA indicating that the site was formed between 14,416 and 16,175 Cal BP. Overlap at 2-3BMA indicating that the site was formed between 14,416 and 16,175 Cal BP. For standard deviations, all three radiocarbon determinations have been calibrated using Calib (Reimer et al., 2009). The evidence of re-crystallization was noted for possible re-crystallization using Flume Trans High-Temperature Scanning. No evidence of post-depositional re-crystallization of material was observed in the sample. Post-depositional re-crystallization of material was observed in the sample. The complex processes involved surface etching and cleaning of post-depositional calcite from the surface of the sample. 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<th>material</th>
<th>Raw date</th>
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<th>calib lower</th>
<th>calib upper</th>
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</tr>
</thead>
<tbody>
<tr>
<td>OLH Tp1 Sp2 (10cm)</td>
<td>Wk-12226</td>
<td>shell</td>
<td>13061</td>
<td>81</td>
<td>14621</td>
<td>16122</td>
<td>12121   13621</td>
</tr>
<tr>
<td>OLH Tp1 Sp10 (50cm)</td>
<td>Wk-12227</td>
<td>shell</td>
<td>12886</td>
<td>83</td>
<td>14416</td>
<td>15879</td>
<td>11916   13379</td>
</tr>
<tr>
<td>OLH Tp1 Sp20 (100cm)</td>
<td>Wk-11430</td>
<td>shell</td>
<td>13092</td>
<td>85</td>
<td>14670</td>
<td>16175</td>
<td>12170   13675</td>
</tr>
</tbody>
</table>

Table 6.2: Radiocarbon determinations for shell samples from the OLH TP1 midden site showing uncalibrated, calibrated and reservoir corrected calibrated ages for the deposit expressed at 2-sigma.

Site Formation and division of deposit for analysis

Whilst it is difficult to assess sedimentation rates for the deposit, the site formed/accumulated as people discarded artefacts and the remains of meals. There is no evidence of disturbance in the form of erosion, scouring, or slumping of sediments within the deposit. The sedimentary matrix consists broadly of small rubble and sand with large quantities of shell. This composition does not change in size or consistency with depth within upper sediments. It is only in Unit 1 where particle size decreases due to the dominance of sterile sandy sediments. The radiocarbon determinations indicate that OLH TP1 sediments were the result of rapid accumulation over a period of perhaps just a few hundred years.

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Three hundred and twenty nine flaked stone artefacts were recovered and analysed from the OLH TPI excavation and include 10 retouched flakes (3.03% of the assemblage), 17 cores (5.16% of the assemblage) and a minimum number of flakes (MINF) of 302 (91.79% of the assemblage). Flaked stone artefacts show greatest concentration in spits 10 (155 artefacts, 34.52% of the assemblage), with lesser, but significant, peaks in spits 11 and 12.

The retouched artefacts recorded also mirror this relationship, only occurring in spits 10 and 11.

Figure 6.9: Frequency of flaked stone artefacts by excavation unit in OLH TPI, Riverleigh, northwest Queensland.
Stone Raw Materials

Five stone raw materials occur within the flaked stone assemblage in OLH TP1: chert, quartzite, limestone, silcrete and greywacke. Chert dominates the assemblage, accounting for 95.4%, with small quantities of flaked stone manufactured from the other local raw materials also occurring (though they comprise less than 2% of the assemblage). Non local greywacke is considered to have most likely been obtained from the quarry (LH9) located 5 km east of the site and accounts for 4.9% (n=21) of flaked stone.

![Graph showing raw material diversity by number/type in OLH TP1, Riversleigh, northwest Queensland.](image)

**Figure 6.10:** Raw Material diversity by number/type in the OLH TP1, Riversleigh, northwest Queensland.

Core Reduction

Nine cores were identified in the assemblage, all being chert. All were much smaller than the average R-chert cobble size indicating discard at a late stage of reduction. The mean block size of the assemblage was 9.23 cm³ (S.D. = 3.06 cm³) and mean weight was 14.85 g (S.D. = 7.85 g). Cores were rotated between one and nine times, with the majority of the sample rotated three to seven times. On average over 50% of surfaces had been flaked and an average of 8.66 flakes had been removed from each core. Whilst the mean length of the
Flake Reduction

The extent of core reduction in the OTH 1.P1 assemblage has been assessed using a simple measure of the amount of cortex present on complete flakes (Figure 6.11). Sixty per cent (69%) of the flakes have less than 25% of dorsal surfaces remaining usable as indicated by flake terminations.

The central core was just 17.33 mm (SD = 5.82 mm), all but 2 cores were still
**Flake Fragmentation**

The OLH TP1 assemblage features a small number of broken flakes ($n = 62$). The vast majority of this breakage is transverse (98.5%) and is dominated by distal flakes (68%). Transverse breaks are most likely to be taphonomic, i.e. through trampling, though breaks do occur during artefact use. Most broken flakes were found in spits 8 - 12 correlating with the largest artefact sample. The high disparity between distal and proximal flakes (Figure 6.12) is probably due to re-use of proximal flakes.

![Graph showing flake type distribution by spit](image)

**Figure 6.12**: Fragmentation of flakes by number and spit at OLH TP1, Riversleigh, northwest Queensland.

**Flake Dimensions**

Flake dimensions were recorded for all complete flakes in the OLH TP1 assemblage. These measurements consisted of axial length, width and thickness of the flake at midpoint. Additional metrical measurements of the width and thickness of platforms were

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**Chapter 6 Southern Study Area**
and blades (as suggested by Hiscock 1988). Transposed into the OTH site, and that it was most likely used in the production of points removed any cortex. These results indicate that only highly reduced greywacke was found to be longer but only a few millimetres wider than those produced from chert. The lowerest greywacke complete flakes were between 45 - 50 mm in length and many broken lowerest greywacke complete flakes were recorded from OTH I.P. These flakes were two types of cores and flakes on site. The reduction of cores and flakes on site. Ansemblage consists of rounded flakes emanating from re-shaping of implements and longer than wide and most likely originated from large blade flakes. In general the chert could be classified as blade-like, however 5 broken distal flakes were at least three times always less than the axial length, with the average width 15.4 mm. No complete flakes in axial length and 48% were found to be less than 2 cm. The width of chert flakes was found to be less than 5 cm in axial length and 48% were round to be less than 2 cm. In general all chert flakes within the assemblage were small with all but 2 were less than 5 mm long and 2.5 mm wide and greywacke, due to the small sample size of other materials. Also made. Discussion of flake dimensions is restricted to observations concerning chert
Retouched Artefacts

Ten retouched artefacts were recorded from the deposit including two backed artefacts. These artefacts have been examined under low power microscope for evidence of residues and use-wear. Two further retouched artefacts (OLH-TP1-10-002 and OLH-TP1-10-003), chert flakes with intact striking platforms, had been snapped through a distinctive retouched notch. This notching and snapping may be associated with preparation of flake fragments for backing retouch. These artefacts provide additional indication of on-site production of backed artefacts. Additionally, whilst no tulas were recovered, it is interesting to note the prevalence of 16 (4.86% of the assemblage) possible tula pre-forms (large distinctive flakes with pronounced bulbar surfaces and gull-wing shaped wide-area flaked platform surfaces).

Usewear and residue analysis was completed for all retouched artefacts from the OLH TP1 assemblage by Richard Fullagar and Judith Field (see Slack et al. 2004). Artefact OLH-TP1-10-001, a chert flake 18 mm in maximum length, 9 mm maximum width, recovered from spit 10, had the platform and termination removed by backing retouch. Steep retouch scars initiated from the ventral surface are continuous whilst steep retouch scars initiated from the dorsal surface are discontinuous, but present at both ends. The chord of OLH-TP1-10-001 had at least one bending scar, and at least 4 scars with feather terminations visible at low magnification (Figure 6.14). At higher magnification (X200) more scars with feather terminations were visible. After sonic cleaning in distilled water for 30 seconds, a distinct film remained visible along most edges. This film was soluble in alcohol and probably comprised lipids, and may be associated with handling during initial analysis of artefacts. After removing the film, edge rounding was still visible along with low development of polish or smoothing. The usewear is not diagnostic of the material.
Chapter 6  Southern Study Area

OLTH11p1-2.009 has seawater consistent with bathing

OLTH11p1-3.003 and OLTH11p1-10.153 were most likely used as a drill with

for percuring soft material, a percuring OLTH11p1-9.039 is a percured take that has been used

Other seawater results indicate that a variety of rocks were likely completed with the sample

swarms, and small swarm fractures are associated with a resin halt.

work is required on ancient function, but the preliminary hypotheses is that the dark

backed circle were different from those removed from the chord with seawater. Further

and swarms fractures of different sizes and shapes (Figure 6.14a). Sharp fractures from the

Residues on OLTH11p1-10.01 included undamaged dark swarms, scattered on all surfaces

Figure 6.16: Residues and seawater on ancient OLTH11p1-10.01 from OLTH1P1.9.039 (Photos: J.

Field and A. Pacifica)

How power magnetization A. Search Region B. Scanning along the used circle (Photos: J.

In this section, soft material and possible use as protective elements or cutting

worked, but is consistent with other studies (e.g. Kramminger 1978, Fuller et al. 1998) that


Shell analysis

The OLH TP1 contains a number of shell midden lenses. During excavation, at least three lenses were noted, and during lab analysis a further two lenses were identified. All shell types recorded from the OLH TP1 deposit are known to occur in the Gregory River. These are dominated by the bivalve *Alathyria peronetta* sp., with low numbers of a second smaller bivalve and at least three types of gastropods: *Stenomelanina densonensis*, *Melanoides sermygla* sp, and *Triora australis*, which are all found in freshwater stream environments and very closely resemble samples from southeast Asia (W. Ponder, Australian Museum, pers comm. 2002).

During the excavations it was noted that most shells were complete and in some places appeared to be cupped. The *Alathyria peronetta* sp. was found to be very friable during excavation. Analysis of shells by stratigraphic units shows four concentrations correlating to spits 8, 12, 14, and 19.

![Graph showing concentration of *Alathyria peronetta* sp. mussel shell expressed as g/m3 for the OLH TP1 deposit, Riversleigh, northwest Queensland.](image)

Figure 6.15: Concentration of *Alathyria peronetta* sp. mussel shell expressed as g/m3 for the OLH TP1 deposit, Riversleigh, northwest Queensland.

Chapter 6 Southern Study Area
Table 6.3: Allelopathic species

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>MIN</th>
<th>NISP</th>
<th>Weight (g)</th>
<th>MIN</th>
<th>NISP</th>
<th>Weight (g)</th>
<th>MIN</th>
<th>NISP</th>
<th>Weight (g)</th>
<th>MIN</th>
<th>NISP</th>
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<td>42</td>
<td>9</td>
<td>3048</td>
<td>14</td>
<td>6.0</td>
<td>42</td>
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<tr>
<td>6.5</td>
<td>22</td>
<td>21</td>
<td>196</td>
<td>11</td>
<td>6.5</td>
<td>42</td>
<td>9</td>
<td>3048</td>
<td>14</td>
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<td>6.0</td>
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<td>22</td>
<td>21</td>
<td>196</td>
<td>11</td>
<td>6.0</td>
<td>42</td>
<td>9</td>
<td>3048</td>
<td>14</td>
<td>6.0</td>
<td>42</td>
</tr>
</tbody>
</table>

rapid succession in a short period of time. Leed here they support the conclusion that the OTTFLP \_indigenous\_meso were deposited in

weights: MIN are commonly used as a measure of the extent of fragmentation of shell and NISP counts were found to be high in spite of the deposit. The high discard rate

where the sps removed high shell discarded. The abundance and fragmentation of shell

were calculated for the shell assemblage. NISP was calculated on the basis of either 100%

The number of individual specimens (NISP) and minimum number of individuals (MIN)
The ratio of the weight of *Alathyria pertexta* spp. relative to MNI showed a significant trend towards larger shellfish for upper spits (see Figure 6.16). However, this trend can be explained by the decrease in the levels of fragmentation (NISP) relative to sample size. If the samples were restricted to those spits with the greatest concentrations of midden accumulation (in order to escape bias created by the upper spit sample sizes) then the ratio of weight to MNI is relatively constant at 0.6:1 (Figure 6.17).

![Graph showing the ratio of weight to MNI](image)

Figure 6.16: Weight of *Alathyria pertexta* spp. By spit relative to MNI for OLH TPI, Riversleigh, northwest Queensland.

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sexual maturity of the species, implying human predation. 

Shells with depth from surface, *V. haliotis peronii* sp. are above the threshold for the individuals were measured and indicate that there has been no significant change in size of 

Changes in mean valve size, and species abundance were calculated as possible indicators 

![Diagram](image_url)

**Figure 6.17:** Weight of *V. haliotis peronii* sp. relative to MNI by shell for main middle phase of 

**SHM**
Figure 6.18: Box plot graph of the mean, mode and range of the valve lengths for all complete *Alathyria pertexta* spp. from spits 10-19 of OLH TPI, Riversleigh, northwest Queensland.

**Summary**

All of the data presented here provides a conclusive synthesis that OLH TP1 represents the remains of a rapidly deposited shell midden created by human agency. The site is dominated by one particular edible species of mussel shell – *Alathyria pertexta* spp. This species is present in very high numbers, and is represented by individuals that are well beyond a foodstuff threshold. The lithic assemblage is found mostly in association with the midden lenses. It is marked by high raw material richness and diversity in the retouched flake assemblage. Most flaked stone within the deposit is in the tertiary stages of reduction and much is broken. It is likely that the debitage relates to OLH locality operating as a large open camp site where re-tooling, implement maintenance and sharpening occurred. The OLH midden are interpreted to represent a residential base camp from which both provisioning and foraging occurred.

Chapter 6 Southern Study Area
Figure 6.19: Location of GRES rockshelter, Rockhampton northwest Queensland. Map A shows the site.

Site Settling

GRE8 - GRES 6.33

or types dam areas occur within 5 km.
point, the river is deep and slow moving with steep overhanging banks. No shallow pools
serves of channels and floodplain habitats associated with the Gregory River. At this
River channel water levels at the top of a limestoneFacing slope. This slope falls steeply to a
approximately 7 km. The rockshelter is located approximately 10 m above the Gregory
explored stream, while to the west the limestone cliffs continue unbroken for
limestone cliffs give way to an expansive terrace associated with a large number of
cliffs that form part of the Gregory River gorge. Immediately to the east of GRES, the
about 100 m above the southern bank of the Gregory River at the base of the limestone
intersection of the plateau and the escarpment plain (Figure 6.19). The rockshelter is situated
within the Beechey limestone plateau. The site is approximately 7 km from the
GRES is located within the woodland environment zone along the Gregory River gorge.
Figure 6.20: Profile of GRE8 rockshelter and position relative to the Gregory River at Riversleigh, northwest Queensland.

Within the GRE8 environs a variety of patch types are present. Riparian vegetation extends from the river bank for approximately 25 m, where it intersects with woodlands of various types. The woodland patch closest to the river is dominated by eucalypts and palms with a thick under-storey of smaller trees and vines. Woodlands closer to GRE8 are characterised by smaller Acacia spp. and grasses. A limestone plateau patch is located directly above GRE8, and features sparse grasses and a few small eucalypts. Local fauna include large and medium macropods and reptiles on the plateau, small mammals and birds within the woodlands, and fish, turtle and mussels in the river.

Site Description

GRE8 is a limestone rockshelter with a dry, flat floor area approximately 5 m x 2 m. At the rear of the rockshelter a small tunnel about 1.5 m in diameter slopes gently upwards before terminating about 5 m behind the primary shelter (Figure 6.21). A large boulder 2 - 3 m maximum dimension and the result of roof fall, sits at the front of the shelter. This
Queensland

Figure 6.21: Plan of Crib showing the location of the west excavations, Riverview, northwest Queensland.

The shelter contains numerous quartz nodules, which appear to have been licked. Visible on the rear wall of the shelter are some of the limestone blocks, particularly outside ceremonial benches. Three red, freckled painted, rock-art motifs are also present and some are visible on the surface of the rockshelter floor and are accessed as a sediment trap.
Excavation

Excavation of GRE8 was undertaken in July 2002 and June 2003. A 50 cm x 50 cm test pit was excavated in the centre of the shelter, just inside the dripline and behind the boulder at the entrance (Figure 6.20). Systematic excavation was undertaken by trowel, in 5 cm spits within stratigraphic units. This location was selected after taking into account the available headroom (ceiling height), likely depth of deposit, and protection from disturbance.

During June 2003 the square was expanded to a 1 m x 1 m area. Limestone bedrock was encountered at a depth of 57 cm below the surface. All excavated sediment was dry-sieved through 4 mm and 2 mm mesh, and preliminary sorting of material was completed in the field with the assistance of Waanyi community members.

Figure 6.22: GRE8 looking to the south. TP1 is in the foreground and is almost completed.
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Perennipora sp.) and other americans (cf. Hiscock 1988).

of this lower unit in the thickness of carbonate excrusion on shells (Anaphora
shell is found in the upper 15 cm of SU2 and is referred to as Unit 2A). A distinct feature
the walls of the shells are common throughout Unit 3. A continuation of dense mussel
limestone rubble and pieces of ocher, probably derived from nearby occurring lumps in
overlying units and consist of dolomite gravel and secondary carbonates. Chert artifacts,
consists of red/brown compressed sediment. The particle sizes are larger than the
in the lower 17 cm of SU2 and is referred to as Unit 2B. Stratigraphic Unit 3 (SU3) was found
limestone skeletal remains, and mussel shell. A dense layer of Anaphora premusa sp. was found
dolomite gravel derived from root fall. Stratigraphic Unit 2 (SU2) consists of a matrix of pelecypods of calcareous day and green grains mixed with some
comprised of a matrix of pelecypods of calcareous day and green grains mixed with some
Stratigraphic Unit 2 (SU2) consists of a matrix of pelecypods of calcareous day and green grains mixed with some
Stratigraphic Unit 1 (SU1) consists of a matrix of pelecypods of calcareous day and green grains mixed with some
Stratigraphic Unit 1 (SU1) consists of a matrix of pelecypods of calcareous day and green grains mixed with some
High brown unconsolidated silts, possibly disturbed by Kangaroo Ranges in the shelter
and is found throughout the deposit. Stratigraphic Unit 1 (SU1) consists of very fine
rubble and bedrock (Figure 6-22). Chert material consists of stone artifacts and shell
The GRES deposit consists of three stratigraphic units overlain with weathered limestone
Sharkia
Figure 6.23: Section profile of the NE wall of GRE8 TP1 showing the locations of the three stratigraphic units and two dense shell layers (labeled as 2B and 3A).

The stratigraphy of GRE8 is very similar to the Colless Creek excavations of Hiscock (1988), where two stratigraphic layers were identified: a grey calcareous clay/quartz unit overlying an orange gravel unit. However, unlike GRE8, the Colless Creek stratigraphic units were separated by a lag unit that consisted of large gravels and stone artefacts. Sediment accumulation at GRE8 appears to be similar to that of Colless Creek Cave, where it was argued that most of the sediment entered the site through fissures above and in the rear of the rockshelter (see Magee and Hughes 1982). At Colless Creek, Unit B (the lower orange sediment) is believed to be similar sediment to that of Unit A but subjected to a long period of weathering (Hiscock 1988:167). No hearths were observed at GRE8 and charcoal was highly fragmented and rare throughout the deposit. While the *Alathyria perexta* spp. appears in section as two concentrated lenses (SU 2B and 3A) it should be noted that it is present throughout the deposit.
During this period sediment accumulation was fairly constant at around 1 cm per year. Sphincter 1-5 represents a period between 13,500 years BP and the modern period. The average rate of sediment accumulation in kilograms of sediment deposition per square meter per 100 years was calculated in kilograms of sediment deposition per square meter per 100 years. The average rate of sediment accumulation for the entire deposit (Figure 6.2) shows a relatively steady accumulation of sediments.

### Table 6.1: Radiocarbon determinations for shell samples from CREES, Pali, Newport, northernmost

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Sample Number (E)</th>
<th>Modern Age (yr BP)</th>
<th>Lab</th>
<th>Age (yr BP) Calibrated</th>
<th>Modern Age (yr BP) Calibrated</th>
<th>Age (yr BP) Corrected</th>
<th>Modern Age (yr BP) Corrected</th>
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<tr>
<td>9</td>
<td>0</td>
<td>37.4 ± 10</td>
<td>39.9 ± 10</td>
<td>7.7 ± 0.2</td>
<td>19.1 ± 0.3</td>
<td>0.7 ± 0.33</td>
<td>37.4 ± 10</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>89.9 ± 10</td>
<td>89.9 ± 10</td>
<td>0.2 ± 0.0</td>
<td>13 ± 2</td>
<td>0.2 ± 0.0</td>
<td>89.9 ± 10</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>193.8 ± 10</td>
<td>193.8 ± 10</td>
<td>0.2 ± 0.0</td>
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<td>0.2 ± 0.0</td>
<td>193.8 ± 10</td>
</tr>
<tr>
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<td>0</td>
<td>203.8 ± 10</td>
<td>203.8 ± 10</td>
<td>0.2 ± 0.0</td>
<td>203.8 ± 10</td>
<td>0.2 ± 0.0</td>
<td>203.8 ± 10</td>
</tr>
</tbody>
</table>

During the deposition of the marine terrace, the shell material has provided the best medium for dating. The CREES deposit has been dated using radiocarbon determinations on freshwater mussel shells.
0.6 kg/m²/100 years. Spits 6 and 7 show very low sediment accumulation rates of approximately 0.07 kg/m²/100 years and are coincidental with the termination of the Last Glacial Maximum. Below spit 7, sedimentation rates are lower than spits 1-5 but comparatively much greater than during spits 6-7.

![GRE8 Age - Depth Curve](image)

**Figure 6.24:** Age - depth curve for GRE8 TP1, Riversleigh, northwest Queensland.

On the basis of the radiocarbon determinations, stratigraphy, sedimentation rates and geomorphic history, the GRE8 deposit has been divided into five phases. Phase A is the period between first occupation and the commencement of the LGM, and correlates to spits 9-11 (and part of Stratigraphic Unit 3B). Phase B includes the LGM, between c. 18,000 BP and 30,000 Cal BP and correlates with spits 7 and 8 (stratigraphic unit 3A and part of 3B the lower midden deposit). Phase C (spits 5 and 6) spans the remainder of the Pleistocene (18,000 - 10,000 Cal BP). Phase D (spit 4 overlies this unit and covers the period between 10,000 and 5,500 Cal BP - the early to mid Holocene. Phase E (spit 3) represents the mid-Holocene period between 5,500 and 2,000 Cal BP. Phase F (spits 1 and 2) provides a record of the most recent 2,000 years.

**Chapter 6** Southern Study Area
### Table 6.6: GRES TPI and Physical Phases

<table>
<thead>
<tr>
<th>Period Represented</th>
<th>(Cal BP) Age Range</th>
<th>Spins</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>N 9.1, 10.11</td>
<td>30,000 - 45,000</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>IGM</td>
<td>18,000 - 30,000</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Post IGM Pleistocene</td>
<td>10,000 - 18,000</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Early Holocene</td>
<td>10,000 - 10,000</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Mid Holocene</td>
<td>0000 - 5,000</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Recent</td>
<td>0000 - 1,000</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

River estuary, northwestern Queensland.

### Table 6.5: Time span and estimated sediment accumulation rates for each spin from GRES TPI.

<table>
<thead>
<tr>
<th>Spins</th>
<th>TPE BP</th>
<th>Years</th>
<th>Time Span</th>
<th>Kg/m²/yr</th>
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<td>2202</td>
<td>2</td>
<td>0 - 2202</td>
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</tr>
<tr>
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<td>4</td>
<td>590</td>
<td>4</td>
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<td>5</td>
<td>3198</td>
<td>8</td>
<td>1,6890 - 2,000</td>
<td>7</td>
</tr>
</tbody>
</table>

Deposition sedimentation rates based on age-depth curve.
In total, 1,899 flaked stone artefacts were recovered from the GRE8 trench. Identification of flaked stone artefacts and subsequent technological analysis was undertaken on the basis of presence of: (i) a positive or negative ringcrack, (ii) a distinctive or negative bulb of force, (iii) an eraillure scar in position beneath a platform or (iv) definite remnants of flake scars. These attributes indicate the application of an external force to a core (see Hiscock 2001b, 2002b). Flaked stone artefacts were classified into the categories of flake, core, or retouched flake. If material did not possess one or more of these characteristics but appeared superficially to be of possible cultural origin it was classified as a ‘non-diagnostic fragment’ as per Hiscock (1988). This fourth category was necessary due to the high levels of small pieces that could not be directly attributed to stone knapping. Such pieces are most likely the result of a combination of factors including heat fracturing in hearths, natural breakage of chert nodules in the walls of the shelter, breakage due to trampling, and knapping activities. Non-diagnostic fragments occur generally as a 1:1 relationship to humanly created stone artefacts.

There are marked temporal changes in the number and composition of the stone assemblage in the GRE8 deposit. The earliest phases of occupation (A and B) which occur from 30,000 Cal BP to 18,000 Cal BP, contain just 80 artefacts including 75 unmodified flakes and five cores including one large (632 g) multi-platform greywacke core. During phases C, D and E (between 18,000 Cal BP and 5,500 Cal BP), artefact discard increases to approximately 10 artefacts per 100 years. Discard rates decrease during the more recent periods. In summary, the rates of artefact discard in the GRE8 deposit point to low intensity occupation up to the end of the Last Glacial Maximum whereupon discard increases dramatically (ten fold) until about 7,500 Cal BP when discard reduces once more. (Table 6.25).
<table>
<thead>
<tr>
<th>Spit</th>
<th>Phase</th>
<th>Volume</th>
<th>number of artefacts</th>
<th>number / kg</th>
<th>number / m³</th>
<th>number / 100 years</th>
<th>total weight (g)</th>
<th>average weight (g)</th>
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<td>5954.06</td>
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<td>4500.00</td>
<td>7.03</td>
<td>397.5</td>
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<td>4</td>
<td>D</td>
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<td>733.8</td>
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<td>C</td>
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<td>9.5</td>
<td>4465.29</td>
<td>7.1</td>
<td>323.15</td>
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<td>7</td>
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<td>80.00</td>
<td>0.1</td>
<td>2.3</td>
<td>0.6</td>
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<tr>
<td>11</td>
<td>A</td>
<td>0.045</td>
<td>3</td>
<td>0.1</td>
<td>66.67</td>
<td>0.12</td>
<td>7.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 6.7: Summary of flaked stone artefact discard rates by spit and analytical unit GRE8 TP1, Riversleigh, northwest Queensland.

![Number of artefacts discarded per m³ by spit](image)

Figure 6.25: GRE8 TP1 flaked stone artefact assemblage showing number of artefacts discarded (/m³) by spit.

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The GRE8 stone assemblage is dominated by unmodified flakes, comprising up to 90% of the total assemblage (excluding spit 10 where sample size is statistically too small). Cores account for c. 2% of the assemblage. Retouched flakes first appear in spit 6 at 17,000 Cal BP and form a small but consistent part of the assemblage after that time (Table 6.8 and Figure 6.26). During phases D and E (10,000 to 2,000 Cal BP) the relative percentages of retouched flakes and cores in the deposit reduce significantly before increasing in the most recent phase.

<table>
<thead>
<tr>
<th>Spit</th>
<th>Number of artefacts</th>
<th>Percentage of Artefact Types in each Spit of GRE8</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Flakes</td>
<td>Cores</td>
</tr>
<tr>
<td>1/2</td>
<td>337</td>
<td>92.9</td>
<td>2.7</td>
</tr>
<tr>
<td>3</td>
<td>225</td>
<td>96.9</td>
<td>1.3</td>
</tr>
<tr>
<td>4</td>
<td>492</td>
<td>97.1</td>
<td>1.8</td>
</tr>
<tr>
<td>5</td>
<td>527</td>
<td>95.3</td>
<td>2.1</td>
</tr>
<tr>
<td>6</td>
<td>238</td>
<td>91.6</td>
<td>2.1</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>96.2</td>
<td>3.8</td>
</tr>
<tr>
<td>8</td>
<td>35</td>
<td>97.1</td>
<td>2.9</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>75</td>
<td>25.0</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phases</th>
<th>Total</th>
<th>Flakes</th>
<th>Cores</th>
<th>Retouched Flakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>337</td>
<td>92.9</td>
<td>2.7</td>
<td>4.5</td>
</tr>
<tr>
<td>E</td>
<td>225</td>
<td>96.9</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>D</td>
<td>492</td>
<td>97.1</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>C</td>
<td>765</td>
<td>94.1</td>
<td>2.2</td>
<td>4.1</td>
</tr>
<tr>
<td>B</td>
<td>61</td>
<td>96.7</td>
<td>3.3</td>
<td>0.0</td>
</tr>
<tr>
<td>A</td>
<td>19</td>
<td>94.7</td>
<td>5.3</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 6.8: Percentages of different artefact types by spit and analytical phases in GRE8 TP1, Riversleigh, northwest Queensland.

Chapter 6 Southern Study Area
Figure 6.27: Graph of the mean weight of worked stone artefacts by analysed phase and expressed by calibrated age for GRR8 TP1, Rebekeelpit, northwestern Queensland.

Generally up to half the weight of the earlier phases (Figure 6.27), comparison with spits 10 and 11, after 16,000 CAL BP, artefacts are notably higher and between 16,000 and about 30,000 CAL BP, sample size does not allow for a similar phases of occupation of the site with the heaviest artefacts occurring in spits 7, 8, and 9, most noticeably in the mean weight of artefacts occurring in the early stages of occupation (Figure 6.27). The mean weight of artefacts has been used as a potential indicator of different reduction strategies.

Figure 6.26: Logarithmic graph of the occurrence by percentage of tool of worked stone types by phase.
Stone Procurement

Ninety five percent (95%) of the flaked stone assemblage at GRE8 consists of chert which has been obtained from either local river cobbles or nodules from nearby outcrops on the plateau. Other raw materials in the GRE8 deposit include greywacke, quartz, silcrete and one exotic volcanic material (an edge ground axe/hatchet on the surface of the shelter). These other raw materials are only present in very small numbers.

During phases A and B raw material richness at GRE8 is restricted to chert and very small numbers of artefacts (n=2) produced on quartz and quartzite. Of these, spit 9 (phase B) features a large quartzite core but no flakes produced from that core. During the post glacial Pleistocene phase C, five raw materials are present in the deposit, including the first occurrence of non-local greywacke which constitutes a small but significant component of the assemblage (n=14). This trend is continued up to the conclusion of phase D at 5,500 Cal BP, thereafter raw material richness reduces (Figure 6.28).

![Figure 6.28: stone raw material richness for each phase at GRE8 TPI, Riversleigh, northwest Queensland.](image)

Chapter 6 Southern Study Area
with those identified by Hiscock at College Creek Cave (1988:207).

While those identified by this method or proximal flakes included in the assemblage, those results also correlate well with those identified by Hiscock's method. These results may indicate that broken flakes than included in the assemblage are consistent with those identified by Hiscock's method. The percentage of broken flakes increases to around 50% of the total.

During Phase B, after the TFR broke, the increase is around 20%. As in Phases A and B (and until the end of the TFR), the increase is lower. The complete flakes show the increase during Phases A and B, and F to almost 20%.

showed that the ratio is small for Phases A and C, but increases during the more recent flaking. Measures of the ratio between longitudinal and transverse breaks for CRES indicate that the result of another mechanism, most likely a combination of heat, and cuttermill breakage. The increase in longitudinal breaks is not due to errors in flaking, some of which have been identified. Longitudinal breaks are accounted for less than 6% of all broken flakes, and these include longitudinal fractures, and into proximal, distal, and complete longitudinal fractures and longitudinal breaks, and were divided into proximal, medial, and distal.

Breakage areas were calculated for flakes from the CRES deposits. Breakage included both

name and length of reduction were all examined in this study.
Figure 6.29: Percentage of broken flakes for each analytical phase in GRE8 TPI, Riversleigh, northwest Queensland.

<table>
<thead>
<tr>
<th></th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
<th>Phase E</th>
<th>Phase F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of flakes broken</td>
<td>26.32</td>
<td>11.86</td>
<td>37.40</td>
<td>46.39</td>
<td>50.61</td>
<td>48.66</td>
</tr>
<tr>
<td>percentage of proximal fragments*</td>
<td>0</td>
<td>3.39</td>
<td>11.96</td>
<td>15.40</td>
<td>14.29</td>
<td>17.91</td>
</tr>
<tr>
<td>percentage of medial fragments</td>
<td>5.26</td>
<td>1.69</td>
<td>5.09</td>
<td>5.46</td>
<td>8.16</td>
<td>3.74</td>
</tr>
<tr>
<td>percentage of distal fragments</td>
<td>5.26</td>
<td>5.08</td>
<td>13.23</td>
<td>16.76</td>
<td>19.18</td>
<td>20.86</td>
</tr>
<tr>
<td>percentage of longitudinally cone split fragments</td>
<td>5.26</td>
<td>0</td>
<td>3.81</td>
<td>1.17</td>
<td>1.22</td>
<td>0.27</td>
</tr>
<tr>
<td>percentage of fragments with both transverse and longitudinal breaks</td>
<td>0</td>
<td>0</td>
<td>2.03</td>
<td>2.92</td>
<td>1.23</td>
<td>1.87</td>
</tr>
<tr>
<td>Ratio of transverse to longitudinal breakage</td>
<td>2:01</td>
<td>6:01</td>
<td>5.2:1</td>
<td>9.2:1</td>
<td>17:01</td>
<td>19.8:1</td>
</tr>
</tbody>
</table>

Table 6.9: Percentage of different types of flake breakage in GRE8 TPI, Riversleigh, northwest Queensland.

The ratio between the rate of transverse breakage relative to complete flakes also provides an indicator of the intensity of the site use of GRE8 through time. Generally an inverse relationship between the ratio of transverse to complete flakes compared to sedimentation rates would be expected when sedimentation rates are high as there is less time to trample

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Despite the sample of cores is very small, most were discarded during phase I at 1 – 16. Although the sample of cores is very small, most were discarded during phase I.

An average of 3.7 cubic centimeters were recorded on the core (range was 13.7 cm$^3$ (S.D. = 8.15 cm$^3$). Cores had been rotated between 1 and 5 times (on average). Multiplatform gravity core in split 9 (6238). The mean block size of the tephra core was small. Seventeen cores were recovered from the tephra excavation. 16 tephra cores and one large

Core reduction

Knapping and reduction

Figure 6.30: Comparison between the ratio of tephra-occupied and complete shales and sediments. Sedimentary tephra cm / 100 yrs for GRE8 TP4, River Esk, North-West Queensland.

Indications that GRE8 was more intensively occupied after about 13,000 yrs BP (Figure 6.30). The transverse to complete tephra, compared to sediment accumulation, is very high. This tephra in splits 3, 4, and 5 this relationship stands, but in splits 1 and 2, 3, 4, and 5, the ratio of tephra to sediment accumulation is much higher. Comparison with sediment accumulation rates for the deposit at GRE8 showed and break increases. If this relationship does not hold, then an increase in site use is
<table>
<thead>
<tr>
<th>Phase</th>
<th>number of cores</th>
<th>av. wt. (g)</th>
<th>av. block size (cm³)</th>
<th>number of flake scars</th>
<th>av. length of longest scar (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase F</td>
<td>3</td>
<td>13.33</td>
<td>19.03</td>
<td>6.33</td>
<td>18.51</td>
</tr>
<tr>
<td>Phase E</td>
<td>1</td>
<td>53</td>
<td>12.12</td>
<td>2</td>
<td>23.1</td>
</tr>
<tr>
<td>Phase D</td>
<td>8</td>
<td>14.61</td>
<td>9.16</td>
<td>5.5</td>
<td>18.06</td>
</tr>
<tr>
<td>Phase C</td>
<td>3</td>
<td>28.63</td>
<td>39.43</td>
<td>2.66</td>
<td>18.43</td>
</tr>
<tr>
<td>Phase B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Phase A</td>
<td>1</td>
<td>31.6</td>
<td>29.95</td>
<td>13</td>
<td>27.6</td>
</tr>
</tbody>
</table>

Table 6.10: Mean weight, block size, number of flake scars and average length of the longest scar for cores in GRE8 TPI, Riversleigh, northwest Queensland.

Flakes

All flakes in the assemblage were produced using direct percussion, and no evidence of pressure flaking or indirect percussion was observed. Bipolar flaking occurred only on retouched flakes from the upper spits, and is represented by a very small component of the assemblage. As with Colless Creek Cave, changes in knapping technique do not appear to account for changes in artefactual material.

Analysis of stone reduction involved metrical examination of the location and force of blows to cores and flake platforms, the nature of core maintenance, and decorration processes. The relative percentage cortical cover on the dorsal surfaces of complete flakes is an indication that the majority of flakes possess no cortex. Small flakes dominate the assemblage. In phases B and E, the relative proportion of flakes with little or no cortex is significantly higher than during other phases. Phase B (the glacial period) flakes with 0% cortex account for 81% of the assemblage and 73% during phase E (the mid Holocene).
This phase platform size was also smaller indicating lesser force was applied. During spits 5 and 6 (phase C) blow were of less force than during other periods. During common high dimensions of the切尔 core, analysis of ventral surface area shows the flakes were found to be less than 5 cm in area and never greater than 7 cm. Rejecting the CRETSP1 (spits 10 and 11) have been excluded from analysis due to sample size.切尔 Core A box plot of the average ventral surface area of complete切尔 flakes for each spit of a box plot of the average ventral surface area of complete切尔 flakes for each spit of prevalence of flakey surfaces and the area of lake ventral surfaces. Figure 6.31 shows Knepp phase precision can be assessed by documenting the types of lake concentrations, the

Applied Force

<table>
<thead>
<tr>
<th>Number of flakes</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>76.99%</td>
<td></td>
</tr>
<tr>
<td>75.75%</td>
<td></td>
</tr>
<tr>
<td>25.25%</td>
<td></td>
</tr>
<tr>
<td>&gt; 25%</td>
<td></td>
</tr>
<tr>
<td>0.0%</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.11: Corex on flakes by phase in CRETSP1, Revneshef, northwestern Greenland.

<table>
<thead>
<tr>
<th>Phase</th>
<th>0 corex</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
<th>Phase E</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Corex on flakes</td>
<td>68.4%</td>
<td>67.1%</td>
<td>66.5%</td>
<td>72.7%</td>
<td>86%</td>
<td>81%</td>
</tr>
</tbody>
</table>
Figure 6.31: Box plot graph of average flake size in cm² for spits 1-9 from GRE8 TP1, Riversleigh, northwest Queensland.

The relative percentages of termination types present on complete flakes from the GRE8 TP1 assemblage is presented in Table 6.12. Aberrant terminations are greatest during phases C and D (17,000-5,500 Cal BP). During these phases the rate of hinge terminations increased, and correlate with the reduction in knapping force determined by ventral surface area.

<table>
<thead>
<tr>
<th></th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
<th>Phase E</th>
<th>Phase F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feather/axial</td>
<td>81.25</td>
<td>89.09</td>
<td>77.34</td>
<td>77.37</td>
<td>87.21</td>
<td>83.75</td>
</tr>
<tr>
<td>Hinge</td>
<td>12.50</td>
<td>5.45</td>
<td>14.42</td>
<td>14.21</td>
<td>6.40</td>
<td>7.58</td>
</tr>
<tr>
<td>Step</td>
<td>6.25</td>
<td>5.45</td>
<td>7.61</td>
<td>6.84</td>
<td>6.40</td>
<td>8.66</td>
</tr>
<tr>
<td>Outré passé</td>
<td>0</td>
<td>0</td>
<td>0.63</td>
<td>1.58</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N =</td>
<td>16</td>
<td>55</td>
<td>631</td>
<td>380</td>
<td>172</td>
<td>277</td>
</tr>
</tbody>
</table>

Table 6.12: Relative percentages of different termination types for the analytical units of the GRE8 deposit (calculations based on sample size of MNF n=1531), Riversleigh, northwest Queensland.
During phases A, B and C, there was little or no core preparation in respect of overhangs. Increasing propensity for overhang removal on core platforms prior to take development was almost half of the original at 4.6 mm (Table 6.13). This trend accords well with an overhang A, reducing steadily until the recent phase B until where average platform thickness is more accurate throughout time with an average thickness of platforms of almost 9 mm during platforms perpendicular to buffer scars. This analysis indicates that knapping became more prevalent of blows with respect to the core face was measured by the width of flake platforms during phase D (100’000-550’000 BP).

There is also an increase in the rate of multiple flake removal of a single flake platform. However, there is no increase in the incidence of flakes that account for just 1.8% of flake as. During this phase, there is an increase in the incidence of flake that accounts for 6.9% of flakes, except for during phase B (30’000-18’000 BP) where they account for 6.3% of flake removal. Unexpected cortical platforms consistently account for one quarter of all flake cores. Platforms were never prepared by pecking or flaking, but most often with the blow made, and (ii) the proximity of the blow to the core edge. A. With Collens application have been applied to the CRF2 data. (i) the type of platform surface to which the final flake makes (Hiscock 1988:213). Two of Hiscock's four measures of force of the location of blows relative to the edge of the core can affect the size and shape of the

Location of the Force of Application
<table>
<thead>
<tr>
<th>Platform Surface</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
<th>Phase E</th>
<th>Phase F</th>
</tr>
</thead>
<tbody>
<tr>
<td>indeterminate</td>
<td>0</td>
<td>0</td>
<td>2.09</td>
<td>2.5</td>
<td>3.1</td>
<td>4.6</td>
</tr>
<tr>
<td>cortical</td>
<td>7.1</td>
<td>1.8</td>
<td>6.1</td>
<td>7.3</td>
<td>6.2</td>
<td>8.7</td>
</tr>
<tr>
<td>single flake</td>
<td>92.8</td>
<td>94.4</td>
<td>83.3</td>
<td>79.7</td>
<td>84.5</td>
<td>81.6</td>
</tr>
<tr>
<td>multiple flake</td>
<td>0</td>
<td>3.7</td>
<td>6.4</td>
<td>9.8</td>
<td>5.4</td>
<td>5.1</td>
</tr>
<tr>
<td>shattered</td>
<td>0</td>
<td>0</td>
<td>2.1</td>
<td>0.6</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>n</td>
<td>14</td>
<td>54</td>
<td>527</td>
<td>316</td>
<td>129</td>
<td>196</td>
</tr>
</tbody>
</table>

Table 6.13: Relative percentages of platform types for the GRE8 TPI assemblage, Riversleigh.

<table>
<thead>
<tr>
<th>Platform Features</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
<th>Phase E</th>
<th>Phase F</th>
</tr>
</thead>
<tbody>
<tr>
<td>% flakes with overhang removal</td>
<td>0</td>
<td>4</td>
<td>6</td>
<td>13.25</td>
<td>14.65</td>
<td>11.2</td>
</tr>
<tr>
<td>average platform thickness (mm)</td>
<td>8.8</td>
<td>5.5</td>
<td>5.2</td>
<td>4.7</td>
<td>4.7</td>
<td>4.6</td>
</tr>
<tr>
<td>total number sampled</td>
<td>14</td>
<td>50</td>
<td>448</td>
<td>264</td>
<td>116</td>
<td>178</td>
</tr>
</tbody>
</table>

Table 6.14: Relative percentages of platform features recorded for the GRE8 TPI, Riversleigh, northwest Queensland.

A comparison of the average length to width of all complete chert flakes shows a trend towards more elongated flakes through time. flakes in the lower spits (5-9) are generally grouped together with a length to width ratio of less than 1.2:1, whereas flakes in the upper spits (1-4) all group around a ratio of 1.3:1 (Figure 6.32). The exception to these trends is in spit 8 where flakes are considerably longer relative to width when compared to spits 7 and 9.
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In sediments where diversity is at its highest but abundance is still low (Figure 6.33), overall there are very few resampled assemblages in the assemblage until the recent phase (ca. 3000 BP). The resampled assemblage becomes more diverse and phase D (10,000-5,500 BP) the resampled assemblage becomes more diverse and rich. This time, all features less than five non-invasive scores which occur at either an early or late phase (ca. 4000 BP). A large quantity of assemblages resampled assemblage also occur in this time. All features less than five non-invasive scores which occur at either an early or late phase (ca. 4000 BP). A large quantity of assemblages resampled assemblage also occur in this time. All features less than five non-invasive scores which occur at either an early or late phase (ca. 4000 BP).

Reanalysis/analyses:

Queensland.

Figure 6.32: Scatter Gram plot of the ratio between average proximal length and average proximal width

Spit

<table>
<thead>
<tr>
<th>LW</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

abundance.
Figure 6.33: Frequency histogram of different classes of retouched artefacts in the GRE8 TP1, Riversleigh, northwest Queensland.

Usewear and residue studies

Usewear and residue studies were completed for the entire retouched artefact assemblage by Veerle Rots and Richard Fullagar. These artefacts included amorphous retouched flakes, backed artefacts, tulas and points. The results of usewear analysis indicate that some artefacts were definitely used whilst other formal implements were not (for example backed artefacts GRE8-1-063, and GRE8-2-1121). Backed artefact GRE8-2-1122 had numerous, very small step scars on one end indicating impact damage.

Spit 4 of the deposit is dated to between 5,500 and 10,000 Cal BP and features numerous retouched flakes including backed artefacts and a tula. These artefacts predate the known antiquity of similar types by many thousands of years. Usewear analysis concentrated on these artefacts.

Artefact GRE8-4-001 is a chert backed artefact, approximately 19 mm maximum length and 9 mm maximum width. Backing retouch is almost continuous with initiations from both directions. The artefact has been snapped at one end, and that edge has less use wear.
microscopes and binoculars. Gaseous films and stain grains were visible under reflected light.

These are also step and cleat scars. The chord displays unusual consistency with the other
shorter edge rounding and configurations use scoring with keel and bending terminations.
Continuous, but only present at one end. In plan view the chord is slightly concave and has

The length of the anterior Backing rounds initiated from the dorsal surface is
broken ends are broken and backings rounded initiated from the ventral surface is continuous
both ends are broken and backings rounded initiated from the ventral surface is continuous
maximum length is c. 19 mm and width is c. 7 mm. A dorsal edge separates two scars but
direction of edge remains could not be determined with any confidence. Sharp tips at
inkedares wood, and backings resins.

0 10 which occurs in the same level features abrassive smoothing, including polish that
while the ventral surface features dark brown smears and spots, a patterned point CR8-4
folds and the dorsal surface has spots of plant/resin near the platform and in the middle
terminations, 5-6 scars of which are invasive. Lescuerat is present on the distal end of the
correlate platform, 5 can of retouch consisting of overlapping keel and bending
recovered from an horizon dated to between 5,500 and 10,000 Cal BP. It features a
hafting resin is present near the platform. CR8-4-1004 is a classic woodchopping
haft has been broken and used, and a residue of orange/red plant material that might indicate
Artifacts CR8-2-1321 is a late stage, from a level dated between 2,000 and 5,000 years BP.
Possible use as projectile elements or cutting tools.

(¢) Kamanina 1978, Fuller 1999, which indicate slicing through soft material, and
smoothing that is not diagnostic of contact material but is consistent with other studies.
It is thought that the anterior break during use. The chord also remains short parallel to
then along the chord, which has slight edge rounding and a few very small bending scars.
Faunal Assemblage

Vertebrate Fauna

The faunal assemblage at GRE8 includes both terrestrial and riverine animals, including small and medium macropods, turtle, fish, and fresh water mussels. A total of 749 fragments of bone were recovered from the excavation, including seven fragments of bone from the surface of the rockshelter. Bones that could not be identified to species were recorded as 'large mammal' (cf. Macropus rufus/Macropus giganteus), 'medium mammal' (cf. Macropus eugenii/Trichosurus vulpecula). 'Other' was ascribed where it was not certain from which taxon the fragment was derived. The calculation of the species recovered from the site was done using the Number of Identified Specimens (NISP) (Table 6.). All fragments of bone were counted including elements from the vertebral centrum, ribs and long bone shafts. The minimum number of individuals (MNI) was not calculated due to the small number of elements identified to species.

In overall terms, bone was not weathered, with most bone recorded as stage 1 (after Berensmeyer 1978). The bones that showed the greatest amount of weathering consisted of the material recovered from the surface of the excavation. Within the lower five spits there was a significant increase of calcium carbonate encrustation on bones. A small number of bones had also been burnt, and consisted of unidentified and very small fragments from spit 4 (10 fragments) and spit 5 (9 fragments).

The majority of mammal elements were medium sized macropodidae, and are likely to be the same species, particularly the cranial material, cf. Macropus eugenii (tamar wallaby) and Wallabia bicolor (swamp wallaby). None of the bones were any larger than Macropus eugenii, the majority falling between the two in size. Two varanid (lizard) vertebrae were identified from spit 2 and 9 and consisted of a partial and complete vertebra (respectively). Turtles were represented by carapace, which were very fragmented.

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(Figure 6.3-d).

Cal BP where there appears to be a clear relative increase in the discard of refuse remains of small mammals appears to increase through the sequence with a spike in spike 5 (c. 1300 CE). With only very small numbers of large and medium mammals, the relative abundance of small mammals appear to have been the most common terrestrial fauna present at Great Barrier Reef.

The fauna analysis indicates some trends in resource exploitation in the history of Great Barrier Reef.

<table>
<thead>
<tr>
<th>Table 6.15: NISP calculations for the vertebrate faunal assemblage</th>
<th>CrE8 TP(1), Reevetleigh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fish</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
</tr>
<tr>
<td>Squid</td>
<td>19</td>
</tr>
<tr>
<td>Lizard</td>
<td>1</td>
</tr>
<tr>
<td>Large</td>
<td>2</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td>Small</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Fauna NISP</td>
<td>108</td>
</tr>
<tr>
<td>Mammals</td>
<td></td>
</tr>
</tbody>
</table>
Figure 6.34: Changes in abundance of vertebrate fauna by spit from GRE8 TP1, Riversleigh, northwest Queensland.

**Invertebrate Fauna**

The invertebrate fauna at GRE8 consists of freshwater mussels and gastropods, as found in the nearby OLH midden. Freshwater mussels consist entirely of *Alathyria pertexta* spp. (Figure 6.35). Gastropods are represented in low frequencies through most of the deposit but never amount to more than 5 g in any excavation unit. Their presence can be broadly correlated with increases in mussel shell. Gastropods were most likely brought into the site attached to mussel shells.

*Alathyria pertexta* spp. first appears in spit 8 and then increases markedly to peak between spits 5 and 7 (c. 100 kg per m³), between 30,000 Cal BP and 13,500 Cal BP. The peak in discard relates in stratigraphic units 2B and 3B corresponds to the dense shell lenses visible in section (this analysis shows that there is no break in shell discard between these two
Chapter 6 Southern Study Area

... approximately 2,500 individuals/m² from split 5 until the surface. Is apparent in MINI. MINI from split 9, these significantly from split 7 and 8 reaching a higher level of fragmentation across. A similar trend for the other levels (phase B), where shell was crossed and recently removed. NISP rises steadily until split 4 and 2 have then been extrapolated for a cubic meter of sediment (Table 6). Excluding split 1 MINI has been extrapolated based on 100% of the excavated material. Both NISP and MINI have then been extrapolated for a cubic meter of sediment (Table 6). Excluding split 1.

Due to large sample sizes, NISP has been calculated using a random 250 of sample, while the archaeological periods are from GRE8 TLP. The archaeological periods are from GRE8 TLP. Figure 6.35: Deced of Alhitha peraxa spp. in Grams per cubic meter by split in GRE8 TLP.

The upper seas...

...Alhitha peraxa spp. continues to be represented but at a greatly reduced level in...
Alathyria pertexta spp. abundance / m³

<table>
<thead>
<tr>
<th>Spit</th>
<th>NISP</th>
<th>MNI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25000</td>
<td>5100</td>
</tr>
<tr>
<td>2</td>
<td>8927</td>
<td>2339</td>
</tr>
<tr>
<td>3</td>
<td>4600</td>
<td>2420</td>
</tr>
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<td>8903</td>
<td>2629</td>
</tr>
<tr>
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<td>4993</td>
<td>2424</td>
</tr>
<tr>
<td>6</td>
<td>5084</td>
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</tr>
<tr>
<td>8</td>
<td>2091</td>
<td>600</td>
</tr>
<tr>
<td>9</td>
<td>1970</td>
<td>45</td>
</tr>
</tbody>
</table>

**Table 6.16: NISP and MNI measures for GRE8 TP1, Riversleigh, northwest Queensland.**

The ratio between NISP and MNI shows peaks in fragmentation in spits 1, 2 and 6, whilst spits 3 and 5 have much lower ratios than the mean of the deposit 3.42 (1 S.D.). The high level of fragmentation for spits 1 and 2 is due to small sample size and trampling. The peak in spit 6 (phase C) is interpreted as an indicator of greater levels in the intensity of site use at this time.

![Graph](image-url)

**Figure 6.36: Ratio of NISP : MNI by spit for GRE8 TP1, Riversleigh, northwest Queensland.**

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measured analysis of shell was undertaken to refine this linear relationship.

High rates of shell discard then occur throughout the middle and upper spine numbers. However, given the lower individuals occur in these levels compared to the upper spine, the average shell is encrustated with calcium carbonate which increases the weight and second phases A, B, and C. E. and G. gain a high ratio of weight to MINI, while the latter phases D, F, and G (Figure 6.37). These is a linear relationship with a diminishing ratio during time in CRF.

The ideal weight of *Halithona perna* sp. for each spine was divided by the MINI for each spine.
Size analysis

Change in the mean valve size together with changes in species abundance provide a good indicator of the effects of human exploitation (see Spenneman 1989). The analysis is based on two assumptions: (i) the relative abundance of preferred shells will decrease through a midden deposit; and (ii) mean shell length will decrease from the bottom to top of the midden due to the effects of the exploitation (see Claasen 1998). People will select larger individuals within a population and reject those below a certain threshold. If the threshold for exploitation occurs at a size that is less than the size of the shell species at sexual maturity there will be risk that the population will be over-exploited. Other factors including environmental change may also affect species size, population structure and location.

The valve length of all complete Alathyria pertexta spp. individuals was recorded and mean length was plotted by excavation unit for GRE8 (Figure 6.38). A line of best fit shows a significant change in size through time. These results suggest over exploitation as a result of foraging behaviour during earlier phases B and C (30,000 Cal BP – 13,500 Cal BP).
The TPI excavation yielded almost 2,000 flaked stone artifacts. Whilst the assemblage is

the shelter

the TLM the increasing accumulation of modern deposit indicators persistent occupation of

the shelter was occupied from c. 37,000 years ago. During the following 4,000 years ago, whilst sediment accumulation in the site is low during the phase the site appears to have either been continuously occupied, or visited.

northeast Queensland.

Figure 6.6: Mean length of Alpinia persea spp. by excavation unit for GEB's TPI, Rifleleigh.
consistent with Hiscock's conclusions for the Lawn Hill data where wider use of the landscape occurred in the post the LGM period. It is also at this time that seed grinding technology appears at GRE8, and stone artefact discard rates increase dramatically.

The faunal assemblage at GRE8 shows distinct relationships between resource exploitation, inferred through combination of lithic discard patterns and the food remains within the TP1 deposit. Until the conclusion of phase B and the wetter conditions of the post-glacial Late Pleistocene, evidence for hunting of terrestrial fauna is meager. After this point small mammals occur in steadily increasing numbers. During phases B and C, (30,000 and 10,000 Cal BP) high densities of *Ailanthyrus perrecta* spp. and small amounts of turtle are found. After phases B and C, mussel shell accumulation is sustained though at a comparatively reduced level and consisting of smaller individuals. These trends appear to be consistent with a change in foraging strategies that includes a post glacial Pleistocene expansion of range and a reconfiguration in diet breadth.

The assemblages from GRE8 TP1 provide compelling evidence for the early occupation of northern Australia, in a location that might have provided a refuge corridor to the arid interior. The discard rates of flaked stone and shell indicate that the shelter provides compelling evidence for a persistent occupation of the Gregory River corridor during the Late Pleistocene.
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Communities occur up to 15 km from the edge of Verdun Creek. Grasslands associated with the adjacent hummocky terrain slope. Riparian vegetation in the vicinity of THZ3 is comprised of dominant local woodlands and a small ar shrub location with evidence of vegetation is above 1 km further west along Verdun Creek.

The closest location with evidence of vegetation is about 1 km further west along Verdun Creek. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. No other sites have been recorded within this area, and the Riverleigh hummocky plain. 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6.4 Riverleigh - Sites Distant to Permanent Water

Complex located over 5 km from waterrockshelter located near intermittent and ephemeral water sources and a large caveun further inscriptions into the prehistoric records of this region. These sites consist of two similar discoveries in the prehistoric area of the research region has providedThe archaeo-

6.4 Riverleigh - Sites Distant to Permanent Water

Complex located over 5 km from waterrockshelter located near intermittent and ephemeral water sources and a large caveun further inscriptions into the prehistoric records of this region. These sites consist of two similar discoveries in the prehistoric area of the research region has providedThe archaeo-
Figure 6.39: Location of LH23 (Verdon Creek site), Riversleigh northwest Queensland. A. shows the general location of the area marked as b. B. shows the location of LH23 and relationship to local patch types.

Site Description

LH23 is a small limestone rockshelter, c. 6 m deep, 4 m wide at the entrance, and 2 m in height. A series of large boulders of up to 2 m in diameter that have fallen from the plateau above and now rest at the entrance of the rockshelter, acting as sediment traps. The surface of the LH23 features sandy unconsolidated sediments and large boulders. At the rear of the site the wall terminates at a stone floor. No flaked stone artefacts have been observed on the surface of the rockshelter. However, many artefacts occur outside the shelter and extend down the talus slope. The shelter has two images near the entrance consisting of a monochrome snake and an emu track.

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This transsect...
Figure 6.41: Site plan of LH23 rockshelter indicating the position of the excavated square, Verdon Creek, Riversleigh, northwest Queensland.

Stratigraphy

The LH23 deposit consists of two stratigraphic units terminating on limestone bedrock/roof fall at 26 cm below the surface. Unit A (10 – 26 cm depth) is comprised of dark grey silt with pieces of limestone rubble. Unit B consists of the upper 10 cm of deposit and consists of loose grey/brown silty sediment (Figure 6.42).

Figure 6.42: Stratigraphic profile of the LH23 deposit, Riversleigh.

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Figure 6.43: Age-depth curve for LH33 TPI, Verdon Creek, northwest Queensland.

<table>
<thead>
<tr>
<th>Table 6.17: Radiocarbon determinations for LH33 TPI, northwest Queensland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>221</td>
</tr>
<tr>
<td>146</td>
</tr>
<tr>
<td>128</td>
</tr>
</tbody>
</table>

The above table shows the results of radiocarbon determinations for LH33 TPI, northwest Queensland. The table includes the sample number, age in years before present (BP), error, material type, upper and lower capitate, and raw bulk ID. The data indicates that the sediments were deposited over a period of approximately 27,000 years, with the oldest deposits dating back to about 27,000 years ago. The age-depth curve shows that the rate of accumulation was not uniform, with periods of higher and lower rates of deposition.
Flaked Stone Assemblage

Stevens analysis of the LH23 flaked stone assemblage examined 510 artefacts: 330 flakes, 17 retouched flakes (including 5 backed artefacts), 4 cores, 114 flake fragments, and 45 flaked pieces. After removal of non diagnostic stone the total sample size is 351 artefacts (excluding fragments and pieces) (Table 6.18).

<table>
<thead>
<tr>
<th>Flakes</th>
<th>Retouched Flakes</th>
<th>Cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Total Assemblage n = 351</td>
<td>330</td>
<td>94.1</td>
</tr>
</tbody>
</table>

Table 6.18: Abundance and frequency of flaked stone in the LH23 assemblage Verdon Creek, northwest Queensland.

Whilst there is no clear relationship in discard over the occupational history of the shelter, the highest rates of discard occur in the lowest spit 7 (Figure 6.44), suggesting that perhaps the occupation sequence may be deeper than the basal excavation levels in the trench. As with the GRE8 site, the LH23 assemblage is dominated by local chert most likely sourced as cobbles from Verdon Creek. Small amounts of greywacke, silcrete and quartzite also occur in the deposit.

Figure 6.44: Artefactual stone by weight and spit for TP1 at the LH23 rockshelter, Verdon Creek, northwest Queensland.

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Similar level of expertise in knapping to other sites in the region. occurrence of aberrant retouching accounts for 21% of the assemblage indicating a platform thickness and area are generally very small (50% with platform > 20 units). The platform surfaces (13%) and with delamination surfaces (5%) forming the remainder. cornered were documented with the assemblage dominated by single flakes (32%). Contacted in area with small platforms. No instances of multiple flakes, crastered, or fashioned platforms have less than 35% cortex on their delaminated surfaces, though there is slighty more variation. The majority of complete flakes (between 78 - 90%) only included at recovered flakes. The majority of complete flakes were produced using direct percussion with bubble hammer. All flakes in the assemblage were produced using direct percussion with bubble hammer.

Table 6.19: Flake breakage in LH23 T1P, Yarraman Creek, northwestern Queensland (n=330)

<table>
<thead>
<tr>
<th>1</th>
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<th>4</th>
<th>5</th>
<th>6</th>
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<td>29</td>
<td>4</td>
<td>13</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

% Flakes broken

and Campbell

Flakes. Breakage is most likely the result of a combination of high levels of heat fracture. The load assemblage. Longitudinally broken flakes comprise less than 2% of all broken flakes. Breakage at LH23 is dominated by transverse breaks which account for 15-40% of
Retouched Artefacts

Of the 17 retouched artefacts, 11 are amorphously retouched flakes, 1 is a broken unifacial point and 5 are backed artefacts. Amorphous flakes featured non-invasive retouch of the distal end and/or one margin. The number of retouch scars on these artefacts ranged between 1 and 5.

Usewear study of the retouched assemblage concluded that all artefacts had evidence of use (R. Fullagar pers. comm. 2007). The backed artefacts featured rounding, smoothing or polish and most featured wear marks on the chord and other indicators of hafting of the backed edge. One example (LH23-6-141) featured usewear consistent with cutting of soft fibrous material.

Fauna

The faunal assemblage at LH23 is primarily mammal bone and is dominated by small and micro mammals (particularly rodents) (Figure 6.45). Macropods and large to medium mammals also occur in small amounts, the most frequently identified being Lagorchestes conspicillatus (spectacled hare wallaby). There are also low numbers of small reptiles (see Stevens 2004:98-99). Stevens considers that the majority of this assemblage has been created by carnivores (most likely Tyto alba the barn owl), with the larger mammal remains brought into the rockshelter by humans (Stevens 2004:99). It also seems likely that some macropod remains in the shelter resulted from natural death.
Figure 6.45: Relative frequency of different faunal classes at LH23, Verdon Creek, northwestern Queensland.

Summary
6.4.2 The Grotto (GRE13)

This site is known locally as ‘The Grotto’ due its location at the edge of a breakaway of the limestone plateau, which features many impressive ‘muffin’ shaped mesas up to 15 m in height creating a maze of small pathways. The ‘Grotto’ is well known to locals and for most of the last 10 years has also been visited by tour groups. The area surrounding and including GRE13 is important to the Aboriginal community and knowledge of the location and significance of the site are restricted. In recent years the Aboriginal community have successfully halted tourist visitation of the area and have protected the GRE13 site from cattle through erection of fences. Although the GRE13 rockshelter has been visited in the past, its location approximately 300 m east of the main ‘Grotto’ location has ensured that it is not known to tourists and is subsequently in good condition.

The Aboriginal community is very protective of the meaning and significance of the GRE13 site. The site is designated as a men’s site and is secret in nature.

*Site Setting*

GRE13 is located at the junction of the Riversleigh region limestone plateau and grasslands patches (Figure 6.46). The site is on the blacksoil plain c. 300 m from the commencement of the plateau proper. The local vegetation consists of grasses dominated by *Triodia spp.* with few trees. Grasses are sparse due to extremely poor soil quality and the presence of dense chert/limestone rubble.
Figure 6.4: Excavations in progress at GREE (the Crowe) rockshelter, Riverleigh, northwestern Queensland. A small intermittent drainage channel less than 100 m in the north of GREE.

Riverleigh is the closest permanent water to GREE and is approximately 2 km east of the site. The O'Shaughnessy River forms the eastern boundary of the O'Shaughnessy River. The O'Shaughnessy River crosses the Crowe drainage basin along the northern edge of the Crowe River. Water flows along this channel during the wet season via small gullies. General location of GREE rockshelter, Riverleigh, northwestern Queensland, A, shows the location of GREE and its relationship to local patch types.
Site Description

GRE13 is a small limestone rockshelter located on the most prominent of the numerous local limestone plateau outliers. The GRE13 outlier is approximately 750 m² in area and c. 10 m in height. GRE13 is on the southeastern side of the outlier, and is a long thin cave created by water flow through rock. The entrance to the shelter is approximately 4.5 m wide and 2 m in height. The cave forms a long tunnel that terminates as a small chamber 10 m from the entrance. The exterior of the breakaway features numerous chert nodules, many of which appear to have been flaked.

The interior walls of GRE13 are almost vertical and extend generally to a height of between 1.5 - 2 m from the floor surface (Figure 6.48). The northern wall features an extensive panel of painted and drawn bichrome rock art. The floor surface of GRE13 consists of unconsolidated sandy sediment and covers an area of approximately 18 m². At the time of excavation, the surface of the site was littered with 15 roughly formed timber posts that were likely to have been used as platforms for storage of European goods by the managers of the local Riversleigh station during World War 2. The surface of the shelter featured a few stone artefacts; however numerous flaked artefacts were noted in the local area around the entrance of the site.
Figure 6.49: Plan of GREE, River Esk, showing location of excavation square, rock art and hunter sites.

...
Stratigraphy

The stratigraphic sequence at GRE13 consists of four units and terminates on fragmented limestone bedrock 30 cm below the surface. Unit A is the lowest horizon (22 - 30 cm) and consists of orange/brown soils and gravel and feature a low density of flaked stone material. Unit B (15 - 22 cm) consists of a dark grey brown colour and feature high levels of charcoal, ash and cultural material. Unit C (11 - 15 cm) is a lighter brown soil with a heavy concentration of ash and flaked stone. Unit D (1 - 11 cm) is loose dark brown soil featuring low densities of charcoal and flaked stone (Figure 6.50).

Figure 6.50: Section profile of TP1 at GRE13, Riversleigh, northwest Queensland.

Chronology

A single charcoal sample from GRE13 was submitted for radiocarbon analysis consisting of a large single fragment of charcoal recovered in situ during excavation in spit 6 (27 cm depth). The radiocarbon determination has been calibrated using the Calib radiocarbon program and expressed to a two sigma range (Table 6.20). The mean of this range is 607 cal BP. The upper spits of the site are considered to be approximately 100 years old due to the presence of an early 20th century metal button in spit 2.
are low in the former spatial peak in the middle sediments before reaching the upper spinos.

Flakewhale flakes (0.45%), and 1 flake each of quartz, and granite. The base of dissect
remaining raw material consists of volumetric flakes (1.6%), 3 limestone flakes (0.7%)
that surround the site. It accounts for 96.6% of the assemblage (n=425) which in the
dominant raw material is chert which is present as nodules on the base formations.
unmoderated flakes (91.6%), 13 cores (2.9%) and 14 retouched artefacts (5.45%).

The CH13 flaked stone assemblage consists of 40 artefacts, including an MNF of 40.

Table 6.2: Radiocarbon determinations and calibration for charcoal from CH13, T.P., Kyrenia,

<table>
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<tr>
<th>(yr cal BP)</th>
<th>Carbon 14 (BP)</th>
<th>Radiocarbon</th>
<th>Number</th>
<th>Laboratory</th>
<th>Measure Sample</th>
<th>Depth (cm)</th>
<th>Split</th>
</tr>
</thead>
<tbody>
<tr>
<td>6573</td>
<td>6543</td>
<td>799 ± 41</td>
<td>9.4 ± 0.2</td>
<td>VR-133359</td>
<td>C13</td>
<td>12</td>
<td>27</td>
</tr>
</tbody>
</table>
Flaked Stone Reduction

Flaked stone reduction has been measured by the percentage of dorsal cortex and documentation of platform features. These measures indicate that the flaked stone assemblage is highly reduced. Seventy three percent of all flakes have less than 25% cortex, 22% of all flakes feature overhang removal scars on the dorsal margin of the flake platform, and platforms are dominated by single flake scars (84.6% n=270) and cortical surfaces (5.6% n=18).

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The average length of longest scar present was 22.5 cm (SD = 4.08 cm), and the average block size was 24.95 cm (SD = 14.8 cm). The most common block size was 27.5 cm (SD = 12.4 cm). The mean was 34.3 g, whereas the median was 32.1 g. To accommodate the outliers, the mean was removed and two heavy outliers were included in the mean. The accuracy of the cores tested was 88% (n=28) however up to 85% correct cover was used in the calculation of the accuracy of the cores. All of the cores were manufactured from chert except for a large stone quarried composite with a chert core. All of the cores were recovered from sites 2, 3 and 4 with most occurring in site 4 (n=8).

Core Reduction

In GRIE III, Wrecked Hill, northern Queensland, 131 cores were recovered from sites 2, 3 and 4 with most occurring in site 4 (n=8).

Figure 6.3: Box plot of the mean, median and range of axial length and width in mid-point of flakes.

Deviation is 9.05% and 6.7% respectively (Figure 6.3).

Flakes at GRIE I is just 1.88 mm and the mean width at mid-point is 15.1 mm (standard deviation is 6.55 mm). These results are consistent with the size of flakes, the mean axial percussion length of...
Faunal Assemblage

The faunal assemblage from GRE13 TP1 consists of few terrestrial faunal remains and is very fragmented. Small to medium mammals, and in particular wallaby are the most abundant fauna, with lesser amounts of large macropod and small mammals. Most faunal discard occurs in spits 4 and 5 of the deposit (Table 6.1).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Spit 1</th>
<th>Spit 2</th>
<th>Spit 3</th>
<th>Spit 4</th>
<th>Spit 5</th>
<th>Spit 6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macropod - kangaroo</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Macropod-wallaby</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td>10</td>
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<tr>
<td>Medium mammals</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Small/medium mammals</td>
<td>1</td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Small mammals</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Avis (bird)</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>11</td>
<td>0</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 6.21: NISP of faunal material from GRE13 TP1, Riversleigh, northwest Queensland.

*Alahyria pertexta* spp. occurs only in small amounts in the deposit, peaking in spits 4 and 5 with 45.4 g and 30.6 g discarded. Although only a fraction of material was recovered from excavations it indicates that exploitation of permanent water sources that are over 5 km distant brought material to this location.

Summary

GRE13 is located in a marginal resource patch at the junction of plateau and blacksoil plains. Most of the time the site is at least 5 km from the permanent water and only after very heavy rainfall would ephemeral pools of water result in the area. These factors combined to result in occupation of this rockshelter occurring very late in the human record for the region. People used the Grotto for the consumption of meals and as a

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Carnamah was excavated the following year in 2003.

Provided permission for future excavation at Carnamah due to logistical complexities
the site and the issue of excavations. During 2002 fieldwork the Aboriginal community
Queensland Parks and Wildlife Service and the Wanyi people rekindled the significance of
meers site. During the 1980s there was widespread discussion between the paleontologists,
Carnamah is well known to the Aboriginal community and is considered a ceremonial
Carnamah was bestowed in reference to the bush known at which grew at the entrance
the site was revisited by Aboriginal elders and myself and a new indigenous name
Carnamah Cave after a helicopter pilot involved in the first trips to the site. During 2002,
Carnamah Cave is part of the cultural and historical significance of the site. The site was named
University of New South Wales. At this time at least two rock art sites were due to investigate
Carnamah was first located and explored in the 1980s by paleontologists from the

6.4.3 Carnamah

Indigenous who had few material requirements while residing there.
people claim their duties with activities that were used as a residential base for just a few
people. This recent view of this locality appears to complement the archaeological
Aboriginal community knowledge of the Carnamah site is use solely as an information

Carnamah is a logistical or residential site for a few people for short periods of time.
Over the last 600 years patterns of Aboriginal occupation are consistent with a
the assemblage probably originates from cobblestone. Another the Creek and O'Shannassy
location to carry out basic maintenance of bladed stone tools. Much of the then present in
Site Setting

Gamanyi is located within the limestone plateau in the Riversleigh World Heritage Area of Lawn Hill National Park. The site is adjacent to the upper reaches of an unnamed gorge which extends to Ixion Creek, a semi permanent water course. The nearest reliable permanent water to Gamanyi is located in the Gregory River and is approximately 5 km distant. This distance is intensified by the nature of the gorge system that must be traversed to access Gamanyi. A one way trip to the river would take between 2 - 3 hours across sharp karren limestone.

The local landscape surrounding Gamanyi is comprised solely of limestone plateau and skeletal soils supporting a meager vegetation community. The vegetation community near the site consists of spinifex, grasses, and scattered eucalypts plus the small native lemon tree at the entrance to the site. During excavation in 2003 the only fauna observed at the site were the numerous bats that inhabited the caves. A variety of small to medium mammal species and reptiles are known to inhabit the plateau in this locale.

Site Description

The Gamanyi site is a series of doline caves, which were created by fluvial erosion of large cavern areas within the limestone. The area surrounding Gamanyi features the remains of what would have constituted a front chamber of the site that has collapsed and now resembles a flat sandy gully between the original walls of the chamber (Figure 6.54).
It is in this rear chamber that palaeontologists have previously excavated two teguarches
surface, and are now filled with rocks, but may have access as pit traps sometimes in the past
in ceiling higher. The ceiling of the chamber has cracks and holes that extend to the
approximately 10 m from front to back. The rear chamber is 60 m x 30 m and up to 30 m
rear chamber is linked to the front by a tunnel that is 30 m x 1.5 m x 2 m and drops
ear of the chamber is a mass of granite, the approximately 10 m x 20 m x 1 m. The
the front of this chamber receives only dappled sunlight and features stone arrangements.
10 m in scope slope and is approximately 40 m x 30 m x 3 m in dimension. The first 10 m in
10 m in scope slope and is approximately 40 m x 30 m x 3 m in dimension. The first 10 m in
width. There are two primary chambers to the side. The front chamber is located down a
from the entrance. They are approximately 20 m below the surface and up to 50 m in
The remaining cavities of Caraminy consists of a mass of complex that extend over 300 m

Queensland.

Figure 6.54: The Caraminy entrance and the now collapsed front chamber, Ravensleigh, northwest Queensland.
Figure 6.55: Plan of Gamanyi showing the two main chambers and the locations of excavations (pit 2 and 3) within the cave, Riversleigh, northwest Queensland.

Excavation

Excavations at the Gamanyi site consisted of three 50 cm x 50 cm test pits. Pits 1, 2 and 3 were placed where there was the greatest chance of sampling a cultural sequence and where they did not affect important site features. Pit 3 was located at the front of the first chamber; Pit 1 in the area of the front chamber that featured deep sediment and no visible disturbance; whilst Pit 2 was placed outside the shelter in deep sandy sediment (Figure 6.56). Due to logistical complexities (lighting, power and safety issues) the rear chamber was not excavated.
nected below c. 27 cm depth. Excavation of recess 3 concluded at a depth of 49 cm below
proceeded to until 49 cm depth. With recess 3 excavated, further excavation was
of roof fell was encountered that proceeded further excavation. In recess 3 excavation
can below surface in recess 1, and to 28 cm in recess 2. At 22 cm in recess 1 a large piece
and consisted of a single unit of unconsolidated very fine brown sediment. To a depth of 22
The stratigraphy of both the trenches excavated within the (Lamany) cave was very similar.

Stratigraphy

Depth of 38 cm below the surface at which point a heavy rubble matrix was encountered.
20 and 49 cm below surface level. Pit 2, located outside the cave, was excavated to a
interpreted. The trenches were excavated until large boulders were encountered between
inferred roof fall. Above the stone, loose sediments and considerable boulders due to
levels. The two trenches located inside the cave were problematic to excavate as they
All three test pits were 50 cm x 50 cm and were excavated to 5 cm below stratigraphic

Figure 6.56: Plan of first chamber at Lamany showing location of excavated trenches, Lamany,

Queensland
the surface, when numerous large slabs of limestone protruded from the sections of the trench and no further control to excavation was possible. The red/orange sediments present in this trench have the same composition as the grey sediment that overly them, but have been exposed to a long period of in situ weathering. Testpit 2, located outside the cavern featured a very different stratigraphy to testpits 1 and 3. It consisted of homogenous brown dry sediment with particles of charcoal throughout.

_Cronology_

Three radiocarbon determinations were obtained for the test pits at Gamanyi. Two determinations were obtained for testpit 2 and 1 from the basal spit of testpit 3. These dates correspond to the levels in each trench where lowest artefacts were recovered. Occupation of Gamanyi commenced c. 1,000 BP.

<table>
<thead>
<tr>
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<th>lab id</th>
<th>material</th>
<th>Raw date</th>
<th>error</th>
<th>calib lower</th>
<th>calib upper</th>
<th>Calibrated mean (2 sd)</th>
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<td>539</td>
<td>432</td>
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<td>OZH616</td>
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<td>1150</td>
<td>50</td>
<td>924</td>
<td>1168</td>
<td>1046</td>
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<td>TP3 Sp8</td>
<td>OZH608</td>
<td>charcoal</td>
<td>1010</td>
<td>40</td>
<td>789</td>
<td>955</td>
<td>872</td>
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Table 6.22: Radiocarbon determinations for the Gamanyi site, Rivensleigh, northwest Queensland.

_Asemblage_

The flaked stone, charcoal, bone and shell assemblages from all three trenches indicate human use of the site in the recent past. The archaeology consists of a small quantity of

_Chapter 6_ Southern Study Area
### Table 6. Southern Study Area

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**Test Pit 2**

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</tr>
</tbody>
</table>

**Test Pit 1**

---

is presented here:

outside the cave (Table 6.3). Due to small sample size, no further analysis of this material.

artifacts are small, their unmodified and broken lacks. Most material was found to occur.

Haked stone artifacts (1 artifact in test pit 1, 35 in test pit 2, and 24 in test pit 3). All
Test pit 3

<table>
<thead>
<tr>
<th>Spit</th>
<th>Charcoal (g)</th>
<th>Gastropods (g)</th>
<th>Bone (g)</th>
<th>Weight of stone artefacts (g)</th>
<th>Number of stone artefacts</th>
<th>Ochre (g)</th>
<th>Ochre (g) - seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2</td>
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<td></td>
<td>11.6</td>
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<td>7</td>
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<td>65.5</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.23: Finds recovered from all test pits at Gamanyi, Riversleigh, northwest Queensland.

Summary

Gamanyi is highly significant to the local Aboriginal people. Aboriginal people occupied the area around the Gamanyi caves and ventured inside sometime in the last 1,000 years. Use of the site appears to have been very limited. The fact however, that Gamanyi was visited during the late Holocene at all, given its distance to water and accessibility problems is a strong indication that Aboriginal people were exercising high levels of foraging mobility at this time and utilizing patches with far less certainty of encounter and with lower ranking resources. The reasons for this are discussed in chapter 8.
practices, more meaningful sites for a variety of tasks, including short term camps and for

following the end of the Hohocene. In the period of enhanced aridity, which people to use these

of Riversleigh were occupied. This broadly correlates with the inundation of conditions

It is interesting that it has only been in the very late Hohocene that the more marginal areas

addition to proximity to good quality stone raw material

of the Gregory River, places that provided ideal habitats for people and fauna and in

areas have been found to directly correlate with the location of the damns along the course

resources, to allow for large aggregations of people for extended periods of time. These

regional patch model, where certain areas (such as OTH) provided enough chipped

sites including the OTH midden, which provides evidence supporting the larger scale

expansion and specialization in how ranked mussel shells at GR2 is during the LGM. Other

rungs and during different climatic phases. No more evident is this than in the

patch types and during different climatic phases. No more evident is this than in the

met by the evidence of changes in subsistence strategies at the different sites in different

settlement model. The expectations of the deer hunt and patch models have been well

coincidence of the region with occupation spanning all the climatic phases of the

The results of excavations at sites in the Riversleigh area provide evidence for early

entire Riversleigh landscape.

Gregory River. During 2003 fieldwork expanded our from the Gregory to sample the

Riversleigh area of the study region. In 2002 this research focused on areas close to the

This chapter has presented the results of survey and excavation that focused on the

65 Chapter Summary
Chapter 7

Excavation in the Northern Study Area –
Lawn Hill, Musselbrook and Elizabeth Creeks

7.1 Introduction
Chapter 7 presents the results of excavations in parts of the research region beyond Riversleigh. This fieldwork included Lawn Hill, Musselbrook and Elizabeth Creeks and their surrounding environments. These investigations broadened the focus to examine the timing and nature of the spread of people across the entire study region. Survey of Danjadanka near to Lawn Hill Creek was undertaken in addition to excavations at Bandangala 1, a sandstone rockshelter beside the permanent watercourse Musselbrook Creek, AL:B37, a large rock art complex site near to Elizabeth Creek, and Wild Dog Dreaming, a midden site along Lawn Hill Creek (Figure 7.1).

![Figure 7.1: Map of Lawn Hill, Musselbrook and Elizabeth Creeks, northwest Queensland showing the location of previously recorded sites and sites recorded during this project. Sites that have been excavated are labeled by name.](image-url)

Chapter 7 Northern Study Area
Within the main Dwyawarrun Gorge at Buluburra, called Wajungunjanga (Figure 7.7), Creek and a small tributary which shits around a prominent sandstone mesa formed block soil plans to present. Wild Dog Dreamtime is 100 m from the junction of Lawn Hill sandstone exposure of the Constance Range Formation, which marks the transition from Creek Cave on Lawn Hill Creek. It is less than 500 m from the commencement of the Wild Dog Dreamtime is located approximately 2 km downstream and east from College Creek.

The Site

Stiles and mounds (Wade 1983, Border 1988). At this location includes Stiles which are perhaps very old, combined with more recent occupation history of this locale. Furthermore, this excavation enabled the direct observation of cultural material found in association with the Keenem Rock Art, which is one of the major themes of the central Burrunguy gorge system at Lawn Hill. Excavation at Wild Dog Dreamtime is one of a suite of sites, including those excavated by Hitchcock which occur south bank of Law Hill Creek (Figure 7.2). The site is an important to the Wanyi community and they maintain strong connections to Dreamtime stories expressed in both.

Wild Dog Dreamtime is a small rockshelter with an associated shell middens adjacent to the

7.2.1 Wild Dog Dreamtime

7.2 Lawn Hill Creek
The small tributary to the east of Wayinggulami has created a large levy bank on the western side, much like the levee found at Louie Creek, and formed during rapid sedimentation in wet season flooding. The levee, which is approximately 400 m x 100 m, features extensive lithic scatters of R-chert and small deflated middens of mussel shell (most no larger than 2 m x 2 m). Wayinggulami is a large isolated mesa of the Constance sandstone formation and is about 300 m long, 200 m wide and 30 m high. Rock-art features prominently along the base of the Wayinggulami formation, and includes both freehand painted bichrome motifs and engravings.

The actual site chosen for excavation is placed within an extensive woodland patch which is adjacent to thick riparian vegetation and large free-standing bodies of water associated with Lawn Hill Creek and tributaries. Resource abundance is high and the patch is very fine grained. It is likely that during dry periods this location featured aggregations of fauna.
In September 2004 a test excavation was completed at the overhang site between the rockshelter and the overhang (1.5 m x 1.5 m) which revealed no distinctive surface scatter of stone artefacts. Origin is the recording forms indicate no distinction of mussel shells and overhang of 30 m x 20 m features an escarpment and rich middle of mussel shells and the outside of the large boulder a second shelter (or overhang) occurs. An area below the surface scatter of vertical cliffs forming a rockshelter and sediment and material contains within and outside the shelter. On vertical cliffs forming a rockshelter and sediments map (figure 7.4). A surface scatter of

Figure 7.3: Location of WDD2, Lawn Hill, northwest Queensland. Map a shows the general location of the area marked as b, Map b details the location of WDD2 and the relationship to local patch types.
The Wayinggulami formation in the vicinity of Wild Dog Dreaming 2 features numerous panels of rock – art including engravings, freckled painting, and drawings. Bichrome rainbow motifs up to 1.5 m in height appear at regular intervals around the base of Wayinggulami, and adjacent to Wild Dog Dreaming two paintings occur within 25 m. The rock art has been accorded different interpretations by Aboriginal people over the last 20 years (see Walsh 1985; Border 1988; Dymock 1993). For the Waanyi, the creation of the rock formation and painted art is known, however the meaning of the engravings is less certain. The engravings have been argued to be of much greater antiquity compared to the rest of the rock-art, perhaps Late Pleistocene in age (Walsh 1985). The position and appearance of the engravings on the Wayinggulami face indicate that their production may not have been contemporary with the painted motifs. The engravings are all small circles that have been pecked into the sandstone with a central dot. Over 60 examples have been documented along Wayinggulami, and have been described by Waanyi and researchers as either eyes or springs.

Chapter 7 Northern Study Area
was considered to be esteemed by people residing. This deposit was located 55 cm from the
A 50 cm x 50 cm deposit was excavated at WID2 in the middle deposit where sediment


**Figure 7.25** Jackson Diamond Showing examples of painted art designs, Lawn Hill northwest.

Iden...
side of the shelter, 4 m from the edge of the surface scatter of shell, and 1.75 m from the
dripline of the shelter. Excavation proceeded in 5 cm spits within stratigraphic units.
Finds were collected *in situ* where possible, and all sediment was weighed and dry sieved
through 4 mm and 2 mm mesh, on site. Finds from the 4 mm fraction were sorted on site,
and all material recovered from the 2 mm mesh plus a bulk sediment sample was retained
for further analysis in the Sydney University laboratories.

*Stratigraphy*

Wild Dog Dreaming 2 deposit consists of a dense shell midden approximately 20 cm deep.
Excavation ceased at a depth of approximately 35 cm, as no cultural material was evident
and large weathered pieces of sandstone rubble were more frequently encountered. Four
stratigraphic units were identified. The basal Unit A (35 - 25 cm) consisted of orange-red
compacted sterile sediment. Unit B (25 - 12 cm) comprised grey sandy sediment.
Towards the bottom of this unit the band of shell diminished (depth of approximately 20
cm). Unit C (12 – c. 8 cm) consisted of darker and compacted brown sandy sediment.
Stratigraphic Unit D (0 – c. 8 cm) consisted of the upper loose brown sandy sediment
(Figure 7.6).

Figure 7.6: Section profile of testpit 1 at the Wild Dog Dreaming 2 site, Lawn Hill, northwest
Queensland.

Chapter 7 Northern Study Area
Table 7.1: Radiocarbon determinations for Teshpi, Wilu Dog Dremminge 2, and Hill Lawn

<table>
<thead>
<tr>
<th>Sample</th>
<th>2100 BP</th>
<th>2420 BP</th>
<th>2495 BP</th>
<th>2735 BP</th>
<th>2533 BP</th>
<th>2790 BP</th>
<th>2805 BP</th>
<th>2830 BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Error</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
</tr>
<tr>
<td>Age (ka)</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
</tr>
<tr>
<td>Date (cal yr BP)</td>
<td>7122</td>
<td>699</td>
<td>7122</td>
<td>699</td>
<td>7122</td>
<td>699</td>
<td>7122</td>
<td>699</td>
</tr>
<tr>
<td>Hemisphere</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
</tr>
<tr>
<td>Location</td>
<td>OZ11624</td>
<td>OZ11624</td>
<td>OZ11624</td>
<td>OZ11624</td>
<td>OZ11624</td>
<td>OZ11624</td>
<td>OZ11624</td>
<td>OZ11624</td>
</tr>
</tbody>
</table>

Return of a radiocarbon determination of 2760 ± 45 (Table 7.1) and midway at the lower and most delaminated part, and been dated previously (2003) and collected in situ from strips 1, 3, and 4. An additional small sample from the edge of the

Table of radiocarbon determinations on freshwater mussel shells were obtained from samples

Chromologia
Flaked Stone Assemblage

A small assemblage of flaked stone artefacts was recovered from the testpit excavation (n=37). Thirty (30) non-diagnostic fragments which may be the result of human knapping were also recorded. All stone artefacts were recovered from the matrix of the shell midden to a maximum depth of 19 cm.

The Wild Dog Dreaming assemblage consists predominantly of chert, available from gravels at Lawn Hill Creek less than 100 m distant to the site. One silcrete and one greywacke flake were also identified. The silcrete probably derives from the lateritic duricrust of the Wayinggulami formation under which the Wild Dog Dreaming site occurs, whilst the greywacke has most likely been transported from a distance of at least 3 km from either Pages Creek, Dinner Creek or Edith Springs quarries. On the blacksoil plains it is the only non-local raw material present (see Hiscock 1988:134-6).

The flaked stone assemblage ay WDD2 is dominated by complete and broken unmodified flakes, plus two heavily reduced chert cores. One of the unmodified flakes is consistent with a rula pre-form as it is larger than most other flakes, has a gull-winged platform and a large bulb of percussion.

![Figure 7.7: Stone artefact assemblage by number and spit from testpit 1 at Wild Dog Dreaming 2, Lawn Hill, northwest Queensland.](image)

Chapter 7  Northern Study Area
Table 7.2: Frequency of blade detached from waste I at WIDID, Deerning 2, Pinion Hill, northwest Queensland.

<table>
<thead>
<tr>
<th>Split and depth</th>
<th>Spat and depth</th>
<th>Total Wt/ha</th>
<th>MNF</th>
<th>Hakes</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5-6 cm</td>
<td>4.5-6 cm</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1.4-2.5 cm</td>
<td>1.4-2.5 cm</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>0.8-1.4 cm</td>
<td>0.8-1.4 cm</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>&lt; 0.8 cm</td>
<td>&lt; 0.8 cm</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

Reduction took place elsewhere (Table 7.2). There was little dorsal cortex on blades indicating that initial stages of rounding/ablation were important. The mean length of complete blades was 24.9 mm and the mean width 16.9 mm. The accuracy size of blades is variable, though it can be noted that larger blades are relatively breakable, resulting in small and applied force, and measures of the extent of reduction. There are no appropriate measures for the WIDID blade. The abundance of blade distribution by number of each material type from Deerning 2.
<table>
<thead>
<tr>
<th>Cortex %</th>
<th>n</th>
<th>Average flake length (mm)</th>
<th>Average flake width (mm)</th>
<th>Average flake area (mm²)</th>
<th>Average flake weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12</td>
<td>15.72</td>
<td>16.645</td>
<td>261.6594</td>
<td>2.39 (s.d.=2.37)</td>
</tr>
<tr>
<td>1-24</td>
<td>1</td>
<td>39.57</td>
<td>28.64</td>
<td>1133.2848</td>
<td>12.9</td>
</tr>
<tr>
<td>25-49</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>50-74</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>75-99</td>
<td>1</td>
<td>20.45</td>
<td>15.73</td>
<td>321.6785</td>
<td>3.15</td>
</tr>
<tr>
<td>100</td>
<td>3</td>
<td>21.82</td>
<td>22.64</td>
<td>494.0048</td>
<td>3.93 (s.d.=5.28)</td>
</tr>
</tbody>
</table>

Table 7.3: Percent cortex on distal surfaces of complete flakes from Wild Dog Dreaming 2 testpit 1, Lawn Hill, northwest Queensland. The measurements for the single flake with 1-24% cortex are from the tula pre-form, hence the discrepancy in size with increased reduction.

Broken flakes comprise almost half of the assemblage, most of which exhibit transverse breakage. The majority of flake breakage probably occurred as the result of trampling, as the ratio of transverse to longitudinal breakage is 5 to 1 (Table 7.4). Distal flakes constitute 21% of the total assemblage whilst proximal and medial transverse breakages 13.1% in total.

<table>
<thead>
<tr>
<th>flake breakage</th>
<th>frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>flakes broken</td>
<td>42.1%</td>
</tr>
<tr>
<td>proximal fragments</td>
<td>10.5%</td>
</tr>
<tr>
<td>medial fragments</td>
<td>2.6%</td>
</tr>
<tr>
<td>distal fragments</td>
<td>21.1%</td>
</tr>
<tr>
<td>longitudinally cone split fragments</td>
<td>2.6%</td>
</tr>
<tr>
<td>fragments with both transverse and longitudinal breaks</td>
<td>5.3%</td>
</tr>
<tr>
<td>ratio of transverse to longitudinal breakage</td>
<td>5 : 1</td>
</tr>
</tbody>
</table>

Table 7.4: Frequency of broken flakes in testpit 1 at Wild Dog Dreaming 2, Lawn Hill, northwest Queensland.
here in the reduction sequence of the dent cores, when knapping problems were more
platforms. Consequently, flakes with hinge terminations are likely to have been produced
smaller than the average size of flakes in the assemblage and were removed because
remaining 24% have hinge terminations (n = 4). Flakes with hinge terminations were
seven to six percent (n = 13) of all complete flakes before further termination whilst the

<table>
<thead>
<tr>
<th>Table 7.5: Flake platforms by type and dimension from the Wild Dog Dreaming 2</th>
</tr>
</thead>
</table>
| type | platform prep. | with % | average
| area (cm²) | thickness (mm) | with | average
| shattered | 1 |
| 1943 | 7.87 | 2 |
| multiple flake | 1 |
| 2.22 | 8.44 | 100 |
| single flake | 6 |
| 2.42 | 3.14 | 0 |
| complete | 8 |
| 4.92 | 10.68 | 0 |

Then twice the mean size of non-complete platform flakes.

of core reduction when the flake was removed. Flakes with complete platforms are more
platform types, the average platform area shows changes in size directly related to the stage
single flakes each constitute 35% of the assemblage. With the exception of full-width
from the deposit were produced on complete platforms. Additionally, platforms comprising a
demonstrated by platform type and size which shows that almost 50% (n = 8) of all flakes
the Wild Dog Dreaming 2 assemblage is dominated by simple core reduction as

Knapping Techniques
likely to arise. The alternative explanation that flakes with hinge terminations were the result of retouching flakes based on their size is unlikely, as there is no evidence of bipolar percussion.

*Faunal Assemblage*

Terrestrial faunal (n = 27 and total weight = 9.8 g) were associated with the midden deposition in spits 1 - 5. No fragments of bone were identifiable to species.

A dense midden feature consisting of freshwater mussel (*Alathyria pertexta* spp.) extends from the surface of testpit 1 through to a depth of approximately 20 cm. The shell accumulations occur through three of the stratigraphic units. Radiocarbon determinations on the shell all overlap at two standard deviations and it is most likely that the observed stratigraphic changes concern the preservational state of shells and increasing depth below surface. Units C (compact brown sediment) and D (light brown sediment) have the same texture and particle size, and colour differences are possibly due to the compaction of sediment and shell preservation. The grey Unit B sediment is most likely the result of the burning of shells onsite or greater deposition of burnt shell material, and is coincident with a peak in charcoal concentration (7.4 g).

All the shell was identified as the bivalve *Alathyria pertexta* spp. (W. Ponder, Australian Museum pers. comm.). NISP and MNI calculations are presented in Table 7.6. Shell increases by weight and number, peaking in Spit 4. Minimum numbers of individuals offer a better representation of the true abundance of material in the site and show that the peak of deposition occurs in Spits 3 and 4, tapering off in Spit 2. The ratio of MNI to NISP is relatively constant at 1:5 until the upper two spits where fragmentation increases considerably can be attributed to a period of *in situ* weathering and trampling.
productive landscapes from c. 2,500 CAL BP. Large dense middens deposits like WD2 indicate that the lower courses (and probably the eastern plains) had become highly abundant resources. It is significant that this site post-dates cultural accretion and probably the result of aggregation surrounding here-fore-standing pools of water with and Coffin Creek by the mid to late Holocene. Sites like WD1, WD2, Dreaming 2 and effectively spread out from the previously occupied caves of the upper courses or Lawn Hill. This data is important as it provides evidence that human subsistence activities had

that the site was clearly frequently visited for a short period of time about 2500 years ago.

surrounding the shelter was the consumption of shellfish. The excavated sample shows

some artefacts were not a focus of activity at WD2, rather, the focus of activities

were probably the site to any material sources. The production and maintenance of

the proximity of the site to any material sources. These findings are not surprising given

these results support that there was no core reduction. These findings are not surprising given

reduction. There is no shape and lack of cores on flakes are indicative of later stages of reduction; there is no

The WD1, WD2, Dreaming 2 assemblage is dominated by local chert and whilst the size

<table>
<thead>
<tr>
<th>Year</th>
<th>MNISP</th>
<th>MN</th>
<th>NISP</th>
<th>Shell weight</th>
<th>NMISP</th>
<th>Leaf Hill</th>
<th>Dreaming 2 Deposits, Lawn Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-7.9</td>
<td>1</td>
<td>63</td>
<td>63</td>
<td>27.8</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-4.3</td>
<td>99</td>
<td>26</td>
<td>426</td>
<td>189.3</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-0.95</td>
<td>317</td>
<td>1000</td>
<td>1960</td>
<td>72.07</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-0.5</td>
<td>202</td>
<td>1162</td>
<td>505</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-0.9</td>
<td>175</td>
<td>1420</td>
<td>637.4</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-3.1</td>
<td>14</td>
<td>437</td>
<td>220.2</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Summary**
might also indicate increases in local population size. The diet breadth model would predict that the consumption of shellfish during these good conditions would either be the result of increased pressure, most likely due to a combination of (i) increased population, and (ii) less clumping of higher ranked resources due to greater availability of water.

7.2.2 Danjadanji

Site Setting

Danjadanji is located on the south side of Lawn Hill Creek mid-way between Lawn Hill Gorge and a commercial camping ground called Adel’s Grove. Covering an area of 0.5 km² the site consists of both fringing riverine, woodland and grassland patches. The intersection of these units occurs about 150 m from Lawn Hill Creek. Two main soil substrates occur, associated with the vegetation communities and consist of alluvial sediments of weathered limestone, tufa and gravel adjacent to the creek and in the creek banks; and hard, cracking clay associated with the black soil plain away from the creek and to the east of a low ridge. Resource abundance at Danjadanji is high within the woodland and riverine patches, but notably less than other areas where Lawn Hill Creek is more substantial. On the grasslands there are few fauna and patch grain is coarse. As such, this area is predicted to have varied in resource density correlated with changes in climate and water availability.
less than one area per square meter to more than 6 areas per square meter. A range
approximately 300 m x 100 m. Stone areas varied in frequency across this area from
at Dampudahai an increased concentration of stone areas occurs in an area

transition to grass plains environmental zone.

Figure 7.10: Lawn Hill Creek at Dampudahai, Lawn Hill, northwestern Queensland. (a) shows a view of collection square B with the area marked as B. (b) marks the location of the Dampudahai

sample and its relationship to local patch types.

Figure 7.9: Location of Dampudahai study area, Riverleigh, northwest Queensland. A shows the

map and its relationship to local patch types.
of isolated artefacts (e.g. stone, metal, ceramic and glass) occur throughout and continue beyond the study area.

**Sampling Methods**

For the purposes of sampling and estimating artefact frequency, the study area was divided into two surface collection areas: Surface Collection Area 1 comprised 12 locations (called 'collection squares'), where artefacts were clearly visible. In each collection square (8 m²) all artefacts were collected. Surface Collection Area 2 included all of the study area beyond the 12 collection squares of Area 1. Only isolated finds were collected in Surface Collection Area 2, although discrete scatters of low artefact abundance were also recorded. Artefacts were generally much less numerous (<1/m²) away from surface Collection Area 1 (refer to Figure 7.11 for map of Danjadanji and location of the collection squares and isolated finds).

![Contour map of Danjadanji, Lawn Hill featuring the location of the collection squares, isolated finds, and relative density of artefacts on the surface. Contour interval 0.2 m.](image_url)
concentration of artifacts. Four plus, each 50 cm x 50 cm were excavated in surface excavation was initially to characterize the soil sequence and assess the subsurface. Following surface survey, four areas were selected for subsurface testing. The aim of excavation was to acquire finds isolated and artifacts were probably in the order of 10%. Effective coverage of the overall study area for the purposes of estimating represented a sample was collected. All larger items (visible from about 5 m - 10 m) were recorded and small scattered and isolated artifacts were encountered. A small study area was surveyed on foot by 3 - 4 fieldworkers spread out several meters apart.

Surface Collection: Island finds

Due to an overestimated abundance, the surface collection of artifacts occurred over a much larger area than anticipated. Consequently, the estimated number of artifacts per square meter for the sample area are 2% of the total area. The sampling strategy encompassed those areas where artifacts were most abundant. Within the sample area of c. 5'000 m², sampling covered 96 m², c. 2% of the total area.

Hypothesis evidence of deliberate halving (Hiscock 1984a).

While not all of the cobble scatters, alone, provided a clear indication that they had deliberately been made by people, it seemed likely, on the base of other sites, that many split cobbles were also artefacts even though they lacked potentially useful cobbles occurred naturally in the area and it seemed likely, on the basis of other sites, that they had deliberately been made by people. The reasons for this were that fresh fracture surfaces and sharp edges was collected, even if they had no diagnostic because plans obscured the ground surface over about two square meters. All stone with flakes and cobbles was collected. At Collection Square 5 the square was extended to 7 m x 5 m. At each location a rectangle measuring 2 m x 4 m was set out. A 2D area was photographed and all artifacts were collected from 12 locations in an area of about 50 m x 100 m.
collection squares 4, 9, 11 and 12. Collection Squares 11, 12 and 4 formed a transect moving away from the creek and included the two landforms in the study area (gentle slopes towards the creek and the ridge). Collection square 9 was one of two collection areas with high artefact frequency: n=49 (the other collection area with high artefact frequency being Collection Square 10, n=61). The time during which the surface artefacts had accumulated or been exposed on the surface is not known, although sediment appeared to be eroding on the ridge tops; stable if not accumulating on slopes down from the ridge towards the Creek; and eroding closer to the Creek bank.

Each of the test pits were excavated by hand in 1 - 10 cm spits, until no further artefacts were found. Excavated sediment was dry sieved through 4 mm mesh. The lowest spits were wet sieved with 2 mm mesh to ensure total recovery.

*Stone artefact analysis*

Stone artefacts include grinding stones (e.g. made of sandstone) and flaked stone (mostly made of chert and silcrete). Artefacts were found in varying frequencies across the study area, and concentrations are defined by analyses below.

*Surface Collection 1: Collection Square artefacts*

All artefacts found in Surface Collection 1 from the 12 Collection Squares including subsurface finds are summarized in Table 7.7. A total of 249 artefacts were recorded comprising 246 stone artefacts, one ceramic fragment and two pieces of metal. The average frequency of stone artefacts for Collection Area 1 is about 2.6 artefacts per square metre, ranging from 0.625 artefacts per square metre in Collection Square 4, to 7.625 artefacts per square metre in Collection Square 10.

Chapter 7 Northern Study Area
Table 7.7. All artifacts from collection area 1 at Darvandil, Lower Pillar, northwestern Queensland. The 9 (split 1) and 11 (split 2) refer to the first column refer to collection squares 111/125, 111/214. The square/split 9, 11, 1, 2 refers to the second column. The squares/split 9, 11, 1, 2 refers to the third column. The squares/split 9, 11, 1, 2 refers to the fourth column. The squares/split 9, 11, 1, 2 refers to the fifth column. The squares/split 9, 11, 1, 2 refers to the sixth column. The squares/split 9, 11, 1, 2 refers to the seventh column. The squares/split 9, 11, 1, 2 refers to the eighth column. The squares/split 9, 11, 1, 2 refers to the ninth column. The squares/split 9, 11, 1, 2 refers to the tenth column. The squares/split 9, 11, 1, 2 refers to the eleventh column. The squares/split 9, 11, 1, 2 refers to the twelfth column. The squares/split 9, 11, 1, 2 refers to the thirteenth column. The squares/split 9, 11, 1, 2 refers to the fourteenth column. The squares/split 9, 11, 1, 2 refers to the fifteenth column. The squares/split 9, 11, 1, 2 refers to the sixteenth column. The squares/split 9, 11, 1, 2 refers to the seventeenth column. The squares/split 9, 11, 1, 2 refers to the eighteenth column. The squares/split 9, 11, 1, 2 refers to the nineteenth column. The squares/split 9, 11, 1, 2 refers to the twentieth column. The squares/split 9, 11, 1, 2 refers to the twenty-first column. The squares/split 9, 11, 1, 2 refers to the twenty-second column. The squares/split 9, 11, 1, 2 refers to the twenty-third column. The squares/split 9, 11, 1, 2 refers to the twenty-fourth column. The squares/split 9, 11, 1, 2 refers to the twenty-fifth column. The squares/split 9, 11, 1, 2 refers to the twenty-sixth column. The squares/split 9, 11, 1, 2 refers to the twenty-seventh column. The squares/split 9, 11, 1, 2 refers to the twenty-eighth column. The squares/split 9, 11, 1, 2 refers to the twenty-ninth column. The squares/split 9, 11, 1, 2 refers to the thirtieth column. The squares/split 9, 11, 1, 2 refers to the thirty-first column. The squares/split 9, 11, 1, 2 refers to the thirty-second column. The squares/split 9, 11, 1, 2 refers to the thirty-third column. The squares/split 9, 11, 1, 2 refers to the thirty-fourth column. The squares/split 9, 11, 1, 2 refers to the thirty-fifth column. The squares/split 9, 11, 1, 2 refers to the thirty-sixth column. The squares/split 9, 11, 1, 2 refers to the thirty-seventh column. The squares/split 9, 11, 1, 2 refers to the thirty-eighth column. The squares/split 9, 11, 1, 2 refers to the thirty-ninth column. The squares/split 9, 11, 1, 2 refers to the fortieth column. The squares/split 9, 11, 1, 2 refers to the forty-first column. The squares/split 9, 11, 1, 2 refers to the forty-second column. The squares/split 9, 11, 1, 2 refers to the forty-third column. The squares/split 9, 11, 1, 2 refers to the forty-fourth column. The squares/split 9, 11, 1, 2 refers to the forty-fifth column. The squares/split 9, 11, 1, 2 refers to the forty-sixth column. The squares/split 9, 11, 1, 2 refers to the forty-seventh column. The squares/split 9, 11, 1, 2 refers to the forty-eighth column. The squares/split 9, 11, 1, 2 refers to the forty-ninth column. The squares/split 9, 11, 1, 2 refers to the fiftieth column.
<table>
<thead>
<tr>
<th>Square ID</th>
<th>Number of Non-Diagnostic Fragments (n)</th>
<th>Number of Cores, Flakes and Retouched Flakes (n)</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
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<td>25</td>
</tr>
<tr>
<td>2.1</td>
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<td>5</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>29</td>
<td>56</td>
</tr>
<tr>
<td>4</td>
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<td>5</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>13</td>
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</tr>
<tr>
<td>6</td>
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<td>24</td>
</tr>
<tr>
<td>7</td>
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<td>11</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
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</tr>
<tr>
<td>Total</td>
<td>321</td>
<td>245</td>
<td>566</td>
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</tbody>
</table>

Table 7.8: Non-diagnostic fragments and diagnostic artefacts from collection area 1 at Danjadanji, Lawn Hill, northwest Queensland. The whole numbers in the first column refer to Collection Squares of 8m². The numbers 2.1, 9.1, 11.1 and 12.1 refer to upper excavation units of 50 cm x 50 cm x 1 cm deep, within Collection Squares 2, 9, 11 and 12 respectively.
small features. 
not represent significance in the subsurface deposits, but rather, downward movement of
and it is thought that the (possibly) smaller artefacts within 1 cm of the ground surface do
is lower than those artefacts on the surface. No artefacts were found below 1 cm depth.
from square 9, unit 1, overlaps with surface collections, the weight of artefacts from unit 1
remained small artefacts not visible on the surface. Although the size range of artefacts
exposed by recent disturbance (e.g., trenching); (ii) scoring or excavated soil is likely to have
excavation are: (i) the artefacts were found within 1 cm of the surface and are likely to be
detected in unit 9 in unit 1. Various factors affecting the higher recovery rate from subsurface
collection squares, there are 6.25 artefacts per m² (n = 49) on the surface and 36 artefacts
suggest they have a higher frequency than surface finds (Table 7.10). For example in
Only limited remains of any of these pits contained artefacts, although estimates

| Table 7.9: Number of artefacts and artefact scatters in collection 2 at Dungadam, Lawn Hill |
|---------------------------------|-----------------|-----------------|
| Central Total                   | 45              | Surveyed points |
| unploughed point                | 6               | Excavated artefacts per m² (n = 49) |
| unexcavated lake                 | 9               | Groundscrapes    |
| groundscrapes                   | 1               | Isolated cores   |
| source                            | 1               | Isolated artefact scatters (Table 7.10) |
| (Refer to Figure 7.1 for location) |                 |                  |
| Number of locations              | 5               |                  |

The survey suggests that metal and glass artefacts are equally visible over the landscape as
Surface Collection 2: Isolated finds...
<table>
<thead>
<tr>
<th>Square/spit</th>
<th>Depth below surface (cm)</th>
<th>Sterile Substrate</th>
<th>Flakes (n)</th>
<th>Retouched flakes (n)</th>
<th>Cores (n)</th>
<th>Stone artefacts (n)</th>
<th>Non-diagnostic fragments (n)</th>
<th>Stone artefacts per m² (n)</th>
<th>Artefacts + non-diagnostic fragments per m² (n)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>11</td>
<td>0.625</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>1</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
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<td>0</td>
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<td>4.2</td>
<td>10</td>
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<td>0</td>
</tr>
<tr>
<td>4.3</td>
<td>20</td>
<td>Hard clay</td>
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<td>29</td>
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<td>Gravel</td>
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<td>0</td>
<td>0</td>
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</tr>
<tr>
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<td>4</td>
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<td>Alluvium</td>
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<td>0</td>
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<td>0</td>
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</tr>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 7.10: Stone artefacts and non-diagnostic fragments from excavations, including surface collection at Danjadanji, Lawn Hill.

Analysis of flaked stone

For collection Squares 1 – 12, a summary description of the artefacts was compiled which included the nature of flaking technology, and the extent of the site in its most concentrated area. Three research questions were addressed: (i) did the assemblage represent either contemporaneous, functionally discrete activity areas associated with a

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### Table 7.11: Number of stone artefacts and emplaces of Happening Episodes (excluding Broken Pieces) for each collection square at Dangarooni, Lawa Hill, Northern Queensland.

<table>
<thead>
<tr>
<th>Square ID</th>
<th>211</th>
<th>245</th>
<th>Total</th>
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</tr>
<tr>
<td>6</td>
<td>01</td>
<td></td>
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<td>2</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Square ID</th>
<th>Number of Flakes + Cores</th>
<th>Minimum Number of flakes + Cores + 0.5</th>
<th>Recounted Flakes (n)</th>
<th>Flakes + Cores (n)</th>
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</thead>
<tbody>
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<td>6</td>
</tr>
<tr>
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<td>9</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Sites recorded in the area.

Technologically classified were recorded to compare and contrast with the other archaeological sites recorded in the area. This data set includes all the data from the study area, the nature of the raw materials, the reduction/technical process, and the tools produced during the period.

**Hypothetical use:**

- A general source for making stone tools.
- Its use was understood, and carried out in gravel beds in the area, with the occupation of the site being characterized by the presence of a long period of occupation. This is particularly true for the mid-late period.
Artefact technological types

The Danjadanji assemblage is dominated by flakes and non-diagnostic fragments. Non-diagnostic fragments do not consistently track variation in flakes. Collection square 11 for example, has an unusually high proportion of non-diagnostic fragments relative to flakes. Collection squares 9 and 10 have good sample sizes for artefacts (flakes, cores and retouched flakes > 35). In these squares the proportion of cores to flakes is higher than in other squares. This may be the result of three possible mechanisms: (i) flake transport soon after manufacture; (ii) spatial variation in the reduction sequence for flaking relatively small, water worn cobbles; or (iii) variation in composition may simply reflect variation in sample size, the smaller samples being unrepresentative.

![Graph showing artefact types in Collections Squares 1-12, n=211 at Danjadanji, Lawn Hill, northwest Queensland.](image)

Figure 7.12: Artefact techno-types in Collections Squares 1-12, n=211 at Danjadanji, Lawn Hill, northwest Queensland.

Flakes vary in size across the study area with largest flakes found further away from the creek (Figure 7.13). Collection squares 1 and 11 had the lowest average flake length and

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and the tip of a crossbow arrow (n=1). A single clear thumb size was found in Collection Squares, and n=9 from isolated finds.

A shovelnosed metal spear point (n=1), a variety of projectile tips were found, including unchipped stone points (n=2) in northeast. A variety of projectile tips were recorded, including unchipped stone points (n=2). Square 12, and two standing stones were recorded as isolated artefacts further to the northwest. In addition to the hacked stones, two flintstone fragments were recorded in Collection Square 7 for each of these squares.

Figure 7.2: Average size of flakes (length, width and thickness) for all collection squares by transect.
Artefact reduction

The degree of artefact reduction has been assessed by the amount of cortex present on flakes, the presence of retouched flakes and the range of cores and flakes.

The variation in the amount of cortex noted is presented in Table 7.12. The amount of cortex on its own may be a poor indicator of reduction, because cortex may persist as part of an implement until late in its use life. For example, one of the three greywacke flakes recorded had 100% cortex on the dorsal surface, although the closest source of greywacke outcrops was more than 5 km away, much further than the chert sources. Nevertheless, > 50% cortex was frequently found in all collection squares. Given the small size of cores, and the natural occurrence of small usable cobbles in the study area, the abundance of cortex is likely to be a consequence of the local availability of small corticated chert nodules.

<table>
<thead>
<tr>
<th>collection square</th>
<th>0%</th>
<th>1-25%</th>
<th>26-50%</th>
<th>51-75%</th>
<th>76-99%</th>
<th>100%</th>
<th>n</th>
</tr>
</thead>
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<td>3</td>
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<td></td>
</tr>
<tr>
<td>7</td>
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<td>1</td>
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<td>49</td>
<td>17</td>
<td>20</td>
<td>14</td>
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<td>174</td>
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</tbody>
</table>

Table 7.12: Cortex on retouched flakes and flakes (MNF) from collection squares at Danjadanjji, Lawn Hill, northwest Queensland.

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... (to rest whether any material quality) occurs close to the stone source.

descriptive features include many such split cobbles which might be expected where can be difficult to detect without microscopy, and may be absent due to breaking. Non-impact points have caused these features may be lacking because cobble can be split by percussion on an oval, a Heronian invention can be identified clearly as an artifact, in which case it is classified as a core. Retouched can be identified clearly as an artifact, in which case it is classified as a core.

Only after a split cobble has been split or fragment (or a core with negative flake scars). Only after a split cobble has been split may be that cores may be split cobbles that have no clear signs of being a flake (e.g., a core, may be that cores may be split cobbles that have no clear signs of being a flake (e.g., a core with a split or fragment (or a core with negative flake scars).)

Although cores are sometimes heavier than flakes (as might be expected since flakes are over flaking, cores may be less than 6% of flakes and retouched flakes.

over flaking, cores, sometimes considered as an error or lack of control other reduction. Non-pass flakes, sometimes considered as an error or lack of control important consideration in producing descriptive flakes for further shaping. Shaping or geometric piece, on other flakes (approximately 7%), suggesting that ovate is an important part of common, some, and retouched flakes (approximately 20%) but is..."
**Artefact concentrations**

The distribution of artefacts for collection squares 1 - 12 suggests that the frequency of artefacts drops as you move further away from the creek. Although artefact frequency fluctuates in transects parallel to the creek, the distribution of isolated finds indicates that artefacts remain common close to the creek and decrease with distance from Lawn Hill Creek. This pattern is supported by other unpublished data (Slack 2002), that argued that concentrations of artefactual material occurred along this part of Lawn Hill Creek and at other locations in the region in the same way. Artefact concentration drops rapidly to the southeast to much less than 1 artefact per 100 m².

**Artefact Discard**

The survey has shown that activities were concentrated closer to the creek, where sediments appear to be either stable or aggrading, compared with erosion along the ridge. All but a few stone artefacts had sharp edges, suggesting that weathering from surface exposure was low, and that artefacts have not been exposed to weathering or damage from flooding or wind erosion. The presence of stone points, tula slugs and fragments of large grinding stones suggests Mid to Late Holocene occupation (within the last 5,000 years) in a marginal environment with scattered resources. A range of historic artefacts also documents recent occupation by Aboriginal people and others. The time frame of occupation cannot be further refined at this stage.

The low incidence of flaked stone prevents a clear indication of discrete activity areas. Artefact technological and functional classes suggest a range of activities which are dominated by manufacture and repair of stone artefacts. Evidence relating to food preparation and other activities is present but is less common than at other places along the creek. Rather than a single discrete phase of occupation, the stone assemblages suggest
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The net result of settlement and subsistence on the plains at Law Hill has been argued to result from the absence of radiocarbon dating on any stratum.

Holecroft. This assertion is made in the presence of radiocarbon dates from about 14,000 BP (see Hiscok 1988:248) and predominantly from the mid and late 9000s BP, figures which were used to argue for a much earlier occupation of the region. However, in later years, when compared to similar sites within the region, the plains' potential for habitation is much greater. The plains, however, is not enough to suggest that the plains are a viable site for habitation. There is some evidence for shell middens along Law Hill Creek, and a large mound of shell middens at Shell Creek (Gresham 1979). The presence of these middens suggests that the plains were a viable site for habitation, but it is not considered whether or not they are a new phase of habitation. The absence of hearths, bones, and shellfish remains may be a new phase at this location. The absence of hearths, bones, and shellfish remains may be a result of particular activities taking place. The site has been reduced to its shell, and the absence of particular activities taking place. The site has been reduced to its shell, and the absence of particular activities taking place. The site has been reduced to its shell, and the absence of particular activities taking place.

Summary

Over a long time period, overlapping activity areas with multiple phases of occupation by small groups of people...
sequences built upon general observations concerning the nature of flaked stone materials and their state of weathering.

The Danjadanji site provides strong support for the models of stone artefact procurement and manufacture developed by Hiscock (1988) and provides evidence that Aboriginal people exploited the plains in foraging activities in the recent past, and procurement of raw materials from areas along Lawn Hill Creek at least during the last 2,000 years and possibly longer, dependent on uncertain patch richness.

7.3 Musselbrook Creek
7.3.1 Bandangala 1

Site Setting

Bandangala 1 rockshelter is located on Bowthorn pastoral station, adjacent to Lawn Hill National Park. The site is approximately 5 km west of the transition from the Gulf of Carpentaria savanna plain, within a sandstone gorge system on the eastern margin of the Barkly Tableland on Musselbrook Creek (Figure 7.14). Musselbrook Creek commences on the Barkly Tableland about 75 km west of the Bandangala 1 site and flows into the Gregory River approximately 100 km to the east. During the dry season (March - November), it is reduced to a series of large waterholes. Bandangala 1 is adjacent to one of these waterholes, which is 3 km in length.
utilised in the past.

ecosystem to the south of Bandangala 1 is considered unlikely that this patch was
considered a part of the Creek system in the past day. Even today, even today, however
immediately to the south, areas located within only a few kilometers along Musselbrook
restricted to the east and west so the site is not accessible from the sandstone plain
is due to the seasonal and unstable nature of water flow in the north. Access to the site is
responsible for being than other areas already discussed such as the southern Creek River. This
This location is one of the most productive patch areas of the region, but it is far less
Bandangala 1 is located within a wooded patch adjacent to a very narrow riverine patch.

Site Description

Figure 7: Map of Bandangala 1 on Musselbrook Creek, northwest Queensland. Dotted lines indicate
annual soils are unsaline.
ephemeral streams. The sandstone escarpment is shaded orange, Late Pleistocene

Figure 74
Figure 7.15: Location of Bandangala 1, Musselbrook, northwest Queensland. Map a. shows the general location of the area marked as b. Map b. details the location of the Bandangala 1 and its relationship to local patch types.

Bandangala 1 is a small sandstone rockshelter at the base of a sandstone escarpment containing an extensive shell midden. A surface scatter of mussel shell, flaked stone artefacts (including tulas, scrapers, and points), a large sandstone grindstone and a muller were identified in a 50 m² area under the escarpment overhang. Rock art consists of a partial bichrome red and yellow rainbow-like motif, well known from other sites in the region (see Border 1988, 1989; Slack 2002; Walsh 1985) and of a series of yellow painted emu tracks, and three hand prints.
Excavation and stratigraphy

By July 2004, a 4 x 4 m test pit revealed an area within the Bandeagaha 1 shelter. Excavation started with the surface middens and surface litter bands. The Bandeagaha 1 rock shelter, Musselbrook Creek, northwest Queensland, Showing Location.

Figure 7.17: Bandeagaha 1 on Musselbrook Creek, northwest Queensland, looking south.
fall) was encountered. All sediments were dry sieved through 4 mm and 2 mm mesh with some preliminary sorting completed on site. Two stratigraphic units were noted, including an ashy shell horizon approximately 15 cm below the surface. The lower unit, A, consisted of a compact red/brown sediment which occurred predominantly in the southwest side of the trench. Unit A sediments commenced from 22 cm depth and consisted of soil mixed with numerous flaked stone artefacts, faunal material and some shell. From 70 cm depth Unit A sediments account for over 50% of the volume of the deposit. At the base of excavations these Unit A sediments had expanded to cover approximately 90% of the trench.

Unit B consisted of a loose brown/grey sediment from the surface to about 140 cm depth. It was contained mainly to the northeast corner, and was comprised of a high density of mussel shell and ash. In some instances defined lenses of shell were observed. Unit B sediments featured very few flaked stone artefacts. During excavation it was further noted that the Unit B sediments overlay the Unit A sediment for the deposit.

![Section profile of Bandangala 1 testpit 1, Musselbrook Creek, northwest Queensland.](image)

Figure 7.18: Section profile of Bandangala 1 testpit 1, Musselbrook Creek, northwest Queensland.

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Section 1.2: The radiocarbon determinations from the Late Archaic occupations were obtained on charcoal and recovered mussel shell from column samples. Six radiocarbon determinations were obtained on charcoal and recovered mussel shell.

Table 7.4: Radiocarbon determinations, Bandana Cave, Russia Creek near Lawn Hill.

<table>
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<th>Sample</th>
<th>Date (BP)</th>
<th>Depth (cm)</th>
<th>Number</th>
<th>Location</th>
<th>Material</th>
<th>Comments</th>
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<td>261/477</td>
<td>charcoal</td>
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<td>OZ3194</td>
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<td>261/476</td>
<td>charcoal</td>
<td>110 (C14)</td>
<td>OZ3196</td>
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<td>1432</td>
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<td>270/0</td>
<td>charcoal</td>
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<td>164/33</td>
<td>charcoal</td>
<td>164/33</td>
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</tr>
<tr>
<td>150</td>
<td>7</td>
<td>200/350</td>
<td>242/9</td>
<td>charcoal</td>
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</table>

Note: The radiocarbon dates are for the Late Archaic occupations at the Bandana Cave site. The dates range from 2610 to 2420 BP, with a majority falling between 2500 and 2000 BP.

62223: Respectivey, were found to overlap at two standard deviations.
deposition rate of Unit B (Table 7.15). It is considered that increased seasonal rainfall at Bandangala 1 appears to have resulted in the scouring of the older Unit A sediments in the northeastern side of the excavation, followed by accumulation of late Holocene Unit B sediments.

On the basis of the stratigraphy and radiocarbon determinations it appears that the Unit A sediments constitute the original site deposit. From around 2,000 years ago these sediments were scoured along the north and eastern sides of the trench and infilled by Unit B sediments. This scouring appears to correspond strongly with the orientation of the site with respect to Musselbrook Creek presumably from enhanced flooding events in the past.

Figure 7.19: Age-depth curve for units A and B, Bandangala 1 testpit 1, Musselbrook Creek, northwest Queensland showing the differential rates of deposition for each unit and extrapolated basal dates.
Chapter 7 — Northern Study Area

A record for the last 2,000 years and 2,000 Cal BP (spins - 9). Phase CI is composed of the upper spins 1 - 3 and provides

Phase CII covers the period between 5,500 HP. This consists of spins 10 - 17 of the deposit. Phase CIII consists of those sediments dated to between 10,000 cal BP and 5,500 cal BP. Phase (or Phase B) consists of those sedimentary deposits laid between 10,000 cal BP and 5,500 cal BP. This defines the Holocene. It encompasses the lower spins (18 - 24). The second

Table 7.16: L. T. B. Deposits have been divided into four multiphase deposits: 1. Bandengadha I, 2. Bandengadha II, 3. L. T. B. Deposits have also been divided into four multiphase deposits: 1. Bandengadha I, 2. Bandengadha II, 3. L. T. B. Deposits have also been divided into

<table>
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<tr>
<th>Site</th>
<th>B</th>
<th>A</th>
<th>V</th>
<th>D</th>
<th>Spn</th>
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Table 7.15: Secular accretion rates for Bandengadha I, II, and III. Note the secular accretion rates for the lower limit of 1000 years.
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<thead>
<tr>
<th></th>
<th>Spits</th>
<th>Age Range</th>
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<tbody>
<tr>
<td>Phase A</td>
<td>18 - 24</td>
<td>10,000 - 13,000</td>
</tr>
<tr>
<td>Phase B</td>
<td>10 - 17</td>
<td>5,500 - 10,000</td>
</tr>
<tr>
<td>Phase C</td>
<td>4 - 9</td>
<td>2,000 - 5,000</td>
</tr>
<tr>
<td>Phase D</td>
<td>1 - 8</td>
<td>0 - 2,000</td>
</tr>
</tbody>
</table>

Table 7.16: Analytical units used for analysis of Bandangala 1 TP1 deposit, Musselbrook Creek, northwest Queensland.

**TP1 Flaked Stone Assemblage**

A total of 918 flaked stone artefacts have been identified from Bandangala 1 TP1. Few artefacts were recorded within the Unit B sediments (n= 161), and were mostly concentrated in the southern quadrant of the testpit in spits 2, 3 and 4 immediately overlying the Unit A sediments. It is possible that that the spit 4 material might originate from the interface with of Unit A.

The abundance of flaked stone artefacts changes greatly through time (Table 7.17). During the earliest phase of occupation between 13,000 Cal BP and 10,000 Cal BP discard rates are low (n = 30). Phase A contains just 1 core and 29 unmodified flakes. In contrast, phase B sediments feature much higher discard rates (n = 313) and a greater richness and variation in the assemblage, including 8 cores and 4 retouched flakes. Phase C also has a high discard rate in terms of weight of sediment, and as a measure of sediment volume. As with phase B, all classes of artefacts are present in the phase C including four backed artefacts. Due to the scouring of the upper sediments of Unit A, phase D sediment within stratigraphic Unit B features much lower discard (n=21) including 2 cores recorded just below the surface of the testpit and one retouched flake.
Figure 7.20: Bandung Field TPI which assemblage for Unit A sediments showing number of artifacts.

Grouped approximately 1\(\frac{1}{2}\) in the middle of the total sample range. D weights appear to have no trend and are variable, whereas phase C, Spils 5 - 9 are grouped by phases in general way. Phase A, Spils 17, 18, 21-23 are all very low. Phase B and however in measure of average weight of flakes stone through time. Average weights (approx. 0.2 per 100 years) increase increase through time. This trend is not reflected although the quantity of flakes stone discarded for the Unit A sediments is very low.
<table>
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<tr>
<th>Spit</th>
<th>Analytical Units Present</th>
<th>Volume A</th>
<th>B</th>
<th>number of artefacts A</th>
<th>B</th>
<th>number / kg A</th>
<th>B</th>
<th>number artefacts / m³ A</th>
<th>B</th>
<th>number / 100 years A</th>
<th>B</th>
<th>total weight (g)</th>
<th>average weight (g)</th>
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<td>0.018</td>
<td>-</td>
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<td>171</td>
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<td>0.9</td>
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<td>B</td>
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<td>0.238</td>
<td>140.4</td>
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<td>0.044</td>
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<td>2000</td>
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<td>0.001</td>
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<td>0</td>
<td>0.011</td>
<td>-</td>
<td>28.9</td>
<td>2.40</td>
</tr>
</tbody>
</table>

* excludes one 216.6g hammerstone  
#Unit A only

Table 7.17: Summary lithic data for Bandangala 1 TP1, Musselbrook Creek, northwest Queensland.

Chapter 7 Northern Study Area
Figure 7.2: Stone raw material incidence by phase for Bandanape 1 TPI, Mussebrook Creek.

Stone raw material incidence of the Bandanape 1 deposit is restricted to six raw materials: 
- Occurring during the phase C, spits 7-9.
- The earliest phase of the deposit features a large deposit of Grade B, 3.5%
- Other raw materials in the deposit include grade A, 2.5%
- Other raw materials are sourced from cobblestones along Mussebrook Creek and brought from more distant sources.

The highest incidence rate of non-chert discard materials, which are overall less efficient, is observed with the highest rates of non-chert discard.

The discards rates of different raw materials and single instances of eyestalk and quarts. The discards rates of different raw materials and single instances of eyestalk and quarts. However, the discard rates of non-chert discard materials are generally lower.
Technological Change

Breakage

Breakage rates include transverse and longitudinal breaks, which have been separated into proximal, medial, distal and marginal transverse fragments, and into proximal, distal and 'complete' longitudinal fragments. The rate of breakage in flakes at Bandangala 1 is low and generally accounts for 22 - 28% of the assemblage (Table 7.18). During phase B breakage is less than 30% of the rate observed in other phases. Broken flakes are dominated by distal and proximal flakes. In all but phase B distal flakes are at least twice as frequent as proximal flakes, whereas phase B features an almost 1:1 ratio. This is thought to be due to re-use of proximal flakes.

<table>
<thead>
<tr>
<th>%</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
</tr>
</thead>
<tbody>
<tr>
<td>broken flakes</td>
<td>28.21</td>
<td>7.16</td>
<td>28.12</td>
<td>22.73</td>
</tr>
<tr>
<td>proximal fragments</td>
<td>9.09</td>
<td>18.87</td>
<td>3.45</td>
<td>7.69</td>
</tr>
<tr>
<td>distal fragments</td>
<td>20.51</td>
<td>18.51</td>
<td>20.95</td>
<td>13.63</td>
</tr>
<tr>
<td>longitudinally conc split fragments</td>
<td>-</td>
<td>3.7</td>
<td>1.85</td>
<td>-</td>
</tr>
<tr>
<td>Ratio of transverse to longitudinal breakage</td>
<td>-</td>
<td>6.01</td>
<td>14.01</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7.18: Flake breakage in Bandangala TTP1, Musselbrook Creek, northwest Queensland.

The ratio of transverse breakage relative to complete flakes has been used as an indicator of the intensity of the site use of Bandangala 1. Comparison of this ratio with sediment accumulation rates for the deposit are presented in Figure 7.22. As for GNEB, it is predicted that there will be an inverse relationship between the ratio of transverse to complete flakes, to sedimentation. If this relationship does not hold then an increase in site use is inferred. Figure 7.22 shows that this relationship is true for phases A, B, and D, but during phase C the ratio of transverse to complete flakes compared to sediment

Chapter 7 Northern Study Area
Accuracy (S.D. = 5.82 mm).

Range was between 2 and 20. The length of the longest complete scar was 17.33 mm on_core (S.D. = 3.06 cm, weight of 14.85 g) and averaged 8.66 break scars (n=6) (and phase D (n=5)). All of the cores were small with a mean block volume of 9.23 cm³ which had between one and three notches. Cores were only recorded for phase C.

Eleven cores were recorded from T.P. 1. This included ten chert cores and one quartzite all_of which had between one and three notches. Cores were only recorded for phase C.

Knapping and reduction

In T.P. 1, Mistletoe Creek, northeast Queensland.

Figure 7.22: Ratio of transversely broken and complete flakes to sedimentation rates for Bandjalang

Sediment accumulation (mean kg/m²/100yrs)

Ratio Transverse/Complete Flakes

Between 5,500 - 2,000 C41BP.

Accumulation is very high. It appears that Bandjalang was more intensively occupied.
Flakes

All flakes in the assemblage were produced using direct percussion, and no evidence of pressure flaking or indirect percussion was observed. Metrical examination of the location and force of blows to cores and flake platforms, the nature of core maintenance, and decortation processes was completed to assess reduction.

The majority of complete flakes possess no cortex, which is consistent with the presence of small flakes in the assemblage. Flakes with no cortex are greatest during phase D (the last 2,000 years). During phases B and C there is more variation in the percentage of dorsal cortex which is consistent with flakes from different stages of reduction. This result indicates that a range of knapping activities took place on site.

<table>
<thead>
<tr>
<th>Amount of Cortex</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>76.69</td>
<td>62.9</td>
<td>69.82</td>
<td>90.47</td>
</tr>
<tr>
<td>0 cortex</td>
<td>76.69</td>
<td>62.9</td>
<td>69.82</td>
<td>90.47</td>
</tr>
<tr>
<td>&lt; 25%</td>
<td>3.33</td>
<td>12.78</td>
<td>8.58</td>
<td>4.76</td>
</tr>
<tr>
<td>26-50%</td>
<td>3.33</td>
<td>5.11</td>
<td>5.5</td>
<td>0</td>
</tr>
<tr>
<td>51-75%</td>
<td>6.66</td>
<td>6.09</td>
<td>3.4</td>
<td>0</td>
</tr>
<tr>
<td>76-99%</td>
<td>3.33</td>
<td>5.11</td>
<td>4.8</td>
<td>0</td>
</tr>
<tr>
<td>100%</td>
<td>6.66</td>
<td>8.01</td>
<td>7.9</td>
<td>4.76</td>
</tr>
</tbody>
</table>

Table 7.19: Changes in the amount of cortex on flakes in Bandangala 1 TP1, Musselbrook Creek, northwest Queensland.

Chapter 7 Northern Study Area
of Lith B recast shellmet.

controlled. It might also be due to taphonomic reasons as these slips are chiefly compu-

artefact reduction in the recast shells and the application of force was less and more

slips 1 - 6 is much smaller than in older levels. This may be because there was greater

development of cores. Vertical surface area comparison does indicate that flake size in

generally less than 4 cm, but can be as large as 7 cm, and is considered to primarily reflect

vertical surface area of complete flakes for each split of Bandiana TPI. Flake area is

vertical surface area of complete flakes were recorded. Figure 7.23 details a box plot of the average

stone cutting. Flake retention type, the prevalence of sharpened surfaces, and the area

reduction of stone raw materials involved techniques that conserved material and reduced

The extent and precision of the force applied, when flaking stone, can indicate whether the

Figure 7.22: Box plot graph of average flake size in cm² for Bandiana I TPI, Mussebrook Creek.
The range of termination types present on complete flakes is presented in Table 7.20. Aberrant terminations occur consistently throughout the deposit, being slightly lower during phase C (5,500 - 2,000 BP).

<table>
<thead>
<tr>
<th></th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feather/axial</td>
<td>86.7</td>
<td>84.3</td>
<td>88.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Hinge</td>
<td>13.3</td>
<td>9.1</td>
<td>5.8</td>
<td>13.3</td>
</tr>
<tr>
<td>Step</td>
<td>-</td>
<td>6.1</td>
<td>5.2</td>
<td>-</td>
</tr>
<tr>
<td>Outré passé</td>
<td>-</td>
<td>0.5</td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>n</td>
<td>30</td>
<td>313</td>
<td>291</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 7.20: Relative percentages of different termination types for the analytical units of Bandangala 1 TP, Musselbrook Creek, northwest Queensland.

Location of the Force of Application

Two measures of knapping force have been used in analysis of the Bandangala 1 TP1 assemblage: the type of platform surface to which the blow is made, and the proximity of the blow to the core edge. The assemblage is dominated by platforms on a single flake scar (77 - 91%) with no evidence for faceting or grinding. Unprepared cortical platforms consistently account for 9 - 14% of the assemblage. During recent phases, particularly phases C and D there is greater variation in platform types including an increase in the frequency of platforms created on multiple flake scar surfaces (Table 7.21).
was more restricted here than other sites.

Table 7.22: Platform remains by phase recorded for the Bandangala 1 TPI, Musselbrook Creek

<table>
<thead>
<tr>
<th>Phase</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Phase D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.30</td>
<td>3.46</td>
<td>2.56</td>
<td>3.62</td>
<td>3.07</td>
</tr>
<tr>
<td>3.3</td>
<td>3.41</td>
<td>3.11</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average platform thickness (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Hakes with overhang removal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.21: Relative occurrences of platform types by percentage for the Bandangala 1 TPI

<table>
<thead>
<tr>
<th>Platform Types</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Hake</td>
<td>16.06</td>
<td>11</td>
<td>7.73</td>
<td>3.0</td>
</tr>
<tr>
<td>Multiple Hake</td>
<td>18.71</td>
<td>8</td>
<td>6.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Corroded</td>
<td>6.09</td>
<td>11</td>
<td>1.12</td>
<td>3.0</td>
</tr>
<tr>
<td>Shellacked</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total number</td>
<td>90</td>
<td>27</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

The width of each platform perpendicular to the building line was used as a measure of the
Comparison of the average length to width of all complete flakes shows increasing elongation through time. Flakes from the lowest two phases are very small with a length to width ratio of 0.8:1, whereas by spits 5 - 7 this ratio is over 1.2:1 (Figure 7.24).

![Graph showing the ratio of average proximal length to average proximal width of complete flakes by spit for Bandangala 1 TP1, Musselbrook Creek, Lawn Hill.](image)

**Figure 7.24: Ratio of average proximal length to average proximal width of complete flakes by spit for Bandangala 1 TP1, Musselbrook Creek, Lawn Hill.**

**Retouched Flakes**

Seventeen retouched flakes were recovered from the excavated sample. All were produced from chert and are characterised by amorphous retouch (n=10). There are five unifacial points and two tulas in the assemblage, occurring in phase B and C, between 10,000 and 2,000 Cal BP. Most of these occur in phase C (5,500 - 2,000 Cal BP) (n=6) and correspond with increased regional aridity, and might therefore be a technological response to increased resource patchiness.

**Chapter 7** Northern Study Area
Relative abundance of small mammals (Figure 7.26). Participatory evidence in Phase C (5.500 - 2.000 BC) and concludes with increases in the medium sized fauna in the site by over 50% of the occupation of the site. This drop in medium sized fauna in the site is by over 50% over the occupation of the site. There is a general decline in the quantity of large mammals in the deposit. This shows a general decline in the quantity of large and medium-sized mammals. The relative percentages composition of each fauna type has been calculated for the period studied (c. 5000 BC - 200 BC). In Phase A, medium-sized mammals (e.g., Mammals and Fungi) were more abundant in a size range. Large mammals (e.g., elephants and rhinos) could not be identified to species were abundant in a size range. As with other sites excavated in this province, bones were recovered. A total of 496 parts (includes both recent and ancient species) with 32.8% of the total.
Figure 7.26: The percentage abundance of bone by fauna type in Bandangala 1 TP1, Musselbrook Creek, northwest Queensland.

The frequency of bone fragments for Bandangala 1 TP1 indicates a high accumulation rate in spits 7, 8 and 9 (n=974 in spit 8), a constant rate (between 200 - 400 fragments) for most other spits, and very low frequencies for spit 17 and below. This data is expressed as weight per cubic metre of sediment (Figure 7.27).

Figure 7.27: Changes in abundance of vertebrate fauna weight by spit/m³ in Bandangala 1 TP1, Musselbrook Creek, northwest Queensland.
Chapter 7 Northern Study Area

30

from Bandana, I. I. displays a steady change in most ambient species through time. In some
that in their focus on producing expedient tools, the thick, stone assemblage
southern sites. The flaking techniques are consistent with other sites of similar
Bandana I show diversity in stone raw materials that are not present in the more
the agro-industry curve and has been regularly visited until recent times. The assemblage
in the Bandana I deposit. Bandana I was first occupied c. 13,000 14C BP (based on

The assemblage is likely consistent trends in the discard of both flaked stone and flaked material.

Summary

Figure 7.28: Frequency of mussel shell expressed as #/m² by spit for Bandana, I. I.1

and natural occurrence at the result of scours and flooding events in Musselbrook Creek. The
younger L. m. sediments (Figure 7.28). Possible mechanisms include human discarded
the Linnaeus shelf. The Linnaeus shelf is very high in the species, and the Linnaeus shelf is very
and low numbers of other mollusca, crustacea, and fish (pecten and
The inventories from Bandana I consists of freshwater mussels /Muscus pontinus

Intertidal Flora
rates, raw material diversity, retouch, diversity of platform types and the occurrence of overhang removal all increase in relative frequency through time. Analysis of the flaked stone assemblage shows that during phase C the site was more intensively utilised than at any other times. Between 5,500 and 2,000 Cal BP the rates of fragmentation relative to sedimentation are also far greater than during any other phase. This phase also features the highest rates of discard, variation in the extent of reduction and raw material richness. This period also corresponds with the highest frequency of faunal discard and an apparent change from large mammal to small mammal consumption.

The composition of the flaked stone assemblage indicates that the population which inhabited the Bandangala area within Musselbrook Gorge had a relatively localised subsistence system, exploiting nearby resources until the conclusion of the mid-Holocene El-Nino period of enhanced aridity. After this time the Bandangala 1 site was visited more intensively, and features lithic raw materials from more distant sources plus greater levels of reduction. This is interpreted as an expansion in foraging area and changes in stone procurement strategies.

Over the last 2,000 years sediments have been scoured by flooding followed by further sediment accumulation, which has created the Unit B sediments. Sediment accumulation is also evident at raised levees associated with freshwater creeks running into the Musselbrook Creek sandstone gorge. The rapid build up of sediment during the late Holocene has been most likely associated with increased local precipitation after the extreme El Niño/Southern Oscillation (ENSO) cycles of the mid to late Holocene in northern Australia which diminished around 2,000 BP (Hope and Golson 1995; Kershaw 1995; McCarthy and Head 2001). Increased local rainfall led to seasonal inundation of Musselbrook Creek since c. 1,000 BP (see Schulmeister and Lees 1992). It is likely that flooding has resulted in rapid sediment deposition in levees along the creeks in all local

Chapter 7  Northern Study Area
Chapter 7: Northern Study Area

The woodland community extending to the north...

500 m in length. As such, there is a gradual absence of thalific and riparian vegetation.

ALT. B37' During the dry season the creek is reduced to a series of waterholes each up to
seasonal but extensive creek and during the wet season it is about 50 m wide near to
nearby, woodland extends up to a distance of 400 m from the site. Elizabeth Creek is a
precau decided of any vegetation located directly behind the site. Mossed book Creek is
suitcases suitable for art. and these art sites are known within 50 m of ALT. B37.

The area would meet passing here. The site is located near the small sandstone
stacks that overlook the side of the hill. Some of these stacks remain high. The sandstone
rocksheier occurs approximately 500 m from the permanent water of Elizabeth Creek.
Elizabeth Creek is located in a group of sandstone outcrops that forms part of an
ALT. B37

ALT. B37

Elizabeth Creek

7.4.1. ALT. B37

7.4. Elizabeth Creek

site decreased.

Larger permanent water supplies became available and subsequent use of the Bandana.

This area may have followed the alteration of ENSO conditions after 1950. A recognition of
sandstone forces as seen at Bandana a. A recognition of Aboriginal settlement of
Figure 7.29: Location of AL:37, Elizabeth Creek, northwest Queensland. A. shows the general location of the area marked as b. B. details the location of AL:B37 and its relationship to local patch types.

Site Description

AL:B37 is a small rockshelter formed on the eastern side of one of the sandstone mesa. The dripline of the shelter is about 10 m above ground surface and the wall of the shelter is comprised of near vertical flat sandstone. The AL:B37 site features the second largest panel of rock art known for the region, and the most complicated array of motifs and techniques. Art covers an area approximately 8 m long and 3 m high, and consists mostly of freehand paintings including bichrome rainbow designs in red and yellow, and monochrome figurative images that have been described as various objects (crocodiles, people, and coolomons) (see Border 1989).
Figure 7.24: AL-B37 site in the background and local vegetation, Elizabeth Creek, northwestern Queensland.

Figure 7.25: AL-B37 with Richard Buckingham holding a scale in front of the extensive rock art panel, Elizabeth Creek, northwestern Queensland.
Excavations

In 2003 a 50 cm x 50 cm test pit was excavated in a position near to the northern end of the shelter (Figure 7.32). The site was excavated in 5 cm spits through unconsolidated sandy sediment to weathered bedrock c. 30 cm below the surface. Further excavation of a remaining section of the trench reached a maximum depth of 50 cm. All excavated sediments were weighed, sieved and sorted on site. Analysis of lithic material was completed at the University of Sydney.

Figure 7.32: AL:B37 rockshelter showing location of test pit and extent of the rock art panel, Elizabeth Creek, northwest Queensland.

Stratigraphy

Two stratigraphic units were identified at AL:B37: Unit A (8 – 30 cm) is comprised of fine sandy orange/red sediment with very few finds recorded in situ. Unit B sediments (0 – 8 cm) consist of carbon rich grey/black sediment (Figure 7.33).
Table 7.3: Radiocarbon determinations for AL-B37, Elizabeth Creek, northeastern Queensland.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age (cal BP)</th>
<th>Date (14C)</th>
<th>Determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>OZH611</td>
<td>2000 yrs ago</td>
<td>3.95 mCal</td>
<td>charcoal</td>
</tr>
<tr>
<td>OZH610</td>
<td>2500 yrs ago</td>
<td>3.95 mCal</td>
<td>charcoal</td>
</tr>
<tr>
<td>OZH609</td>
<td>2750 yrs ago</td>
<td>3.95 mCal</td>
<td>charcoal</td>
</tr>
</tbody>
</table>

The table shows radiocarbon determinations for AL-B37, Elizabeth Creek, northeastern Queensland, with ages ranging from 2000 to 2750 years ago. The samples include charcoal, indicating a terrestrial origin.

Figure 7.33: Section profile of the AL-B37 test pit, Elizabeth Creek, northeastern Queensland.

The figure illustrates the stratigraphy of the site, showing different layers of sediment, including charcoal and stone. The section drawing highlights the various components found at the site, such as fine sandy, wet buried, and charcoal deposits.
Cultural Material

A total of 25 flaked stone artefacts, a surface find of one grindstone, 18 g of fragmented mussel shell, and 2.2 g of unidentified bone were recovered from AL:B37. The shell, bone and ochre-like material, charcoal and other organic material were recovered from the Unit B sediments. Unit A yielded only flaked stone artefacts.

The flaked stone assemblage consists of 25 artefacts (MNA). Eighty eight percent of this was comprised of unmodified flakes. Two amorphous retouched flakes were recovered from spit 2 (Unit B) and one chert core from in spit 4. The assemblage is primarily comprised of small quartz flakes (n=13) spread throughout Unit A with smaller numbers of chert (n=7), quartzite (n=4) clustering in Unit B (spit 2) (Table 7.24).

<table>
<thead>
<tr>
<th>Spit</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>retouched flakes</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>flakes (mnf)</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Table 7.24: Flaked stone assemblage of AL:B37 TP1, Elizabeth Creek, northwest Queensland.

Summary

The AL:B37 assemblage suggests only recent infrequent and transient visits to this site. During initial visits from about 1, 800 years ago lithic discard is comprised of only very small local quartz flakes. High frequencies of charcoal and higher rates of lithic and faunal remains found in the upper Unit B sediments represent the main occupation of the site.
like all other Elizabeth Creek were periodically visited. Dog dunging were occupied, and eventually even the more marginal patches where sites occupation of Mushroom Creek increased but with greater mobility, sites including Wild further reconnaissance in the northern settlement system occurred. The intensity of activity on similar mammals and likewise resources.

occupied at Bandana 2, people constructed their foraging range and diet breadth by occupying a period between 2,000 and 5,000 CAL BP. A contraction in subsistence material, different artifact types, and acquiring a range of fauna. However, with the onset of settlement in the area with a variety of stone implements initially on the most substantial of the northern wetlands, Mushroom Creek appears to have occupied a period of abandonment c. 17,000 BP. Settlement appears to have reoccurred following a period of abandonment c. 13,000 CAL BP. By this time Law Hill had also been occupied and the remainder of the northern region does not appear to have been settled until the 18th century. The southern region was the first occupied by the Law Hill Law Hill Hill areas of the research region. This northern region features a different settlement and subsistence strategy than was the case for the southern areas. While Law Hill was first occupied sometimes prior to 18,000 years ago, the southern areas of the research region were not occupied by Law Hill until the 18th century. This chapter has discussed the results of the excavations in the excavation program that created these within the shelter and most likely produced the excavations rock art panels.

People visiting the site during this phase brought more distinct new materials with them, earlier (quartzite). The formation of the radiocarbon chronology is required to confirm this, further refinement of the radiocarbon chronology is required to confirm this, possibly.
The results of the excavations and analysis for these northern sites support the differential patch model presented earlier. It is clear that different strategies of settlement, resource procurement and technology occurred in the north compared to the south. This is considered to be primarily a product of variability in climate, causing uncertain rainfall, combined with a hydrology that is much less stable and does not support large free-standing pools of water (as the south does), thereby limiting the potential for aggregations of population.
Chapter 8 Discussion and Conclusion

Australia: the Goul Plan and the Deadly Labyrinth. At Riverleigh and Lawn Hill this
issue are illustrated by the junction of the two primary geomorphic units of northern
Gregory River, Lawn Hill Creek and Musshoek Creek. Within the studio area these
The Riverleigh/Lawn Hill project was focused on three of the largest regional stream: the
and would have provided a focus for human subsistence activities in the region.
Economic resources defining around these areas, in the woodlands and upland
which have shown at the same rate as today even during the height of the LGM.
environments in a series of permanent water courses, some of which are sparser red
hills, savannah woodlands, spinifex plains and large rock outcrops. Though these
The Gulf of Carpentaria has a diverse array of and semi-arid landscapes extensive salt
8.1.1 Resources
the climate changes of the last 40,000 years.
models, (ii) the known constraints and constraints of the research area (resources); and (iii)
Lawn Hill region is based on three sources: (i) the functional predictions of the HBE
information. The following model of settlement and subsistence for the Riverleigh and
the theoretical framework of chapters 4 and 5 this chapter discusses the implications of this
Gulf of Carpentaria region and Australian Prehistory. Using this data in combination with
The Riverleigh and Lawn Hill data has provided a rich record of human occupation of the
8.1 A Model of Settlement and subsistence for Riverleigh and Lawn Hill

Riverleigh/Lawn Hill Region, Northern Australia.
Evolutionary Anthropology and Aboriginal Prehistory in the
Between the Desert and the Gulf
junction has created extensive gorges containing numerous economically important resources. As such, settlement and subsistence strategies at Riversleigh and Lawn Hill are closely linked to the location of critical resources in the landscape and the structure of sites. These resources include permanent water, stone sources, and natural shelter.

(i) Distance to permanent water

Distance to permanent water has often been invoked as a primary constraint to human settlement (cf. Allen 1972; Gould 1977; Hiscock 1988; Smith 1988; Veth 1993), though in some cases the importance of this resource is arguably over-emphasized at the expense of other explanations for site location and structure (cf. Thorley 1998a). However, within the Riversleigh and Lawn Hill region the location of permanent and semi-permanent water is well mapped, and effectively mirrors the spatial patterning of hunter-gatherer occupation and subsistence activities. All of the major watercourses in the research area have remained relatively stable in their course and flow over the last 40,000 years. The only interruption to water flow has been the possible reduced flow of northern rivers and areas on the eastern plains during periods of increased aridity, seasonal discharges, and temporary tufa dam formations.

All sites of greater than 10,000 years BP that are known from this region have a close association with water and none are more than 2 km from the nearest river. All but one site (Gamanyi) are within 1 km of a permanent water source. When undated surface lithic assemblages are added to the database, over 80% of all sites are within 2 km of permanent water.

(ii) Distance from Knappable Stone Sources

The location of stone raw material sources is highly predictable for the research region. Chert is known to occur as cobbles in river and creek banks, and in limestone outcrops in

Chapter 8 Discussion and Conclusion
Approach to the archaeological record

Research region presented good potential for exploring the application of the HB

The configuration of water, stone sources and shelter in the riverside and Iowan Hill

occupation, though may have witnessed periodic visits.

in ceiling height. Many other shelters of similar dimensions have no visible signs of
rock art. Mosel sites with occupation deposits are over 10 m. in door area and at least 1.5 in
rockshelters display evidence of occupation in the form of lithic material, middens, and
little scatters and rock art (Hodder 1999, Hiscok 1989). Within the study area numerous
isolated mesa within the plains environment, and show signs of occupation in the Form of
limestone and sandstone gorges of the major water courses. Some shelters also occur on
Rockshelters occur primarily in the western area of the research region, within the

Along these streams may have had shelters associated with them.

Along these streams may have had shelters associated with them. Rockshelters and rock art
scatters which are found within woodland and limestone patches

observation (cf. Cresswell 1983), these areas generally not preserved in the archaeological

gatherers also used temporary shelters made from plant materials, as noted in ethnographic

Natural shelter includes rockshelters and caves. Although it is very likely that hunter-

investigations the dominant raw material used for made stone manucaeture is chert.

eastern plains, whereas shelter and guartile are more variable in their occurrence. All sites

the western and southern riverbank plains area. Eroded rock features as exposures on the
8.1.2 Site Location and Settlement at Riversleigh and Lawn Hill through time

In addition to the critical resources, settlement and subsistence has also been determined by the location and frequency of economic resources. The relationship between food and essential resources (i.e. water) has varied over the last 40,000 years, due primarily to climatic changes.

Occupation Periods

There are six climatic phases in the model of settlement and subsistence for Riversleigh and Lawn Hill (phases A - F). Phase A covers the initial settlement period of the region between c. 50,000 and 30,000 Cal BP. Phase B includes the period of climatic deterioration known as OIS2/the Last Glacial Maximum (LGM), between 30,000 and 18,000 Cal BP (see Lambeck and Chappell 2001). Phase C occurs between 18,000 and 10,000 BP, marking the final stages of the Pleistocene epoch when climatic conditions improved, though were still variable. Phase D, c. 10,000 - 5,500 Cal BP was warmer and wetter, roughly paralleling the modern day regional climate. Phase D features short periods of climatic instability - the Younger Dryas cold period at c. 10,300 BP and climatic flux associated with the El Nino southern oscillation (ENSO) c. 5,500 Cal BP. Phase E covers the enhanced El Nino arid period between 5,500 and 2,000 - 1,500 Cal BP, which was characterised by extensive arid/drought periods. Phase F comprises the recent past between 2,000 Cal BP and the present. For each of these different phases the nature of site location and settlement within the research region shows distinct patterning.

All of the sites presented in this thesis were dated by radiocarbon determinations on shell or charcoal. Chronologies were established using age-depth curves coupled with geomorphic and stratigraphic data. A summary graph of the chronology of occupation for
Chapter 8: Discussion and Conclusion

During this phase, occupation evidence for the Creek (CREE) rockshelter deposit at Kneesley is represented by the City of Lawrence region. The Australian mainland was joined to New Guinea, and the Gulf of Carpentaria was a permanent waterway. As a result, the major research areas of the research region had grown significantly. While the major research areas of the research region had grown significantly, and the Gulf of Carpentaria was a permanent waterway, the climate of the research region was similar to the climate of the initial occupation phases. During the initial occupation phases, the climate of the research region was similar to that of today, although perhaps a little wetter (Lambeth 2002; Lambeth and Chapdel 2001).

Based on calibrated C14 dates and remaining climate phases, the graphic below illustrates the chronological and spatial relationships within the Kneesley/Lawrence region.
GRE8 comprises c. 80 flaked stone artefacts only. The lithic assemblage suggests that the site, and probably the wider Gregory River valley, featured a very low intensity of occupation. It is possible that the regional occupation included the northern river corridor of Lawn Hill Creek as the Unit A sediments (undated sediments below the site lag surface) at Colless Creek Cave are likely to span this period (Hiscock 1988).

The artefact assemblage during this phase at GRE8 consists primarily of locally available chert with marked variability in artefact size and weight. Perhaps founding populations, with little local knowledge were testing raw material properties and flaking characteristics, and occupation of the area was marked by infrequent visitation.

**Phase B: Last Glacial Maximum (c. 30,000 – 18,000 Cal BP)**

Between 30,000 and 18,000 Cal BP a period of sustained reduced temperatures and precipitation occurred. Low precipitation and consequent widespread aridity reduced the size of Lake Carpentaria, reduced river flows and limited the likelihood of any presence of ephemeral water. Severe droughts, high winds, and dust storms were common events in northwest Queensland over this period. The effect on the local environments in the study area would have been severe. Patch productivity and grain would have decreased substantially, and the low value grassland and spinifex patches expanded dramatically.

As with phase A, the LGM phase is represented by the ongoing occupation of GRE8, Riversleigh. At Lawn Hill, it appears that Colless Creek was abandoned sometime during either the previous phase or during the LGM as evidenced by the lag deposit recorded between Units A and B (Hiscock and Hughes 1984:12). Unlike Lawn Hill, the Gregory River corridor continued to provide a focus for settlement. While the area near Colless Creek Cave may have been occupied during this time, there is no archaeological evidence.
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In time required to harvest the resource became necessary in order to maintain a presence risk. The relative ranking of muskellunge was raised to a position where increased harvests of
the recognition of habitat required in particular food resources and increased forage. Plains grasslands and
shrub communities would have expanded to replace woodlands. Pines, grasslands, and shrub
composites and possibly disappeared from some areas. The loss productive block of
have contracted and possibly disappeared from some areas. On the Green River, woodlands
been reduced in number, size, and diversity. With climate change occurring during the LCM, the more productive
patches would have

In response to the increased forage uncertainty associated with the LCM,
include the resource may have been negated by increased produce of the local area and
results of harvesting and processing initiatives. The expansion of hunter gatherer diet breadth in
order to achieve a scalable return, muskellunge necessitates significant investments in
participants implies an expansion of diet breadth to include a resource food of lower rank. In
participants obtained from the local living patch of the Green River. The change in discard
obtained from the local living patch of the Green River. The wild range of terrestrial plants known from
condensed change in hunting exploration. The wide range of terrestrial plants known from
the same time that the hunting techniques tended towards conservation, there is a

Harves Learning overwhelming removal and density of resources was

Highly reduced, as evidenced by the relative abundance of stone with little or no coarse, and
significantly smaller. The assemblage is dominated by the locally obtained river chert and is
LCM phase, contrasting with the pre-LCM when the average size of artefacts was
AGREEs the lack of stone assemblage is consistent in both weight and size for the entire
was abandoned during the peak of Glacial activity.

In support and is considered far more likely that the central area of the research region
in this landscape. In phase B and C mussels became a feature of a specialized resource base.

*Phase C: Climatic Amelioration during the Late Pleistocene (18,000–10,000 Cal BP)*

Phase C is marked by irregular improvements in climate. Average temperatures and rainfall gradually increased following glacial melting and flooding of the continental shelf. The Arafura Plain was quickly inundated around 10,000 Cal BP, changing the environment around the coast dramatically (Torgersen 1988). Within the research region the riverine fringing vegetation recolonised grassland areas, with resulting improvements in patch richness.

The first evidence for human occupation appears along the most substantial of the permanent watercourses. Along the Gregory River the GRE8 site continued to be visited and the accumulation at OLH midden began c. 15,000 Cal BP. Other middens, not yet identified, may have also been created at this time. In the central Lawn Hill area both Colless Creek and Louie Creek caves were occupied, and in the north of the study area the Bandangala 1 site at Musselbrook Creek was visited from about 13,000 years ago.

*Occupation of the Gregory River*

At GRE8 changes in the faunal and lithic records indicate transformations in subsistence strategies during phase C. In the lower spits which correlate to phase C, discard of mussel shell peaks before decreasing in the later phases. It is most likely that this indicates a focus on riverine resources and specialization on mussels during and immediately following the height of the LGM around 18,000 to 16,000 Cal BP. After this point discard of mussel shells decreases substantially and small mammal bone frequencies increase. There appears to be a shift in resource acquisition from riverine to a wider, more general focus. Smaller mammals increased in dietary importance, and effectively pushed the profitability of mussel

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of the previous phase, and indicates greater levels of stone reduction. Phases also feature production of triangular flake tools. The OTH assemblage also contains a variety of stone raw materials including grounds, cores, and a large number of backed blades. The OTH is an abundance of cores at varying stages of production within a large assemblage of flaked stone artifacts. These were used for both manufacturing and use of stone tools. The OTH indicates that the site was used for both the manufacturing and use of stone tools.

The associated stream areas also provided easy access to the favored channel over cobbles watered at these locations with floating ideal habitats for Macropus phascalus. The dams provided access to large fish resources and to small mammals that moved past the associated with fish moving streams, while providing crossing places and controls large and extensive areas than become micro-archaeological. The OTH dams created large slow flows which are not surprising as the enhanced rainfall led to expansion of the meandering of the Creek for several years. The OTH midden is almost one mussel shells from the Creek for 16,000 CAL BP. The OTH midden is almost one mussel shells from the Creek for 16,000 CAL BP. The OTH midden is almost one
smaller platforms and are more elongated. Chert continues to dominate the assemblage however raw material richness increases to include greywacke, quartzite and silcrete. Other trends in flaked stone reduction include higher frequency of flakes with dorsal cortex and greater occurrences of aberrant terminations. The increase in discard rates, coupled with a reduction in flake size, are most likely the result of more intense reduction of cores and retouched flakes during this time. Rather than increased reduction being a response to higher levels of risk, which one might expect, the trend at GRE8 appears to be the result of changes in subsistence strategies. In effect, a wetter climate and larger and finer grained profitable patches, led to changes in lithic reduction where artefacts were more reduced than previously, perhaps in the manufacture of hafted points to support hunting. The high discard rate of small flakes, elongate flakes and the high incidence of aberrant terminations all suggest point production. Direct evidence for point production is rare in any excavated site in the region, however the first unifacial point in the GRE8 assemblage occurs between 5,500 and 10,000 Cal BP during phase D (in Spit 4). Points have rarely been found in any site that is considered a residential base, and it is likely that they were discarded when broken or when reaching the end of their use - life.

Early point production at GRE8 is further supported in the occurrence of retouched flakes from approximately 14,000 Cal BP. These retouched flakes include amorphous retouched and notched flakes, and formal backed artefacts with evidence of hafting. The first example of grindstone technology also occurs in this phase at about 13,000 Cal BP.

The intensity of human occupation at GRE8 appears to increase substantially during phase C with a greatly increased rate of transverse flake breakage and increased sediment accumulation. During this period it is likely that shelters were used on a seasonal basis with significant changes in the demography of the river corridor after the LGM.

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extends beyond the excavated trench and may ultimately yield a longer cultural sequence.

Muskellooke Creek was occupied from about 13,000 cal. BP. The deposit at Bandana Site 1
the excavations at the Bandana Site have shown that the northern lower corridor of

Occupation of Muskellooke Creek

and larger flakes (Fischbein 1983).

of and controlled, as evidenced by lower absolute concentrations, greater platform sizes
forehead and controlled, as evidenced by lower absolute concentrations, greater platform sizes
larger than those at other phases and much larger than those at CRF-146. Knapping was
knapping was

cobble sources were favored, reduction sequences here different from CRF-8. Flakes are
reduced in the post-LGM period, compared with succeeding phases. Although they are
reduced in the post-LGM period, compared with succeeding phases. Although they are

Unlike the CRF-8 assemblage, the discarded flakes found at Lavan Hill is not as heavily

BP.

also suggests that the intensity of occupation was greater between 13,000 and 15,000 cal.
The degree of flaking indicated by artefact breakage at Colless and Lavan Creek
prey species. These changes are documented in both Colless Creek and Lavan Creek cases.
difference in a broader resource base expressed as a replacement of muskellunge by higher ranked
about 700 m away at the junction of the two creeks. After c. 13,000 cal. BP there is a
is a small tributary of Lavan Hill Creek and it is more likely that these resources came from
there was a strong reliance on forage resources including muskellunge and fish. Colless Creek
River. During the first thousand years of the post-LGM phase at Colless Creek there
income foods, including similar acquisition strategies to those seen along the Oregon
conclusion of the LGM. Trends in local resource exploitation coincide with a focus on
Al Colless Creek and Lavan Creek cases occupation sequences begin soon after the

Occupation of Lavan Hill
However, based on the levels of flaked stone discard, it is concluded that the creek area were first occupied after the LGM when Musselbrook Creek would have had a more regular and stable water flow. During this post-glacial phase there are very few stone artefacts at Bandangala 1, and it appears that occupation of the Musselbrook Creek area was intermittent and by small mobile groups.

**Phase D: The Early Holocene (10,000 – 5,500 Cal BP)**

The early Holocene was characterised by a wetter and warmer climate than the preceding phases (Gagan *et al.* 1994; Kershaw 1983, 1995; Kershaw and Nix 1989; McGloine *et al.* 1992; Nix and Kalma 1972). These climatic conditions facilitated an environmental recovery from the glacial contraction of vegetation and faunal habitats along the rivers of Riversleigh/Lawn Hill. Fringing riparian corridors and woodlands expanded with a corresponding increase in patch richness and grain.

Phase D is represented in the regional archaeological record by the rockshelter sites of GRE8 at the Gregory River, Colless Creek Cave and Louie Creek Cave at Lawn Hill Creek, and Bandangala 1 at Musselbrook Creek. It is also likely that numerous undated artefact scatters, consisting of very weathered artefacts, also date from this period (cf. Hiscock 1988).

During the early Holocene, use of all four rockshelter sites decreased as seen in a lower incidence of flaked stone artefacts and faunal remains. At GRE8 and Colless Creek Cave, the occurrence of mussel shells also decreases, corresponding with increases in discard of small and medium to large mammal remains. At both sites the general overall reduction in faunal material perhaps indicates less food was prepared and consumed in the caves.

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During this time, the archaeological evidence for human occupation in this region is limited. The mid-Holocene was characterized by a general trend to inhabit in northern Australia. Phase E3 (Flinian Mid-Holocene, 5,200–2,000 Cal BP).

Outcrops and lake water bodies are seen at the G3H middle (G. Hiscock 1988).

1. The abundance of recovered artefacts in all assemblages at this time, which can be interpreted as a function of limited collection or less reduction at specific cave locations. It is noted likely that the hand axes were more common in at least one assemblages from all sites and indicate less intrusive use of the immediate area.

2. Dispersal and higher raw material efficiency.

Further at the Bandungara site, the lack of assemblage lenses very high rates of non-local stone artefacts. Non-local stone artefacts account for up to 40% of the assemblage at these sites during this phase. From the use of local chert over cobbles to ground chert, which was available nearby. There is also a slight increase in local platforms combined with a low incidence of cores. There are also a slightphysically smaller assemblages with a further reduction in the use of hammers and a correlate.

At CREE the lack of assemblage contains fewer artefacts. There is a continuation of
to GRE8, Wild Dog Dreaming (at Lawn Hill), and Bandangala 1 (Musselbrook Creek). At GRE8, stone artefact reduction becomes more conservative with features similar to the phase B (the LGM) assemblage. These include a reduction in raw material richness, general reductions in flake size and a trend towards elongation. Flakes are generally without cortex, feature the greatest percentage of overhang removal and the smallest platforms.

At Lawn Hill, Colless Creek and Louie Creek caves appear to have been abandoned during this phase. However, open middens within the gorge system such as Wild Dog Dreaming (WDD) support the notion of a second arid phase driving a focus on riverine resources and reduction in foraging range. At WDD occupation begins c. 2,700 Cal BP. If the associated flaked stone scatters are of a similar age then foragers were firmly focused on local resources including artefact manufacture similar to at Colless Creek Cave during the post LGM phase at about 16,000 Cal BP.

At GRE8 the ‘arid phase’ is coincident with the highest occurrence of transverse breakage of stone flakes, indicating an increase in occupation frequency from phase D. There is also a further increase in small mammal remains. At Bandangala 1 sediment accumulation is reduced compared to other phases, though the rates of transverse flake breakage are high, indicating more intensive occupation. There is a similar trend towards more elongate flakes as seen at GRE8. At both sites there is also a notable rise in the frequency of backing retouch.

The flaked stone assemblages at both sites indicate conservative use of raw materials and a focus on local resources within gorge riverine patches. These trends in flaked stone manufacture support the risk-sensitive models such as that proposed by Hiscock and Attenbrow (2002). They suggest that during the El Nino period of increased aridity

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which includes shell, and a range of large and medium mammals. The presence of central
features a clear assemblage in the series of reduction and a micaceous sandstone and
brownstone with an assemblage consisting of several hundred pieces of stone, bone, and shell.

The site, which is located at the intersection of the Tonopah Plaine and Basin and Range, and
in the larger valley courses, following the abandonment of the Hohokam area. Similarly, the CRF13
 locality was a productive patch during periods of cheer flow as groups navigated between the
localities. This site is a small shelter on an ephemeral creek. The relative abundance of shell, bone,
and artifacts indicates that the Verde Creek

When most recent occupation phases features a semi-arid monsoon climate, as seen today.

**Phase A: The mosaic period (2000 BP - Present)**

One means of increasing tool utility and efficiency, achieving on small flakes for use as blades or composite projectile weapons is suggested as

Technologies that reduced foreign uncertainty, in particular, the proliferation of backing
foragers responded to increased foreign uncertainty with a corresponding proliferation of
material and the dominance of lower limbs and ribs indicates that animals were transported to this location following capture. Finally at the large cave complex of Gamanyi, there is evidence of Aboriginal occupation within and outside the cave, dating from at least 1,000 Cal BP.

A second new area with occupation during phase E is Elizabeth Creek. At AL:B37 a few flaked stone artefacts and a dense layer of charcoal are dated to the very recent past. If the production of art at this site is coincident with the age of the deposit (i.e. 147 Cal BP), it provides a recent minimum age for the art style described as freehand figurative. The art at AL:B37 includes yellow arched motifs that are also present at 15 other known art sites, including Bandangala 1 and Wild Dog Dreaming. This regional art style may signify a continuity of the present linguistic group over the entire northern half of the research region. The absence of similar motifs in the south is considered to be primarily the function of a different geology that does not facilitate the production of art. At Bandangala 1 there is a good likelihood that occupation of the site also continued to this recent period. Unfortunately evidence for recent occupation has been scoured away by recent flooding.

Undated surface assemblages occur in all environmental zones across the research region, although they are rare and spatially limited on the limestone plateau and grassland plains. As with Hiscock's 1988 surveys, the current research found that areas near to permanent water and quarry sites more frequently contained sites than those farther away. Areas closest to quarries (including the chert river cobbles located along river courses), contained the highest frequency of flaked stone artefacts. Hiscock reported that over 80% of all sites in the Lawn Hill area were situated within 3 km of stone sources, or within 3 km of permanent water, and 100% of sites were within 3 km of either water or a quarry (Hiscock 1988:81-88).

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commenced sometime before 37,000 Cal BP. Age-depth curves indicate that the lower
1994; Thorne et al. 1999). The occupation of GEE and the Gregory River corridor
short c. 45,000 year chronology (Alverson and O’connell 2004, Gellerey and
prehistory. There are two competing arguments: a long > 60,000-year occupation on a
prehistory; The timing of early human entry into Australia continues to be a key question for Australia

8.2.1 Archaeological models revisited

Anthropological models revised

phase most of the rock art within the study area was created
distance to permanent water and some sources. It is also more likely that during this recent
major river systems. During this period the location was strongly correlated with
The most recent phase of Aboriginal occupation within the research region encompassed
are also related to the availability of seasonal water and shelter,
which also have their greatest concentrations (Hiscock 1988). Undated surface assemblages
a combination of productivity and hunter-gatherer preference for well-vegetated areas,
River, because higher frequencies of flaked stone discard and this appears to be the result of
discard. Areas on levee banks, e.g., Wind Dog Dreaming, Dangadina, and along the Cregrwy
within the woodland patches on the river Corridors have different roles of which
stream areas and would have lower levels of mobility.
location (as areas along the side of large waterholes were more productive than shallower
within these patches residental mobility would have fluctuated, based on the particular
patches were always exclusively utilised by low residential mobility outside of these areas.
expected that residential locations within the most productive woodland and riparian
areas near perennial water were used as central places within a foraging range. It is
artefacts in GRE8 are possibly 45,000 Cal BP. However, caution must be observed as these artefacts comprise a small assemblage and co-occur with a limestone rubble matrix, and may derive from slightly younger sediments. The occupation of GRE8 from about 40,000 Cal BP provides the first conclusive evidence for early occupation in this part of Australia, and compares in age with Ngarrabullgan to the east (David and Dagg 1997; David et al. 2007). Importantly the archaeology of the Gregory River corridor provides insights into the possible routes by which people entered Australia and perhaps the arid zone.

The timing of occupation at GRE8 and Ngarrabullgan offer compelling evidence that colonisation routes are consistent with Birdsell’s argument for a northern route into Australia through New Guinea (cf. Birdsell 1977). Colonisation pathways for the east of Australia would have followed two possible pathways: around the west of Lake Carpentaria or down the east coast. Arrival via the edge of Lake Carpentaria at about 45,000 Cal BP would have followed major rivers and associated fine grain patches. Upon reaching the southern extent of Lake Carpentaria the main drainage systems provided access inland. The most significant of these rivers are in the southern Gulf and include the Nicholson, Gregory, and Leichhardt. It is along these three rivers and their tributaries within gorges that the archaeological signature is greatest.
Australia, including the Puritjara/Kupi Mara region.

the Lake Eyre Basin and would have provided direct contact with inland and southern

The Coonongana River near present-day Coooonawrel. The Coonongana River is a part of

the region. Curious were only separated by a 30 km of poorer less watered country, from the head of

Curious were only separated by a 30 km of poorer less watered country, from the head of

provides support for Yeh's corridor settlement model. People living in the Coonongana River

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settlement (Hiscook and Williams 2005). However, the early occupation of the Coonongana River

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The settlement of the and interior is another important issue in Australian prehistory.
8.2.2 Occupation during the Last Glacial Maximum

The last 20 years in Australian archaeology has been dominated by arguments that most of inland and Northern Australia was abandoned during the height of the Last Glacial Maximum (Hiscock 1988; Smith 1988, 1989, 2006; Veth 1989, 1993). General consensus has been that the interior of the continent became too arid to sustain a human presence and that people retreated to other more temperate areas until conditions improved (but see Smith 1988, 1996, 2006). The bio-geographic model developed by Veth posits that during the Last Glacial Maximum humans retreated to what have been variously referred to as 'refuges' or 'oases' (see Veth 1993; Hiscock 1988).

The search for archaeological sites that provide evidence of 'refuge' occupation has targeted likely geographic zones (see Marwick 2002; Veitch et al. 2005; O'Connor and Veth 2005). However, the evidence for any archaeological LGM refuges is still sparse and requires more data. Three regions of northern Australia have been claimed to provide evidence for refuge occupation; the Hamersley Plateau, the Carpenter’s Gap area of the Kimberley’s, and Lawn Hill. Evidence for Pleistocene occupation of the Hamersley Plateau is at present inconclusive. Until detailed chronologies, lithic assemblages and new excavations are reported, a refuge region cannot be supported. At Carpenter’s Gap, occupation during the LGM has only recently been claimed (O’Connor and Veth 2005). This is reliant on a combination of site data, including a mix of site chronologies and lithic assemblages which at present is inconclusive. Finally, refuge occupation has previously been argued for the Lawn Hill area (Hiscock 1988). Lawn Hill was occupied before and after the height of the LGM, but there is more evidence for abandonment of this area during the LGM than for it being a refuge. Hiscock has only ever claimed that the Colless Creek cave provides evidence of occupation post-LGM (Hiscock 1988).
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In contrast to earlier occupation that focused on sites located in the valleys of the river, there is no evidence of any permanent occupation of the region during the LGM. Resource procurement strategies that involved exploitation of raw materials were observed and used. However, no other evidence for the occupation of the region during the LGM has been found. When considering the number of occupied locations in the region during the LGM, it is likely that GREEs was one of the most prominent and successful. As a result, human occupation persisted during the LGM, as recorded in the archaeological record. 

People were located much further away, 

I take (Capricornia) of (my) vision in to the sea was very significant, to the east near the LGM and that basin. The area was a large region and that regional basin was observed in three ways. After Hiscock (1988:227):

- The Gregor River occupied a small population occupied the Gregor River Gorge
- The Gregor River Gorge might be occupied in three ways
- A deposit of deposit approximately 20 cm of deposit. Consequent evidence of occupation at this site and period is represented within the GREE. This site is small, and a lengthy temporal period is represented within
with exploitation of a broader resource base. The increased aridity of the LGM resulted in a contraction of range to the 'refuge', i.e. the gorge sections of the Gregory River, with limited foraging ranges, and ultimately specialization in local lower ranked resources.

This refuge occupation persisted until c. 16,000 Cal BP, whereupon foragers became outwardly focused once again. With climatic amelioration foraging range expanded to include the eastern plains, new technologies were developed, a wider range of stone raw materials were exploited and overall residential mobility increased with re-occupation of Lawn Hill. It remains unresolved as to whether refuge occupation persisted, and if these changes occurred due to environmental changes or if new populations entered the region the way that the original colonists did.

Settlement re-configurations in the study area were definitely made possible by climatic amelioration post-LGM. Soon after Lawn Hill was re-settled, Musselbrook Creek was also visited. However, the nature of occupation in this northern part of the study region was more short term, variable and probably more seasonal than the occupation of the southern research area. Due to the ephemeral nature of Musselbrook and Elizabeth Creeks, the northern study area has never been as productive and resource rich as the south. While Riversleigh and Lawn Hill feature stable water flow and large freestanding pools created by tufa dams, the northern rivers are less stable. During more arid conditions, Musselbrook and Elizabeth Creeks are reduced to a series of billabongs with far lesser patch productivity than in the south. During periods of aridity, visitation of the northern area would likely have been short-term from residential bases south at Lawn Hill.

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The weightlessness of the HBE approach relies on the premise of the paleo-ecological and archaeological records, both for the region and more generally. The model is necessarily

explanations of behavior.

use, technology, and human exploitation to be identified, and related to functional

With these concepts relatively known for the region, this has allowed for changes in the

mapped, where the location of critical resources is known and are also relatively constant,

part choice and other breach models were developed within a landscape that has been well

hypotheses resulting and (m) final analyses is also readily applicable to HBE models. The

and testable: (n) the analysis of various stories repeatedly lead to new testable hypotheses

These are three primary strengths to the approach taken here: (i) the HBE model is simple

which HBE has been applied to the research area.

However, as with any theoretical approach these are strengths and weaknesses in the way in

excavation of archaeological sites in different places, locates and regions of the study area.

The HBE model developed for this study has been subject to extensive testing through the

way of explaining behavior, including that of the past.

behavior is driven by evolutionary mechanisms. HBE provides the only real theoretical

functional explanations of behavior, rather than historical contingency. As human

(9th and 10th centuries), it provides an interpretive framework that is based on

observe complexities in behavior that might not be apparent in the archaeological record

beyond the use of ethnoarchaeological analogies. (see Barton 2001:354). HBE also allows us to

archaeological record. Use of the various models of HBE allows archaeologists to move

which to model explanations of human behavior that are readily observable in the

The evolutionary approach used here provides a strong theoretical background upon

8.3 Evolutionary Models and Archaeology
based at this time on very coarse environmental data. Reconstructions of local environment are reliant on proxies for distant areas. It is hoped that future palaeoenvironmental research might target the study area and provide better scaled data. Detailed observations of foraging behaviour are also limited here by the coarseness of the archaeological record and problems of equifinality (see Cosgrove 2000:187-88). These problems are especially pertinent for northern Australia where deposits feature many thousands of years of occupation in just a few centimetres depth making it very challenging to undertake detailed appraisal of the HBE models more than generally. In addition, the practical challenges of the temporal and geographic spread of the suite of sites analysed has presented a further issue; for example OLH is a rapidly accumulating deposit spanning a few hundred years in c. 1m depth, whilst GRE8 spans 40,000 years and is c. 55cm in depth.

The second limitation of the HBE model approach to the research project has been in the relationship between the nature and extent of patches and habitats and the foraging model itself. The model focuses on a detailed level of local habitats, and the actual archaeological sampling was designed accordingly. However, rather than detailing specific relationships between sites and local patches in all instances, the results of this research have highlighted larger scale trends in regional land use (e.g. between the nature of patches in the north versus the south of the study area). It could be argued that it is only the significant changes in subsistence manifested in shifts in stone technology and/or faunal exploitation that become evident in the archaeological record. These changes correlate to either significant or prolonged periods of climatic change, or to the local landscape scale of patches. Further testing of the propositions of the model is required. Excavations at other substantive rivers to the north, specifically along the Nicholson River, might address these issues.

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8.3.1 Optimal foraging theory

The archaeological records from Riversleigh and Lawn Hill provide compelling evidence for humans to have always aimed at achieving an optimum in diet by resource procurement, through strategies aimed at minimizing foraging uncertainty. The ways it was accomplished have included flexible settlement patterns, resource procurement and adaptive changes in lithic technology. At times these changes have been significant, for example during and immediately after the Last Glacial Maximum when a resource procurement strategy targeted a low ranking resource prior to developments in stone technology (coinciding with environmental changes) facilitated changes in diet breadth.

The HBM derived model predicts a mix of residential bases, short term camps and limited activity areas for different patch types in the research region. Residential bases were predicted to be in close proximity to permanent water, shelter and stone resources, and as such would focus on the gorge areas of the major rivers in the region. All gorges had the potential to show signs of occupation from or before the LGM. However, as the archaeological record shows, some gorges were not occupied until post-LGM climatic amelioration, and others were abandoned during the LGM. The Gregory River provided a focus for settlement since human arrival. The low resolution of occupation sequences allows broad temporal trends to be evaluated but precludes assessment of pre-seasonality, patch and travel thresholds relating to resource procurement. Observations based on mammal remains were explored to further understandings of occupation patterns but were unfortunately limited.

Short term camps were predicted to occur along seasonal and ephemeral watercourses in areas near stone sources, and this prediction is supported by the data. Short term camps were created during periods of high residential mobility and featured evidence of tool curating plus debitage and was related to maintenance of artefacts rather than their
production. At the Verdon Creek shelter, there is clear evidence for stone assemblages consistent with this expectation, though here there is also evidence of expedient reduction sequences such as backed artefact production. Short term camps in more marginal environments might have come unexpectedly very late in the regional archaeological record. However, interpretations of the recent past are benefit from better archaeological resolution than older phases. It is likely that short term camps occurred throughout the research region along seasonal watercourses during older periods of climatic stability.

8.3.2 Technological provisioning and stone artefact technology

The technological organization of flaked stone artefact manufacture can provide insights into the ways in which foragers structured activities and the strategies they used for resource procurement. Flaked stone artefact studies have shown that various forager performance characteristics including time budgeting, mobility constraints, design theory and utility can be examined archaeologically (Clarkson 2004:66). The nature of tool provisioning within the study area and whether it was a specific task or fitted in with other tasks, shows that time budgeting was not a strong limitation on foragers. Changes in mobility constraints are evident in the regional record and are directly related to regional climatic changes and localised environmental adjustments. For example during periods that featured greater logistical mobility, raw material richness increases correspondingly.

Investment in tool design and manufacture are usually expected during periods of increased diet breadth at times of increased risk that correlate to environmental and resource stress (see O'Connell and Hawkes 1984). As such, greater tool diversity would be expected during periods of resource or environmental stress as people modify procurement strategies to solve technological problems and enhance their ease of prey

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Historically, attempts to standardize tool kits did occur, but mainly during the Ice Age. However, recent studies have shown a focus on standardization, and changes in tool design have been noted. The existence of such behavior does not appear to be random or accidental, but rather a reflection of cultural and technological developments. The emergence of complex tool designs involved standardized production techniques, which appear to have been influenced by the availability of resources and the need for efficiency.

Changes in technological innovation and design are needed to address changes in utility increases, and may have reduced risk through composite weapon development and hunting.

The introduction of composite weapons allowed for higher utility in the form of more effective new technologies (e.g., points), and may have provided higher utility in the form of more effective new technologies (e.g., points), and may have.

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Pleistocene and mid Holocene. These periods involved the production of backed artefacts (flexible designs), points, and tulas and often feature evidence of hafting. During periods of greater logistical mobility there are a greater number of small tools indicating both portability and versatility.
Chapter 8: Discussion and Conclusion

In these ways the archaeological data presented here has provided important new insights into the prehistory of continental Australia. In these ways the archaeological data presented here has provided important new insights into the prehistory of continental Australia. The subsequent timing and pattern of occupation of the and zone colonization routes and the subsequent timing and pattern of occupation of the continent, the importance for our understanding of the process of human settlement of the continent, the Lewis and HBE approaches to prehistory has provided new data for northern Australia that is

of and settlement.

low ranked management. These results are consistent with Welsby (1993) bio-geographical model provided by the permanent rivers in the local fluvial areas; a refuge location, a refuge extreme climatic conditions. During the LGM a small population persisted in the refuge.

River: People remained in the Grampians River valley and surroundings during the most

the Grampians River valley and surroundings during the most

Chill. Before progressing inland along the major permanent rivers, such as the Grampians

of high yielding areas who targeted high ranking resources and followed the shores of the

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Chill of Cape 1000 by 40,000 BP. This evidence supports a northern colonization route

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The results here show that humans had colonized the inland region to the south of the

and colonization of forest-forming ranges, can all be correlated to fluctuations in environmental

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stages and the subsequent composition of faunal bone assemblages as well as expansion

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resource exploitation from dispersed to locally available resources, changes in reduction

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changes in local environmental conditions brought about by climate change. Show in

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40,000 BP. Re-configuration in human behaviour were found to be consistently related to

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humans have occupied the southerm and central parts of the research region from at least

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and decided reconsideration of two interpreted by Peter Hiscock (1988). It found that

This thesis has presented the results of excavations at eleven sites in northwestern Queensland

Conclusions
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