Aṟa Irititja Mituṉi

(*Tracking the Past*)

An investigation into Aboriginal occupation and resource use

Island Lagoon, South Australia.

By

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Master of Natural Resources (Ecosystem Management)

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Abstract

This thesis presents the results of an archaeological investigation of the distribution and character of archaeological sites in the landscape around Island Lagoon. This work has been undertaken in order to determine whether there is discernible pattern of social and economic activity or the use of a particular technology that might tell us specifically when Aboriginal people occupied Island Lagoon and how they utilised the natural resources in the region.

The Island Lagoon region is located in the south-west of Kokatha country and is a very significant place for Kokatha people. Island Lagoon also has significant mythological importance to Kokatha. The specific objective for this work was to attempt to determine where Island Lagoon fits in terms of settlement of the arid inland of Australia and whether sites around the lagoon can contribute further information that might help confirm settlement models that have been proposed for our desert regions. This work also uses Island Lagoon as a case study to explore the issues of Aboriginal response to the climatic variability and changing environments of the late Pleistocene and through the Holocene, in terms of inland settlement patterns, society, economies and resource use and technologies.

The research provided evidence that Kokatha ancestors primarily utilised the dune and lunette landsystems to the SW of Island Lagoon away from the immediate edge of the Lagoon. In those locations they had access to temporary water resources in the claypans and canegrass swamps provided by episodic rainfall events. Those sites were also close to good quality raw materials on the neighbouring silcrete plains. The sites were clearly workshop floors and were used to manufacture tools for later use. All surveyed and sampled sites consistently provided evidence of assemblages that reflect the Australian small tool culture of the mid to late Holocene, probably after 2,000 BP. The evidence gathered during this project indicated that all sites were probably used by Kokatha male ancestors to make toolkits that included scrapers and points, from the high quality silcrete, for hafting to hunt and to work wood.

Declaration

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

Signature

Date

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Foreword

The interest in, and motivation for, this project has come from two sources, my long-term association with the Kokatha, Antakirinja, Yangkunytjatjara and Pitjantjatjara people of the Western Desert and, my professional work in the Woomera region from around 1976. At that time, I was undertaking cultural heritage management work in my role as a manager for the National Parks and Wildlife Service and spent a lot of time in the Woomera region protecting sites within the Woomera prohibited area. It was common, at this time, for residents at Woomera, including American military personnel based there, to collect and sell Aboriginal artefacts from sites in the region. Many were illegally sold in the United States!

More recently (since 2004) I have been working on a number of Native Title projects in the Gawler Ranges, to the west of the Woomera and Island Lagoon area. Those projects include the preparation of Cultural Heritage Management plans for the Gawler Ranges and Lake Gairdner National Parks with the Native Title holders and also, a Property Management Plan for Lake Acraman. While undertaking field work for those projects with Kokatha representatives I located and surveyed a number of Holocene sites around Lake Acraman and Lake Gairdner (Vickery 2011 and Vickery and Jenkin 2014).

Through this process I developed a curiosity about when Aboriginal people first inhabited the area as well as an interest in how the Aboriginal people lived in this environment through the late Pleistocene and Holocene. The evidence for Aboriginal activity in the region usually includes surface artefact assemblages in deflated dune systems but occasionally, middens, hearths, quarries, art and engraving sites and burial sites.

Chapter 1: Introduction

This thesis presents the results of an archaeological investigation of the distribution and character of archaeological sites in the landscape around Island Lagoon in central South Australia. The research set out to characterise the nature of Aboriginal occupation of Island Lagoon and how this relates to prevailing models for settlement of the Australian arid zone. Of particular interest are issues of Aboriginal response to the climatic variability and changing environments of the late Pleistocene and through the Holocene, in terms of inland settlement patterns, society, economies and resource use and technologies.

The Island Lagoon region is located in the south-west of Kokatha country (Figure 1), and is of mythological importance to Kokatha people (R. Starkey, personal communications, May 11, 2015). Archaeological evidence, including the relative density and diversity of known sites around the Arcoona plateau immediately to the east of Island Lagoon, suggests that this area was a major node for regional settlement.

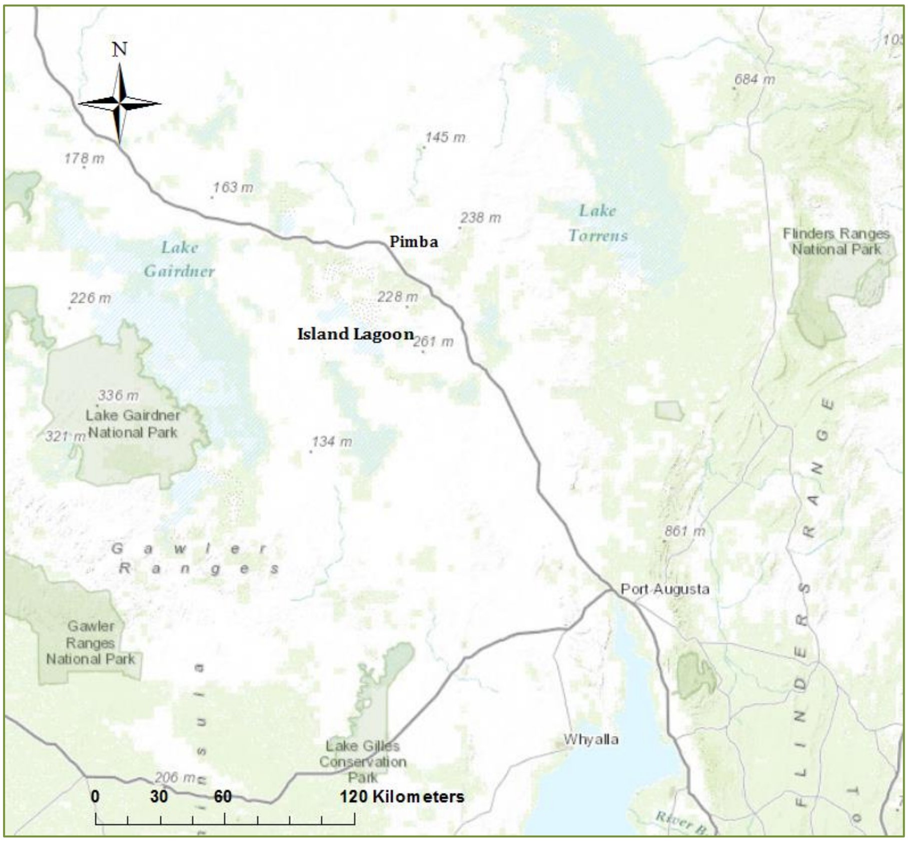


Figure 1: The location of Island Lagoon in South Australia.

Archaeology of the Australian Arid Zone

A number of previous models have been used to explain evidence that particular land systems in the desert regions of Australia, including uplands and river systems, were occupied in the late Pleistocene (Brown 1987; Lampert and Hughes 1988; Maynard 1980; Smith 1987 and Smith et al. 1991). Evidence from Puritjara, on the north-eastern edge of the Gibson Desert in central Australia (Smith et al. 1997), indicates that the arid zone was occupied at least 40,000 years ago. Veth (1989) developed a 'biogeographic' model that suggested that the early occupants may have avoided the sand-ridge deserts at this time, including the Great Victoria Desert to the north-west of Island Lagoon. This model has been referred to as the 'barrier, refugia and corridor' model (Veth 1989) or the 'barrier desert theory' (Smith 1988). Veth (1989b) also proposed the 'Islands in the Interior' model which proposed a re-colonisation of the deserts after the Last Glacial Maximum (LGM), or around 22,000 BP, from areas of refuge. Aboriginal people existed in desert regions prior to the LGM and successfully adapted in different ways to survive in some of those regions through this period. Hiscock and Wallis (2005) developed the 'desert transformation' model where they suggested that early colonizers moved into inland Australia circa 40,000 BP, when water and other resources were more available and developed flexible foraging strategies that enabled them to survive.

Work by Williams et al. (2010) that analysed radiometric ages from more than 600 archaeological sites across northern and central Australia and demonstrated a changing archaeological signature closely correlated with climate variability through the past 2000 years. Results indicated an increase in archaeological signatures across northern and central Australia over the last two thousand years with declines in western and northern Australia between 700 and 1000 BP, and again after 1500 BP. These shifts suggest an increase in population through the late Holocene, as well as a disruption or reorganisation of resource systems occurred across Australia during those periods and that those responses broadly correlate with transitions of the El Niño Southern Oscillation (ENSO).

In a more recent study, Williams et al. (2015) investigated the effect of climate systems on human settlement patterns over the past 35,000 years using 5,044 radiocarbon dates from 1,750 archaeological sites. This work used radiocarbon data as a proxy for human activity, along with results of regional/continental scale climate syntheses (Reeves et al. 2013, Petherick et al. 2013). This work included regional time-series curves for the arid interior of Australia with data indicating a population increase over the past 10,000 years that was initially slow, peaking at the Holocene climatic optimum 8,000 to 6,000 BP before declining at 4,000 to 2,000 BP. This decline is evidenced by the reduction in artefact discard rates at locations including, Puritjarra and Kulpi Mara and the introduction of technologies such as the 'long use-life' artefacts such as the Tula adze and the use of resins for hafting as well as elaborate hunting toolkits (Smith 1996).

The data also indicates a population increase in the arid zones over the past 1,500 years associated with climate amelioration as a result of La Nina conditions, improved social organisation and technologies.

A number of other workers have investigated sites in the Australian arid or desert regions. Sites in the Western Desert region include Koonalda Cave, Puritjarra (Smith 1997), Kulpi Mara (Thorley 2004), Serpents Glen (Veth and O'Connor 1996) and Kaalpi (Veth and Smith 2001). There are two sites in South Australia (SA), in similar arid environments on dune and playa lake systems, which have also been investigated. Walshe (2012) investigated the late Pleistocene hearth site on Coopers Dune near Port Augusta which has been dated to 40,000 BP, making it the oldest known site in South Australia. This site is also one of only two sites in southern Australia, and one of only seven locations in Australia to demonstrate such antiquity (David et al. 2011; O'Connor and Veth 2006). The second site, a late Pleistocene site at Hawkers Lagoon in the Southern Flinders Ranges (Lampert and Hughes 1987, 1988), is also relevant to the Island Lagoon work, once again, because of its location in a similar environment and its potential comparative value.

Island Lagoon

Island Lagoon is located approximately 450 kilometres north of Adelaide, 150 kilometres north of Port Augusta and 15 kilometres to the west of Pimba in South Australia. The Stuart Highway passes immediately to the east of Island Lagoon as does the Ghan railway line that travels south to north from Adelaide to Darwin (Figure 1). Island Lagoon is bordered by pastoral properties including, Wirraminna, Arcoona, Oakden Hills and Mahanewo. The Department of Defence Woomera prohibited area extends into Island Lagoon but only covers a small section of the lagoon around Narrungar.

Island Lagoon, sometimes included as part of Lake Macfarlane, is part of a complex of playa lakes, or dry salt lakes in this region of South Australia that reflect Pleistocene drainage systems, and drain east into Lake Torrens and to the Lake Eyre basin to the north-east. A playa lake is a pan, or dry lake or flat-bottom depression that seasonally fills with water in arid regions and are therefore considered 'ephemeral'. The most notable of those are Lake Eyre, to the north-east, which derives most of its inflow from monsoon rainfall in north-eastern Australia and Lake Torrens, to the south-east, which is the most appropriate playa lake in the broader region for climatic comparison. The other local playa lakes occurring in the region include Lake Gairdner, Lake Everard, Lake Harris, Lake Acraman, Lake Macfarlane, Pernatty Lagoon and Lake Hope. The playa lakes in this region are thought to be of Holocene age (Delgarno 1981), but were formed on the older drainage systems of the late Pleistocene and have fluctuated between wet and dry throughout the Holocene. Williams et al. (2015) also describes the period of Marine Isotope 3 or 60,000 to 25,000 BP (late Pleistocene) as a time of variable climate with mainly cool and arid conditions that included lacustral, or lake-like, phases of increased moisture when the inland mega lakes were formed that have resulted in the inland contemporary playa systems.

Figure 2: The location of Island Lagoon in regional South Australia, SW of Pimba.

Figure 3: Island Lagoon above left, viewed from the east and above right, viewed from the south.

The lagoon is approximately 35 km long (north to south) and 15 to 20 km wide (east to west) and is located on what is virtually the south-eastern edge of the Great Victoria Desert. The lake surface is, on average, 75-80 m above sea level and is made up of gypsiferous muds, clays and silts with some gypsum crystals. A layer of salt crust, mostly from 30 mm to 75 mm thick covers this surface. This crust, however, can range in thickness from a few centimetres to over one metre. A few islands are scattered across the bed of Island Lagoon and are comprised of Holocene deposits covered by Aeolian sands. The Lagoon holds surface water during the winter and spring months from August to October in most years. The lagoon is usually dry by November. Occasionally, springs can be found where saline groundwater discharges onto the lake surface forming low mounds.

The Melbourne Argus (6 April 1916, p. 6.) reported on the discovery of a 'spear factory' at Eucolo Creek by W.R. Thomas and H.Y.L Brown who were surveying and drilling for water and described artefacts in the region derived from imported material – according to Brown, a qualified geologist. This article also refers to a myth, the Two Men Dreaming or *Wati Kutjara*, which explains ochre trading into the region. Other myths relating to Island Lagoon include; the Seven Sisters, the Two Kangaroos or *Malu Kutjara* and the Native Cat or Urumboola Dreaming.

Previous surveys relating to Kokatha Aboriginal Heritage in the Woomera and Island Lagoon region were undertaken by a number of workers including; Berndt 1983; Fitzpatrick and Wood (2004: 4-5); Hewitt (1976, 1978); Pulleine (1926); Tindale (1974); Cane (1984, 1987); Gara (1989) Hewitt (2000) (Arcoona plateau and Eucolo Creek), and most recently; Hayward (2012). Details of research conducted by those workers are provided later in this thesis on page 41.

Research Questions

This case study will discuss the Island Lagoon sites in the context of contemporary models for desert occupation. More specifically, the research set out to evaluate the role of playa lakes and associated land systems in relation to Aboriginal settlement and subsistence strategies together with possible effects of Holocene climate variability on the pattern of Aboriginal occupation of those systems during that period. To achieve those two objectives the following research questions were developed:

1. What can the distribution and character of archaeological sites in the landscape around Island Lagoon tell us about the way Aboriginal people occupied the area and utilised the natural resources in the region; and

2. Does archaeological evidence indicate specific types of economic activity, technology or resource use or any obvious association with biogeographic events that link occupation with a particular period?

Thesis overview

Chapter Two reviews the relevant literature relating to the Aboriginal occupation of the arid regions, discussing both the climate and paleo-environment through the terminal Pleistocene, pre- LGM, LGM, post LGM and the Holocene. The chapter discusses the models for the settlement of the inland regions of Australia in the context of those challenging climatic periods. The chapter also reviews the literature relating to economies, society and technologies during the Holocene. Finally, the chapter reviews earlier archaeological and anthropological work in the region.

Chapter three describes the general environment of Island Lagoon, the study site, including, the climate, geology, land-systems, biodiversity and ecology of the lagoon. This chapter covers the period of European exploration and settlement of the region and provides details of known or registered archaeological sites in the region. The chapter also discusses more recent archaeological work on the Arcoona Plateau, to the east of Island Lagoon.

Chapter four provides a background of the Kokatha people of the Island Lagoon region from both pre and post contact perspectives. This chapter includes a discussion of the historic extent of Kokatha territory, historic and contemporary relationships and cultural associations, ethnography, relevant mythologies and material culture. This chapter also provides details of the recent Kokatha Native Title Consent Determination.

Chapter five summarises the research methods, including archival and desktop research used to access background information relating to Kokatha cultural information and Aboriginal heritage site information for the Island Lagoon region. The chapter also outlines the design of the field surveys and the methods applied to the collection and analysis of field survey data as well as the limitations of the survey.

Chapter six presents the results of the field surveys. Those results include; the identification and remote mapping and ground truthing of landsystems around the lagoon as well as the recording of six previously unrecorded sites. This chapter also includes details of the data recorded from sample plots within the three sampled sites.

Chapter seven provides an analysis and discussion of the results of the field surveys. This includes an analysis and discussion of the location of the new sites in the landscape and the archaeological data recorded from the three sampled sites.

Chapter 8 draws some conclusions and makes recommendations for future work that might shed further light on the activities of Kokatha ancestors in the Island Lagoon/Arcoona Plateau region.

Chapter 2: Literature Review

This chapter reviews the current evidence relating to the Aboriginal settlement of the Australian arid zone in the context of climatic and palaeoenvironmental variability since the terminal Pleistocene. The chapter then discusses occupation models for the population of the inland regions of Australia in the context of those challenging climatic periods. The chapter also reviews literature relating to economies, resource use and technologies during the Holocene as well as literature relating to archaeological work in the Western Desert and in the Island Lagoon region.

Palaeoenvironments

Australia's position on the earth's surface puts the continent between the tropics and the Southern Ocean and the large land mass contribute to the continental effect. This effect includes distinct rainfall and temperature gradients from the coast to the inland. Reeves et al. (2013) and Williams et al. (2015) have identified the last 35,000 years as a period of great climatic variability from the end of Marine Isotope Stage 3 (MIS 3) through the LGM and a de-glaciation period into the Holocene. This variability may have been caused by the effect of the ratio of the Australian land to sea mass, monsoonal effect and also the climatic impact of the El Nino Southern Oscillation (ENSO) (Reeves et al. 2013). The last 35,000 years has also been a key period for the formation of land features such as paleo channels including rivers and lakes in the temperate zones of Australia (Nanson et al. 2008; Veth et al. 2009 and Williams et al. 2015). Many of the drainage systems that now form the playa lakes in the Island Lagoon region apparently developed at this time.

The early glacial period, at 32,000–22,000 BP, stimulated dune formation in the centre of the continent due to prevailing drier conditions and a change in flora to shrubland and grassland. During the LGM, 22,000–18,000 BP, conditions in the south-east of the continent were glacial with the temperature possibly up to 9°C cooler than today (Miller et al. 1997). Increased runoff into drainage systems and rivers occurred as a result of increased snow melt. There is evidence for intensified dune-building activity in the arid centre and on the margins of the arid zone of the continent as well as a substantial change in plant composition to grasses (Petherick et al 2013; Reeves et al 2013). There is also evidence for increased rainfall in South Australia (Ayliffe et al. 1998) and also for flooding in the Southern Flinders Ranges (Haberlah et al. 2010) during this period.

From 18,000–15,000 BP conditions were wet, warm and humid. Lacustrine systems in the middle of the continent were drier as evidenced by enhanced dune building and Lake Eyre and the Willandra Lakes are believed to have been dry during this period. It is thought that tree flora emerged again during this period. During the late deglacial period, 15,000–12,000 BP, immediately before the Holocene, the climate was variable and rainfall increased in the centre of Australia due to monsoonal effect. The water level in Lake Eyre increased due to greater precipitation (Magee et al. 2004) and aeolian activity in the arid zone persisted and possibly increased during this period resulting in ongoing dune building (Fitzsimmons et al. 2007, 2013).

The early Holocene, 12,000–8,000 BP, was a period where glaciers to the north of Australia had disappeared and the seas rose over the continental shelf (Barrows et al. 2011, Reeves et al. 2013). Lake Eyre was at peak discharge during this period and the southern islands, including Kangaroo Island, were isolated from the mainland due to the sea-level rise over the continental shelf. The mid-Holocene, 8,000–5,000 BP, was a period of maximum temperatures in Australia with the sea-level at its current level and humid conditions are evident in the Flinders Ranges and the Lake Frome region of South Australia (Fitzsimmons et al. 2013). By the mid to late Holocene (5,000–2,000 BP), landscape building due to fluvial activity had ceased and inland lake levels had decreased again, was largely caused by El Nino Southern Ocillation (ENSO) reverting to El Nino mode (Reeves et al. 2013).

The Holocene period, which commenced at around 11,700 BP (Walker et al. 2009), included periods of extreme climatic variability. Gliganic et al. (2014) specifically investigated the late-

Holocene climate using what they refer to as natural archives in northern South Australia. This involved the use of fluvial, aeolian and lacustrine sedimentary archives, pollen and other biological proxies to investigate the palaeoclimate for periods of the Holocene. This and other work (Fitzsimmons et al. 2013) indicates that the period of the early to mid-Holocene was warmer and wetter. At about 6,000 BP, during the mid-Holocene, the climate dried and became more unreliable for human existence and this wet and dry variability has been ongoing into the late Holocene. As indicated earlier, El Nino climatic conditions commenced approximately 5,000 BP and persisted until 2,000 BP ago with severe drought periods persisting that caused more general aridity in deserts with a slight easing of conditions in more recent times. These conditions and the variability in natural resource availability were difficult for desert people. Work at Puritjarra by Bowdery (1998) and Smith (2006) indicates that the desert grasslands stabilised at about 1,500 BP but conditions were still variable and risky for human occupation.

Evidence for occupation of the Australian arid zone

There is reliable evidence from a range of archaeological sites such as Allens Cave (Hiscock 1988a), Kulpi Mara (Thorley 1998), Lake Mungo (Bowler et al. 2003), Puntjutjarpa (Gould 1971, 1977, 1978, 1980; Hiscock and Veth 1991), Puritjarra (M.A. Smith et al. 2001) and Willandra (Allen et al. 1998), that indicates that Aboriginal people had occupied most of the inland regions of the Australian mainland by at least 45,000 years ago.

Puritjara, a rock shelter in the sand plains and dune fields of central Australia north-west of Warburton, is an example of long-term occupational site with reliable water resources. Smith (1997) excavated the Puritjara site and radiometric analysis indicated that the lowest excavated artefacts came from a level that was approximately 39,000 BP (Smith et al. 1997). Artefacts were recovered from all levels of the deposit indicating repeated early human use from 40,000 BP up to the early Holocene when the variable climate limited resources for occupation of the arid regions of Australia. Allen's Cave (Roberts et al. 1996) on the Nullarbor Plain, also contains artefacts in levels more than 40,000 years old, while Lake Mungo in western New South Wales, a major fluvial system pre-LGM, contains the oldest human remains in Australia (Bowler et al. 2003). The Mungo site is basically an eroding lunette from which archaeologists have reconstructed the lake's history from a series of sedimentary strata and the Lower Mungo stratum, specifically, exhibits evidence of human activity, hearths, middens, burned skeletal material, other skeletal material and artefacts. One of the skeletons (WLH 3), located in the uppermost level of the Lower Mungo stratum was initially dated at 60,000 BP but based on contemporary methods of sedimentary analysis indicates an age of around 40,000 BP. Other evidence for human occupation at Lake Mungo is contained in stone artefacts buried below the level of WLH 3, where the OSL analysis of sediments around the artefacts, indicate an age of 45,000–50,000 BP (Bowler et al. 2003). This was somewhat contentious and was rejected by O'Connell and Allen (2004) based on their view that the artefacts may have moved downwards due to the effect of burrowing animals but Bowler's dates are now generally accepted (Bowler et al. 2003).

The work by Lampert and Hughes (1987) at the Late Pleistocene site at Hawker Lagoon in the Southern Flinders Ranges and the initial work by Walshe (1997) and Walshe *et al.* (2001) at the Coopers Dune site near Port Augusta are the most relevant to this project because they point to Aboriginal activity, in different landscapes, in the arid regions of South Australia, as older than 40,000 BP. The Hawker Lagoon Pleistocene site is a fireplace/hearth on the margin of Hawker Lagoon in the southern Flinders Ranges (Lampert and Hughes 1987, 1988; Walshe 2005). Walshe (2006) excavated a hearth in Cooper's dune west of Port Augusta near Dempsey's Lake. The hearth has been dated at ca 40,000 BP. The site is in a Quaternary dune and is associated with many knapped silcrete and quartzite cores. Tindale (1930) identified stone tools and megafaunal bone present on the dunes west of Port Augusta and Cooper (1959) suggested that the stone tools provided evidence of human megafaunal interaction. Williams (1982) placed the lower horizon and its megafaunal remains in Marine Isotope Stage (MIS) 3 or 27,000 to 60,000 BP. This suggested that the archaeology was less than 27,000 years old. Lampert (1976) compared the archaeology to Lake Mungo, noting that the two assemblages were similar in type to Coopers Dune, displaying on-site knapped stone that lacked any calcarenite coating. By comparison, the Lake Mungo assemblage displayed no evidence for on-site knapping and the majority of stones were coated with calcarenite. Those observations led Lampert to suggest a chronology of 17,000–15,000 BP for the Coopers Dune site.

Grün et al. (2008) have, more recently, dated samples of megafauna teeth from the Coopers Dune and arrived at age estimates of 60,000-45,000 BP, placing the megafauna within or older than the (2001) extinction window suggested by Robert's et al. and confirming Williams' (1982) earlier dating of the deposit at early MIS3. Williams (1982) also identified components of eggshell from both emu and the extinct *Genyornis newtoni*. OSL results provided an age range of 100,000 years old at the base and 35,000 to 30,000 years old at the top of the dune (Walshe et al. 2001). A summary of this evidence would suggest that the Cooper's Dune site is a late Pleistocene site occupied after the extinction of *Genyornis newtoni*, later than 27,000 BP and possibly as late as 17,000 BP, or very late Pleistocene, as suggested by Lampert in 1976 (Lampert 1976).

Models for arid zone occupation

Archaeologists have suggested a number of models for the settlement of the arid zone of Australia that attempt to explain the interrelationships between Aboriginal settlement patterns and the prevailing climatic and environmental conditions at different times over the past 45,000 years.

Veth (1989) proposed a biogeographic model for desert occupation. This model, also referred to as the 'barrier desert' model, broadly classifies regional landsystems into uplands (refuges), rivers and gorges (corridors) and sandridge deserts (barriers). This is a broad concept and identifies the Great Victoria Desert and Simpson Desert regions, for example, as barriers and the West McDonald Ranges, the Musgrave Ranges and the Blackstone Ranges as refuges. The

Flinders Ranges and the Gawler Ranges in South Australia may also fall into the 'refuge' category. As discussed earlier, Hughes and Lampert (1988) excavated Hawker Lagoon in the Flinders Ranges and determined occupational dates at ca 15,000 BP and 5,000 BP. They suggested that those dates of periodic occupation that appear to have been separated by a period of 10,000 years. Hughes and Lampert (1988) suggest that this 'abandonment' results from the effect of paleoclimatic variation. That is, the climate and environment was suitable for human occupation at those times but that the climate was too harsh or variable for human occupation in the region for that 10,000 year period that separated those occupations. Walshe et al. (2001) excavated hearths on this site in 2001 and cobble stones and stone tools provided dates of 550 BP, 1,500 BP and 1,230 BP. This evidence is supported by dates obtained from work at Lake Frome to the north east. In addition, there is evidence from the Strzelecki Desert for Late Pleistocene occupation of this region (Smith et al. 1991). It seems that the Flinders Ranges region and the north east of South Australia, including Lake Eyre, were occupied before the last LGM and again after that period. It has been postulated that microclimates in the Flinders Ranges, where water and other resources were available locally to Aboriginal people during harsher climatic periods, including the LGM, and provided a refuge for those populations when the deserts were abandoned. The notion of sandridge deserts and stony deserts as 'barriers' is based on the fact that there is no archaeological evidence for occupation of those regions during the LGM, which was a cool and arid period (O'Connor et al. 1998 and Hughes and Hiscock 2005).

The desert transformation model (Hiscock and Wallis 2005) supports the idea that people had occupied the inland regions by 40,000 BP during the period of the Terminal Pleistocene when the climate was cooler with more water available and conditions were generally more conducive to human occupation than today. According to Hiscock and Wallis (2005) inland people did not need to employ specific economic or social strategies for desert survival before 40,000 years BP and used this 'lacustral' wetter phase to expand and explore inland landscapes.

Hiscock and Wallis suggest that inland populations were small and did not need to employ the risk reduction strategies of the late Holocene. Thorley (1998) has also suggested that early inland dwellers, during the mid to late Pleistocene, focussed their economic activity along the resource rich riverine valleys and inland lakes which in the context of the Veth model would be considered to provide 'corridors' and 'refuges'.

Clearly, human populations must either develop strategies to cope with or otherwise avoid unsuitable environments, to reduce risks to their long-term survival. For example, foraging strategies may be adjusted to be more flexible as small populations adapt to survive in those inland environments when climatic change made environments colder, drier or more extreme (Hiscock and Wallis 2005). From around 32,000 BP, there is evidence of localised adaptations to changing environmental conditions and resource availability that occurred with the development of grassland-based ecosystems as a result of changes in rainfall, temperature and surface water availability (Hiscock and Wallis 2005). In relation to South Australia, there is evidence, from sites such as the Lake Eyre Basin and the Strzelecki Desert (Lampert and Hughes 1987), that our inland desert regions were also abandoned during the LGM, when very cold and dry conditions persisted in inland South Australia.

In some inland locations, where uplands or wetter areas provided a base for survival during the LGM, populations survived to opportunistically exploit nearby resources. Puritjara provides a good example of where this strategy perhaps enabled people to survive through the LGM (Smith 1989c).

Patterns of occupation, population, resource use and adaptation in the Australian arid regions in response to climatic conditions

The climate during the pre-LGM period was relatively mild and certainly milder than the arid regions of Australia today and existing social and economic systems were probably adequate to enable survival in those regions during this period without adaptation. Aboriginal people moved into those regions and populations increased and expanded (Thorley 1998, 2001; Hiscock and Wallis 2005).

As discussed earlier, there were profound environmental changes during the LGM, a period of extreme climatic variability and environmental stress. Bowler (1976) originally proposed that the first colonization of the desert regions was followed by forced abandonment during the LGM and that re-colonization only occurred in the late Pleistocene and the early Holocene. The Desert Transformation Model (Hiscock and Wallis 2005) proposes that inland dwellers moved into the deserts from refuges using flexible foraging strategies when environmental conditions ameliorated and then modified social and economic systems as the climate became harsher and their environment changed. To be successful, it is likely that those people also had developed knowledge, over a long period of occupation, about their regional environments. This accumulated knowledge facilitated the development of appropriate economic strategies and technologies that supported survival as the climate became more unreliable. Where populations persisted by adapting to the local environmental conditions it is possible that they exploited local resources by foraging in small bands, seasonally from refuges, or moved from point to point out of refuges along corridors, when environmental conditions permitted (Hiscock 1984, 1988a; M.A. Smith 1987). Barrier sand-ridge deserts, where the environment became very difficult for human survival, were abandoned or avoided during the LGM. For example, there is evidence that the Lake Eyre basin, in South Australia, was abandoned during that period (Lampert and Hughes 1987).

Traditionally, archaeologists, based on early work in the Western Desert (Gould 1967, 1968b, 1969a, 1969b, 1971), have developed a view of Holocene populations as being conservative in terms of minimising risk. Early assumptions were of a society and economy that was homogenous across the arid regions of Australia and remained unchanged through the variability of the late Pleistocene and the Holocene. This is not the case and clearly different strategies were employed in different regions at different times. Life is dependent on water and, as indicated earlier, rainfall was variable throughout the Holocene, with direct effects on the ecology of the desert regions and the Aboriginal inhabitants. Smith (1993) and others, have suggested that the availability of water was the greatest limiting factor on settlement of sand-ridge deserts. According to Gould (1991), the response of Western Desert people to unpredictable rainfall was to either employ a strategy of drought escape, where they abandoned high risk areas completely during dry climatic periods or evaded droughts by settling around refuge areas where water and other resources were reliably available. There is evidence to support this proposition for example at Puntjutjarpa where artefact densities in specific stratigraphic zones indicate that this site was only occupied for a few periods in the Holocene and was abandoned from 4,500 BP until 1,000 BP, a very hot and dry period.

A number of researchers (M.A. Smith 1993, 2005; Veth 1996, 2006) have reported large numbers of sites with lithic artefacts from the mid to late Holocene that could indicate greater forager mobility or population increase during the mid to late Holocene. Excavations in rock-shelters such as Puritjara (M.A Smith 2005, 2006), have also exposed large numbers of artefacts at levels from the last 10,000 years possibly indicating a population increase from the mid Holocene . This apparent increase in desert populations in the late Holocene could indicate economic development with associated population increase, as has been proposed by Smith (1986a). There is also evidence for the exploitation of plant material, including seeds, as a response to the mid to late Holocene reduction in game animals and therefore protein. This proposition is supported by the discovery of grindstones in late Holocene levels at Puntjutjarpa (Smith 1986a) and Kaalpi (Veth et al. 2001; Veth 2006). Veth (2005) confirmed this but argued that the grinding of bone had occurred over a long period but was most intense in the harsh desert areas. Evidence from Intirtekwerle (Gould 1996), Serpents Glen (O'Connor et al. 1998) and Kaalpi indicates that this practice was more recent, perhaps over the last 1,000 years.

Smith (1993) suggests that, given the environment of the late Pleistocene, desert people would have had detailed knowledge of the available resources in those regions, including plant species, and that they used technology that included millstones for grinding seed at this time. This is supported by work done by Kamminga (1978), Jones (1993), Roberts et al. (1990a, 1993, 1994, 1994a, 1996) and Allen (1974). Smith (1993) argues that having this technology may have enabled the movement into deserts when conditions permitted, but that this was not the motivation for colonisation and that instead, the occupation of sand-ridge deserts through corridors was limited by the available resources. Smith (1993) also suggests that people might have foraged in deserts from neighbouring corridors opportunistically for short periods when conditions were suitable and Veth (1989) suggests a number of other factors that he considers to be important adaptations for the colonisation of 'barrier' areas. Examples include the development of hafted implements, such as Tula adzes, for working hardwoods and, as alluded to earlier, millstones for processing seed. Other significant adaptations include the detailed knowledge of the distribution, seasonality and processing methods for seed-bearing species in the hummock grasslands and the ability to construct and maintain deep wells to access ground water (Veth 1989). An ability to develop and maintain social networks was also an important factor for colonization of deserts.

In summary, the archaeological evidence indicates that Aboriginal population have employed adaptive strategies to survive in arid regions during adverse environmental periods over the past 40,000 years. Adaptive strategies can be grouped into the categories of, social, economic and technological adaptation. Examples of those strategies which have been referred to previously include the abandonment of regions in extreme dry periods and the avoidance of areas during droughts and the retraction to refuge areas. Adaptive strategies also include the capacity to fragment populations when climatic conditions were extreme to forage more broadly in small, non-territorial mobile bands or to aggregate in larger populations as conditions ameliorated and to develop networks opportunistically when necessary.

Evidence for specific social, economic or technological responses to particular environmental conditions, could assist in linking site or regional occupation with a particular time period. Such evidence might include; the emergence of what has been described as the Australian small tool tradition in the mid-Holocene. This technology involved the use of small stone tools that were hafted to form composite tools that were easily maintained and were ready for use thereby reducing the risk of foraging failure during the mid-Holocene. For example, the Tula adze is a hafted, composite tool common in desert technology used to create wooden vessels to carry seed and water (Sheridan 1979). Tula adzes, along with millstones, have been associated with the settlement of 'barrier' deserts during more hospitable periods over the past 10,000 years.

Often referred to as a 'toolkit' that included the Tula adzes, unifacial points and backed blades. The development of the 'toolkit' is considered to be a response to environmental stress and may have facilitated the periodic exploitation of sand-ridge deserts from refuges, along corridors, during the Holocene. Hiscock (1994) also, has suggested that the development of this technology may have been a risk reduction strategy and a response to the economic risk caused by the variable climate during the middle to late Holocene. It is known that backed blades and points were used before 5,000 BP, as has been demonstrated by Hiscock and Attenbrow (1998), and were not brought into Australia recently as was suggested by Bowdler (1981). Apparently, they were made at very low rates for a long time and manufacture increased substantially from about 3,500 BP.

Bio-geographic Events Linked to Periods of Desert Occupation

There are a few notable biogeographic events that align with climatic phases and human occupation of the deserts of Australia. One of those events is the extinction of what are commonly referred to as 'mega fauna' which are technically Pleistocene fauna. Those animals included: *Sthenurus*, a large kangaroo; *Geniornis,* a large emu-like flightless bird; *Diprotodon opatum*, a large herbivore; *Zygomaturus*, a giant wombat-like marsupial, and finally; *Palorchestes*, a cow-sized quadruped. Debate around the cause of extinctions of megafauna has been ongoing for decades. Some researchers advocate 'overkill' by the newly arrived humans while others prefer the impact of climate variation and environmental change in the late Pleistocene causing habitat modification resulting in the extinction of fauna unsuited to and unable to adapt to the changing environmental conditions.

For example, the large emu-like flightless bird, *Geniornis newtoni,* once found in northern South Australia, appears to have gone extinct at around 35,000 BP (Miller et al.1999; Trueman et al. 2005). The debate around 'overkill' or faunal extinctions associated with human arrival continues. Trueman et al. (2005) suggested, as a result of work at Cuddie Springs, where there is record of megafaunal and human skeletal remains in a secure stratigraphic context that there was a long period of coexistence of humans and megafauna. This work undermines the 'overkill' theory and therefore removes a 'blitzkrieg' as the explanation for megafaunal extinction. The fossil record at Cuddie Springs indicates that Pleistocene megafaunal extinctions occurred gradually during a period of climatic and therefore environmental/habitat change. From this and other work it is likely that *Geniornis* co-existed with humans for at least 7,000 years. *Geniornis* eggshell has recently been located at the Coopers Dune site west of Port Augusta dated at ca 40,000 – 60,000 BP (Walshe 2012).

Summary

The location of Australia puts the continent between the heat of the tropics and the cooler Southern Ocean and its large land mass also contributes to the continental effect with distinct rainfall and temperature gradients from the coast to the interior. Reeves et al. (2013) and Williams et al. (2010) identify the last 35,000 years as a period of climatic variability and a period for the formation of land features such as drainage paleo channels including, rivers and lakes in the temperate zones of Australia (Nanson et al. 2008; Veth et al. 2009 and Williams et al. 2015). El Nino climatic conditions commenced approximately 5,000 BP and persisted until 2,000 BP ago with severe drought periods persisting that caused more general aridity in deserts with a slight easing of conditions in more recent times. These conditions and the variability in natural resource availability were difficult for desert people.

Veth's (1989) 'barrier desert' model, broadly classifies regional landsystems into uplands (refuges), rivers and gorges (corridors) and sandridge deserts (barriers). The Flinders Ranges region and the north east of South Australia, including Lake Eyre, were occupied before the last LGM and again after that period. It has been postulated that microclimates in the Flinders Ranges, where water and other resources were available locally to Aboriginal people during harsher climatic periods, including the LGM, and provided a refuge for those populations when the deserts were abandoned. The desert transformation model (Hiscock and Wallis 2005) supports the idea that people had occupied the inland regions by 40,000 BP during the period of the Terminal Pleistocene when the climate was cooler with more water available and conditions were generally more conducive to human occupation than today.

From around 32,000 BP, there is evidence of localised adaptations to changing environmental conditions and resource availability that occurred with the development of grassland-based ecosystems as a result of changes in rainfall, temperature and surface water availability. Evidence, from sites such as the Lake Eyre Basin and the Strzelecki Desert (Lampert and Hughes 1987), suggests that SA inland desert regions were abandoned during the LGM, when very cold and dry conditions persisted in inland South Australia.

An apparent increase in desert populations in the late Holocene tends to indicate economic development with associated population increase, as has been proposed by Smith (1986a). There is also evidence for the exploitation of plant material, including seeds, as a response to the mid to late Holocene reduction in game animals and therefore the availability of protein. Smith (1993) has suggested that, given the environment of the late Pleistocene, desert people would have had detailed knowledge of the available resources in those regions, including plant species, and that they used technology that included millstones for grinding seed at this time. Smith (1993) also suggests that people might have foraged in deserts from neighbouring corridors opportunistically for short periods when conditions were suitable and Veth (1989) suggests a number of factors that he considers to be important adaptations for the colonisation of 'barrier' areas. Other archaeological evidence indicates that Aboriginal populations have employed adaptive strategies to survive in arid regions during adverse environmental periods over the past 40,000 years. Other strategies, referred to previously include, the abandonment of regions in extreme dry periods, and the avoidance of areas during droughts. Adaptive strategies also include the capacity to fragment populations when climatic conditions were extreme to forage more broadly in small, non-territorial mobile bands or to aggregate in larger populations as conditions ameliorated. An ability to develop and maintain social, trade and economic networks was also an important factor for colonization and re-colonisation of the arid regions. Technological examples include the development of hafted implements, such as Tula adzes, for working hardwoods and, as alluded to earlier, millstones for processing seed. The development of the 'toolkit' is considered to be a response to environmental stress and may have facilitated the periodic exploitation of sand-ridge deserts from refuges, along corridors, during the Holocene. Hiscock (1994) has suggested that the development of this technology, often described as the Australian small tool tradition in the mid-Holocene. Often referred to as a 'toolkit' that included the Tula adzes, unifacial points and backed blades this may have been a risk reduction strategy and a response to the economic risk caused by the variable climate during the mid to late Holocene.

Other significant adaptations include the detailed knowledge of the distribution, seasonality and processing methods for seed-bearing species in the hummock grasslands and the ability to manage water resources. Other technological examples of adaptation include; the capacity to access water by managing water wells. Evidence for specific social, economic or technological responses to particular environmental conditions, could assist in linking site or regional occupation with a particular time period.

Chapter 3: The study site - Island Lagoon

This chapter describes the Island Lagoon region that includes the study site and provides background information relating to the environment, land-systems, natural resources, history, tenure and land-use and the known archaeology of the region. The current state of those elements reflect changes, over time, in climate, environment, human occupation and resource use during the Mezozoic Era, 252–66 mya, and Cenozoic Era, 66 mya to the present, which includes the Quarternary Period and therefore the Pleistocene and the Holocene. Background knowledge of those changes will assist in determining the timing and nature and pattern of Aboriginal occupation and resource use.

The general environment of Island Lagoon reflects the underlying geology, land-systems and soil variations, and is usually related to the presence or absence of calcium carbonate, and the degree of soil salinity. Some of the plain and dune areas on the western side of the lagoon comprise sandy soils over a clay base. The dunes and sandplains support mulga (*Acacia aneura)* and Western Myall (*Acacia papyrocarpa*) woodland. The low drainage channels and flats are covered with Samphire (*Tecticomia halocnemoides and Sclerostegia tenuis*). On the eastern side, the Lagoon is bounded by the silcrete rises and uplands of the Arcoona plateau, shrub steppe covered with chenopods including, Saltbush (*Atriplex sp.)*. Where the dunes have little or no calcium carbonate cover, native pine (*Callitris glaucophylla*) woodlands occur.

Figure 4: Examples of typical vegetation communities around Island Lagoon; Acacia woodland, above left, and shrub steppe, above right, covered with Chenopods including, Saltbush and above, dunes supporting native pine woodland.

This region was initially explored by Edward John Eyre in 1839 and Stephen Hack in 1857. Hack also named Lake Gairdner after G. Gairdner, the Chief Clerk of the Colonial Office. Eyre and Hack were followed by John McDouall Stuart in 1858. Stuart explored the lands between Lake Torrens, Coober Pedy and Lake Gairdner. The work of those explorers resulted in the opening up of this region for economic development including, pastoralism.

Landuse in the region is primarily pastoral — the grazing of sheep and cattle with mineral exploration, mining and tourism as well as Department of Defence operations over some areas. Most of the pastoral operations around Island Lagoon were established in the 1850's. Those pastoral stations include; Wirraminna, Arcoona, Oakden Hills and Mahanewo. Oakden Hills, where the survey sites are located, has operated from 1852 when it was first occupied by John Jackson Oakden, the son of a Tasmanian pastoralist (Figure 5).

Figure 5: Pastoral infrastructure on Oakden Hills station (Yalymboo); left, evidence of past pastoral activity (posts cut from Native Pine, possibly by Aboriginal workers) adjacent to Site 4 and contemporary pastoral infrastructure, right.

Mineral exploration, particularly for copper, gold, uranium and iron ore is active in the region and the Olympic Dam mine, a uranium and copper mine, operated by BHP Billiton, is the major mine in the region. Woomera was established in 1947 as an Australian Defence Force (ADF) Base servicing the RAAF Woomera Test Range. The base and township lies within the bounds of the Woomera Prohibited Area (WPA) and the WPA covers most of South Australia's North-West (Figure 6). Woomera today is also a tourism centre and literally thousands of tourists travel up and down the Stuart Highway to and from Adelaide and Darwin.

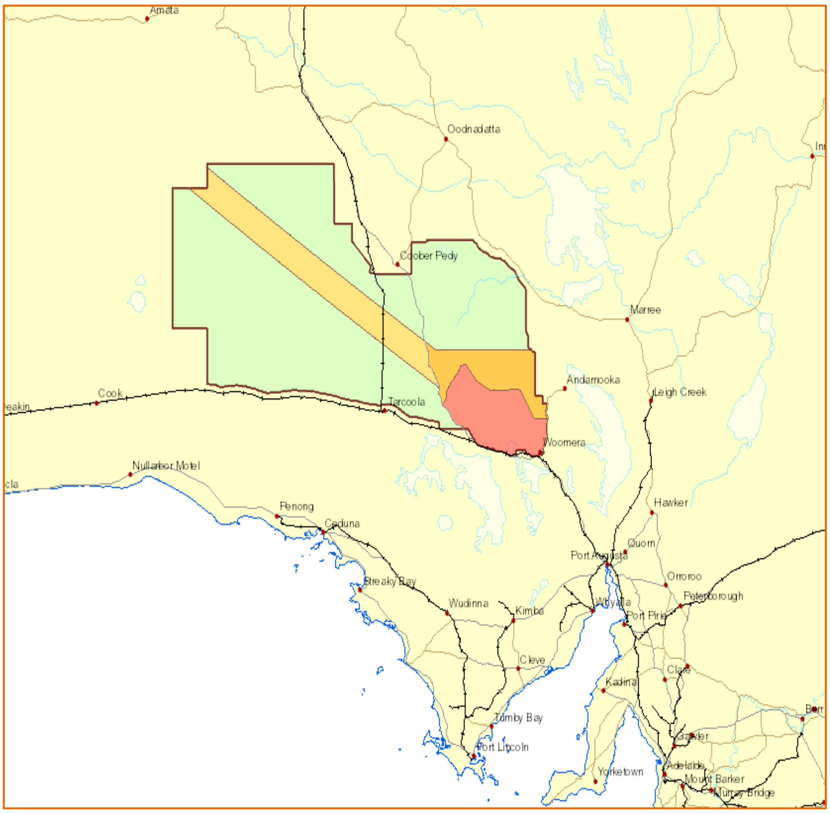


Figure 6: The Department of Defence Woomera Prohibited Zone (Department of Defence).

Modern climate

The climate of the Island Lagoon (Woomera) region is dry and similar to many other arid regions of Central Australia where evaporation exceeds precipitation. The region has high summer temperatures, low humidity and rainfall well below 250mm per annum. Woomera has a mean maximum temperature of 34.8 degrees Celsius a mean minimum temperature of 19.8

degrees Celsius, average annual precipitation of 165.8 mm, winds S- SW January to June at 15 to 20 kph and N-NW July to December at 12 to 22 kph (Bureau of Meteorology 2015)

Geology

The geology of the study area is relevant for this project as geology determines landform, landscape, soil, water movement and availability and potability. Geology also ultimately determines vegetation cover, wildlife habitat and the availability of other natural resources necessary for occupation by Aboriginal people. Geological resources provide materials for stone tool manufacture and, importantly, may provide a means of establishing tentative broad dates for archaeological sites for example, where sites are located within Holocene dune systems. Figure 9 provides an overview of the surface geology of the Island Lagoon region.

Island Lagoon is located on the far eastern edge of the Gawler Craton, an ancient and stable landmass that has not been subject to major tectonic activity for over a billion years. The mid-Proterozoic basement surface in the northern and central areas of the Adelaide Geosyncline and the Stuart Shelf (the Island Lagoon region) lie beneath a thick cover of younger sediments. According to Preiss and Robertson (1996) the deformation of the geosyncline is of Delamerian Orogeny (mid-Cambrian to Early Ordovician or 514 – 485 Ma) and is a sedimentary basin of marine sediments including siltstone, sandstone, dolomite and limestone. Those sediments of the Adelaide Geosyncline include the sandstones of the Pandurra Formation (Crawford 1964 and Crawford and Forbes 1969) which occur within the Carriewerloo Basin. The sediments are a unit of un-metamorphosed quartz and lithic sandstone as well as medium grained sandstone, pebble conglomerate and shale resulting from the erosion of the Gawler Ranges.

Those sedimentary rocks are covered by the aeolian sands from the late Pleistocene (128 – 11,600 BP) and the Holocene 11,700 BP (Walker et al. 2009). Callen and Benbow (1995) suggest that the playas in the Gawler Ranges region reflect the pattern of Tertiary watercourses that drained SE across the region into the Billa Kalina area. Callen and Benbow also suggest that the clay gypsum lunettes on the surface of Lake Acraman, immediately west of Island Lagoon, result from marine aerosols blown inland by prevailing SW winds in the late Pleistocene. The Kwatersky Dune Field immediately west of the Gawler Ranges is another example of dune formation created by the interactions of prevailing winds with the playa system. Bourne et al. (1974) obtained radiocarbon ages of 27,000 to 10,300 and 22,000 to 16,000 years BP for carbonate accumulations in the dunes of the Kwaterski Dune Field suggesting dune formation in the Terminal Pleistocene and into the early Holocene. They suggested that there was no significant age difference between dune formation and secondary carbonate accumulation but according to Callen and Benbow (1995), this is debatable. Gypsum and quartz sand lunettes are commonly present around playa lakes within the Great Victoria Desert region.

Gypsum and quartz sand lunettes are also found around the playa lakes of the Great Victoria Desert and also north of Island Lagoon in the Lake Phillipson region where minor longitudinal dune formation postdate lunette development. The sand dune systems in the region east of the Gawler Ranges, including those around Island Lagoon are derived from, or associated with, the inland dune fields of the Great Victoria Desert. This long northwest/southeast trending tongue of vegetated dunes re-occurs on the western side of Island Lagoon. The draining process from the Arcoona plateau and infilling led to the formation of the Lagoon. Today, the drainage pattern is localised, with intermittent streams carrying relatively small amounts of rainfall to the lake. The sand dune complexes and lunettes south and west of Island Lagoon are largely of Holocene origin (Dalgarno 1981) and may provide broad dates for surface sites around the Lagoon.

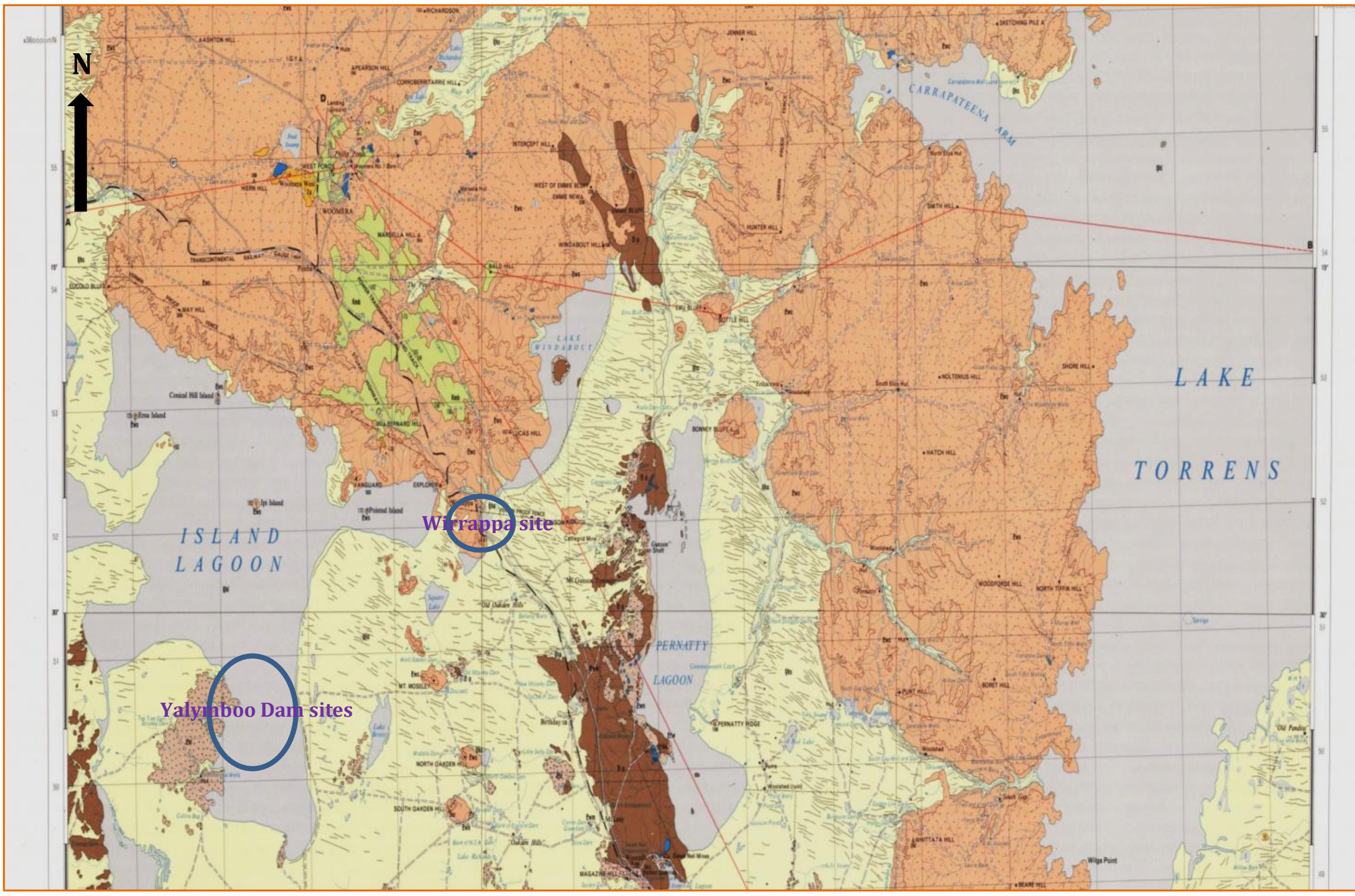


Figure 7: The surface geology of Island Lagoon, including the areas of the Yalymboo Dam and Wirrappa sites in Quarternary (Holocene) dune systems (adapted from Dalgarno 1981).

Landsystems

The Interim Biogeographic Regionalization of Australia (IBRA) classifies Australia's landscapes into 89 geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. Those bioregions are formed from 419 sub-regions which are more homogenous geomorphological units in each bioregion. IBRA is comprises a detailed subset of the global ecoregions (Australian Government, Department of the Environment, 2015). IBRA is effectively a planning tool and, at the sub-region level, provides a mechanism to identify and classify land-systems at the coarsest level. Island Lagoon is in the IBRA Gawler (GAW) Bioregion and the GAW 3 (Gawler Lakes) sub-region (Figure 8).

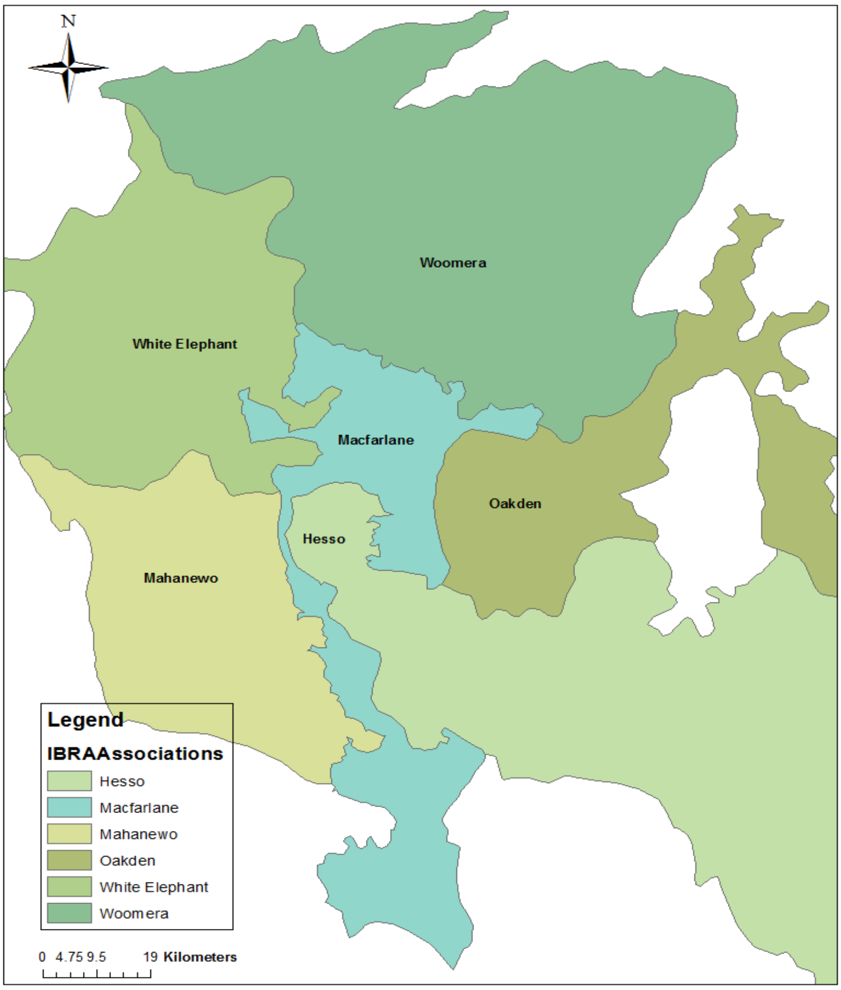


Figure 8: Island Lagoon – IBRA Gawler Ranges sub-regional associations. Sites are located in the Hesso and Oakden associations. Island Lagoon is comprises the Macfarlane association.

IBRA Association	Geographic name	Landsystem	Geology	Soil	Vegetation
Woomera (GAW 4)	Arcoona plateau	**Plain** (silcrete plateau, rises & hills).	Quartzite, colluvium, sand, alluvium.	Red duplex soils and sands.	Chenopod and Samphire shrubland.
White Elephant (GAW 3)	Gawler Lakes	**Sand-plain** (sand-plain and dunes with calcrete rises)	Sand, quartzite, silcrete and alluvium.	Red calcrete earths, red sands and red calcrete loams	Tall open woodland of Mulga, Turpentine Mulga, Myall and Bluebush and woodland of Native Pine and Blackoak and Chenopod shrubland of Samphire
Mahanewo (GAW 3)	Gawler Lakes	**Sand-plain** (sand-plain and dunes with silcrete rises)	Sand, quartzite, silcrete and alluvium	Red calcareous earths, reddish sands, powdery red calcareous loams and crusty red duplex soils	Chenopod shrubland of saltbush, low open woodland of mulga and black oak, woodland of native pine, tall shrubland of horse mulga, tall shrubland of mulga and steel bush and low open woodland of myall and bluebush.
Hesso (GAW 3)	Gawler Lakes	**Plain** (plain with silcrete-capped rises)	Sand, silcrete and alluvium.	Red calcareous earths, crusty red duplex soils and reddish sands.	Chenopod shrubland of Saltbush and Bluebush, low open woodland of Mulga and Black-oak, woodland of Native Pine, tall shrubland of Horse Mulga and Myall
Oakden (GAW 3)	Gawler Lakes	**Sand-plain** (sand-plain with dunes and hills of sandstone)	Sand, silcrete and alluvium.	Red calcareous earths, reddish sands, powdery red calcareous earths.	Tall open shrubland of mulga, turpentine Mulga and Myall on the plains, woodland of Native Pine and Black-oak or Horse Mulga on the dunes, Chenopod shrubland of Saltbush
Macfarlane (GAW 3)	Gawler Lakes	**Playa plain** (salt lake surface and drainage channels)	Alluvium and gypsum	Grey calcareous loam and red duplex soil	Chenopod shrubland of samphire and nitrebush

Table 1: Summary of IBRA Associations and landsystems around Island Lagoon.

Landsystems are mapping units based on an ecosystem approach where several features including climate, geology, landform, soil and native vegetation are integrated to provide a comparative tool for research or management of the effects of land use (Victorian Government, Department of Primary Industry, 2015). Landsystems are commonly mapped in terms of landform, geology and vegetation. The principal landsystems in the Island Lagoon complex include the playa plain of the lake, silcrete plain to the south-west of the lake, rises such as the Arcoona tablelands to the east, sandplains to the south-east and north-west and dunes and lunettes. Table 1 summarises the landsystems around Island Lagoon with a description of key features of those landsystems and Figure 9, below, provides examples of those landsystems.

Figure 9: Views of typical landsystems around Island Lagoon, clockwise from top left, playa plain (lake bed), silcrete plain (gibber plain), sandplain, residual dunes or lunettes and canegrass swamps or gilgais.

Biodiversity and ecology

The ecosystems of the Island Lagoon region reflect the very low annual rainfall and significant impact from feral animals, pastoral activity, mineral exploration and mining activity; however, despite that, these ecosystems remain relatively biodiverse. The ecosystems of Island Lagoon region include the rises and shrub-steppe plains with a cover of Chenopods, the low-open woodlands of the dunes and sand-plains covered by Acacia, Callitris, Casuarina and other species as well as the playa drainage systems of Samphire. Dominant vegetation on the shrub-steppe include: Low Bluebush (*Maireana astrotricha*), Pearl Bluebush (*Maireana sedifolia*), Black Bluebush (*Maireana pyramidata*) and Bladder Saltbush (*Atriplex vesicaria*). The vegetation of the drainage systems includes Samphire (*Tecticomia halocnemoides* and *Sclerostegia tenuis*) and other species. The dominant plant species of the sand dunes and sand plains include: Mulga (*Acacia aneaura*), Myall (*Acacia papyrocarpa*) Umbrella Wattle (*Acacia oswaldii*), Native Pine (*Callitris glaucaphylla*), Black-oak (*Casuarina pauper*), Bullock Bush (*Alectryon oleifolius*), Sugarwood (*Myoporum platycarpum*) and many others. Some of those species and the understorey species provide bush foods and medicines for the Aboriginal people of the region (Figure 10 and Table 2).

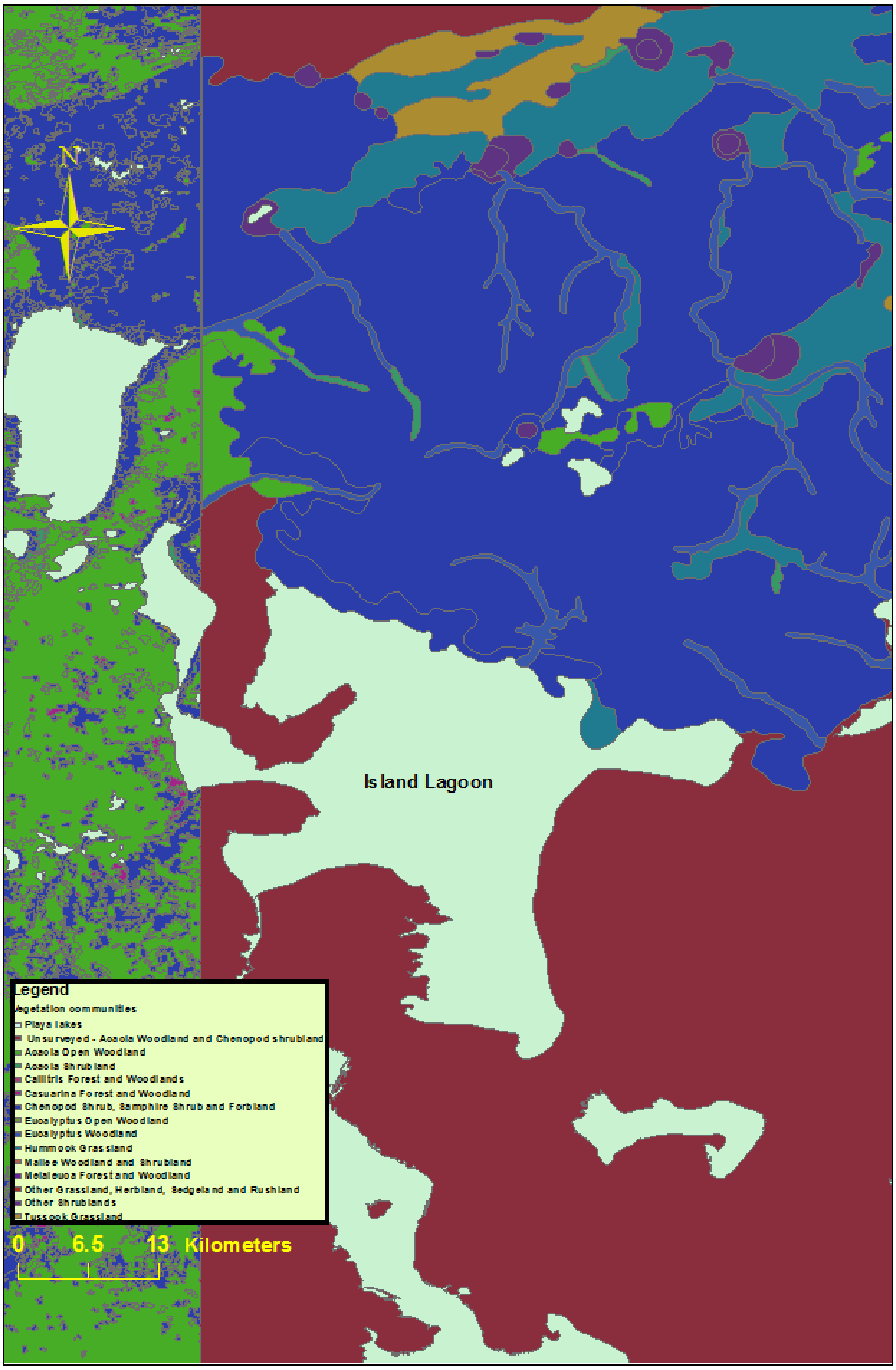


Figure 10: Vegetation communities of Island Lagoon

Vegetation community	Dominant species	**Land-system**	Comments
Tall open woodland	*Eucalyptus sp., Acacia aneura* and *Alectryon oleifolius, Myoporum platycarpum* over *Aristida contorta, Eragrostis eriopoda, Maireana georgei, Ptilotus obovatus var. obovatus* and *Monachather paradoxus.*	**Sandplain (sand plain and silcrete plain with residual sand-dunes).**	
Chenopod low open shrubland	*Atriplex vesicaria, Atriplex nummularia, Maireana astrotricha, Maireana pyramidata, Rhagodia spinescens.*	**Rise/plain/hills (silcrete plains, tableland and hills).**	Some drainage channels, cane-grass swamps and gilais.
Low open woodland	*Acacia papyrocarpa, Callitris glaucophylla* and *Casuarina pauper* over *Maireana sedifolia, Ptilotus obovatus, Atriplex vesicaria, Enchylaena tomentosa Lycium australe, Maireana pyramidata, Austrostipa sp.* and *Sclerolaena obliquicuspis.*	**Sandplain (sandy plain with calcrete).**	Some calcrete rises.

Table 2: Vegetation communities with dominant species around Island Lagoon aligned with landsystems.

Those ecosystems also provide habitat for a number of bird, mammal and reptile species including, for example; the Australian Bustard (*Ardeotis australis*) and Emu (*Dromaius novaehollandiae*), the Red Kangaroo (*Macropus rufus*) and Western Grey Kangaroo (*Macropus fuliginosis*), Goanna, Bearded Dragon, Shingleback lizard and other small marsupial carnivores such as the Little Long-tailed Dunnart (*Sminthopsis dolichura*), the Stripe-faced Dunnart (*Sminthopsis macroura*), the Fat-tailed Dunnart (*Sminthopsis crassicaudata*), the Kultarr (*Antechinomys laniger*) and others. Many of those animal species have totemic significance but for some people, provide a protein rich food resource.

Figure 11: The Australian Bustard (*Ardeotis australis*) – a threatened species and significantly traditionally only eaten by men, above left and above right, possibly, the nest of the extinct Greater Stick-Nest Rat (*Leporillus conditor*).

The archaeology of Island Lagoon

There is physical evidence for Aboriginal occupation of the Island Lagoon region in the form of several surface archaeological sites to the east of the lagoon on the Arcoona plateau. Nineteen archaeological sites are registered on the Site Register (Central Archive) of the Department of State Development Aboriginal Affairs and Reconciliation (DSD-AAR) and include; camp-sites, quarries, workshop sites (surface lithic artefact scatters) and rock-art sites (engravings). The AAR record for registered sites is not complete record and as there are many other 'reported' sites in the region. Also site locational details are often inaccurate as a result of poor mapping skills or Kokatha cultural restrictions. Figure 12 and Table 3, below, provide details for those sites.

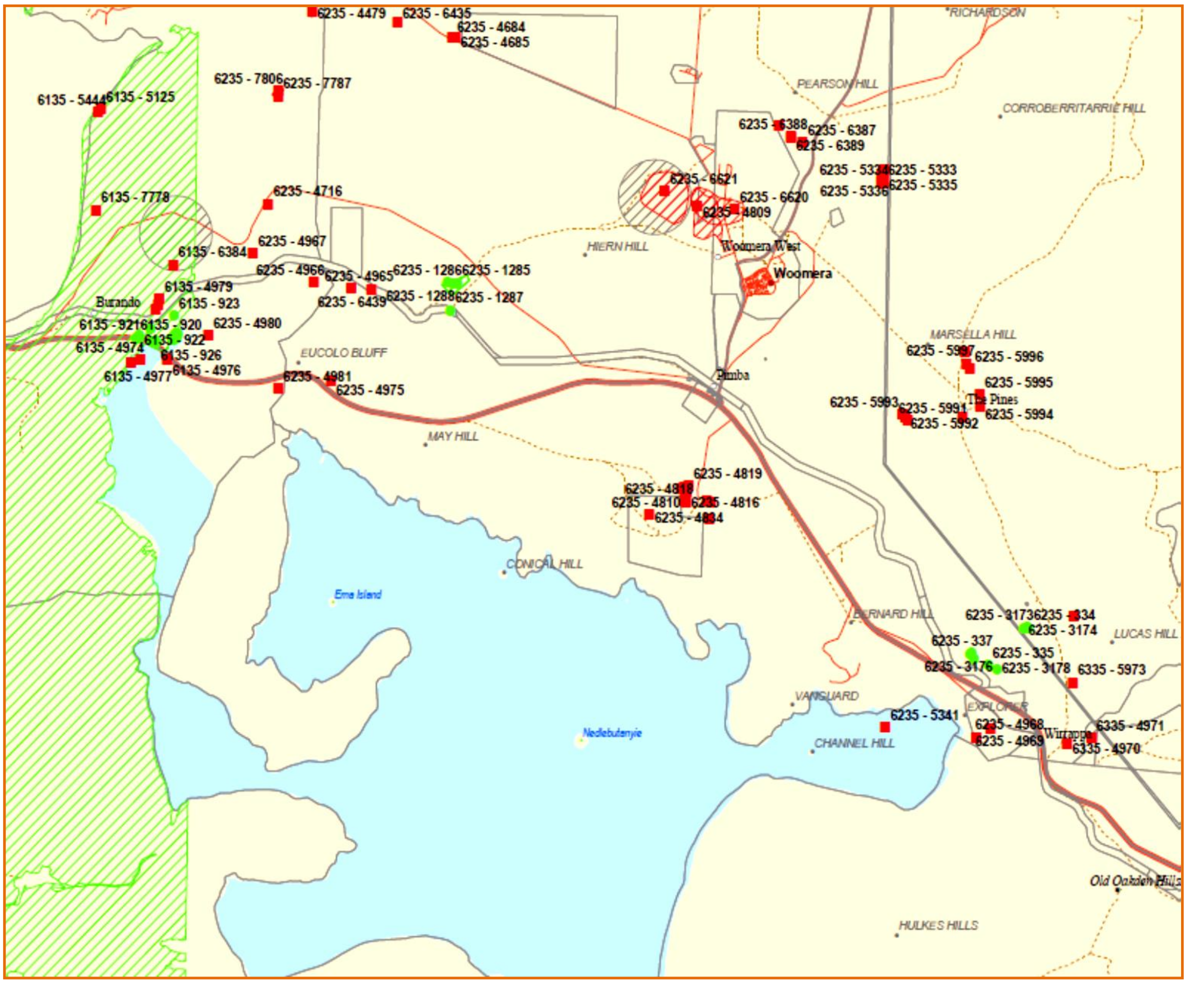


Figure 12: Registered sites in the Island Lagoon region (Adapted from DSD - AAR).

Site Number (DSD – AAR)	Easting	Northing	Details/Description
6235 -5341			Archaeological (artefact scatter)
6235 - 4981			Archaeological (artefact scatter)
6235 - 4975			Archaeological (artefact scatter)
6235 - 4968			Archaeological (artefact scatter)
6235 - 4836			Archaeological (art/engraving)
6235 - 4835			Archaeological (stone arrangement)
6235 - 4834			Archaeological (art/engraving)
6235 - 4819			Archaeological (quarry)
6235 - 4818			Archaeological (stone arrangement)
6235 - 4817			Archaeological (stone arrangement)
6235 - 4816			Archaeological (stone arrangement)
6235 - 4815			Archaeological (art/engraving)
6135 - 4979			Archaeological (artefact scatter)
6135 - 4978			Archaeological (artefact scatter)
6135 - 4977			Archaeological (artefact scatter)
6135 - 4976			Archaeological (artefact scatter)
6135 - 4974			Archaeological (artefact scatter)
6135 - 922			Archaeological (artefact scatter)
6135 - 920			Archaeological (artefact scatter)

Table 3: Summary of known Island Lagoon sites – based on the DSD - AAR Central Archive

Figure 13: Examples of stone tools from similar environments in the Island Lagoon region, Lakes Acraman and Gairdner; from top left, pirri points and scrapers, stone axe and tula.

As alluded to in the introductory chapter, previous surveys relating to Kokatha Aboriginal heritage in the Woomera and Island Lagoon region have been undertaken by a number of workers including; Gara (1989) Hewitt (2000) (Arcoona plateau and Eucolo Creek) and Hayward (2012). Cane's (1984, 1987) work in the Western Desert focussed on using sites and specifically the stone tools on those sites to interpret hunter-gatherer behaviour in that region. The most recent work on material in this area was by John Hayward in 2012. Hayward used the hoard of lithics, mainly the stone adze hoard, located and originally described by Ron Hewitt in 1970, to analyse the concept of an Australian lithic toolkit. Previous archaeological work in the broader region includes work by; Berndt 1983; Fitzpatrick and Wood (2004: 4-5); Hewitt (1976, 1978); Pulleine (1926) and Tindale (1974). Two other sites in South Australia (SA) have some relevance to the Island Lagoon sites because they are in similar arid environments, dune and playa lake systems, not far south of Island Lagoon. Walshe (2012) investigated a late Pleistocene hearth site on Coopers Dune near Port Augusta which was dated to 40,000 BP, making it the oldest known site in (SA). This site is also one of only two sites in southern Australia, and one of only seven locations in Australia to demonstrate such antiquity (David et al. 2011; O'Connor and Veth 2006). A late Pleistocene site at Hawkers Lagoon in the Southern Flinders Ranges (Lampert and Hughes 1987, 1988) is also relevant to the Island Lagoon work, once again, because of its location in a similar environment south of Island Lagoon and therefore its possible comparative value. Sites have also been found in deflated Holocene dunes around Lakes Acraman and Gairdner immediately to the west of Island Lagoon (Vickery 2011; Vickery and Jenkin 2014).

Chapter 4: The Kokatha

This chapter introduces the Kokatha people, their traditional land, history both pre and post contact, anthropology (myths) and describes their culture. The chapter also provides information on the contemporary Kokatha, including their recent Native Title determination.

Kokatha people

Kokatha people have been identified as being of the Western Desert culture (Berndt 1959) which includes Aboriginal people in north-west South Australia, eastern Western Australia and the south-west of the Northern Territory. The geographic region of the Western Desert includes the Great Sandy Desert, the Gibson Desert and the Great Victoria Desert. This is important in the context of this work. Western Desert culture has specific identifiable characteristics, particularly in relation to language, but members also share cultural mores, myth and law, social structure and a broad geographic landscape that is remote and arid. Elkin (1931) identified common cultural features including the Madu Wonga language and similar kinship systems social structure, mythologies and totems. Elkin (1931) and Ellis (1978) identified neighbouring Central Lakes groups to Kokatha as Adnyamathanha, Kuyani and Arabana to the east and Barngarla to the south-west. Those groups differed culturally in that they divided society into two moieties, *kurara* and *matheri* (Gara 1989) and applied patrilineal totemism based on the location of conception rather than place of birth with a three phase initiation process that included chest scarring known as *wilyeru.* Gara (1989) and Tindale (1974) noted that Kokatha had adopted some of those practices, for example, the *wilyeru* initiation process. Those differences between the Kokatha and the Arabana, Barngarla, Kuyani and Adnyamathanha, are defining in terms of identifying the eastern boundary of the Kokatha and Western Desert culture.

The name Western Desert 'Bloc', describes the Madu Wonga (Pitjantjatjara/Yangkunytjatjara) linguistic group who share cultural mores, myth and law, social structure and a broad geographic landscape. Groups that share that root language include; Antakarinja, Yangkunytjatjara, Pitjantjatjara, Ngatajara, Ngaanytjatjara and Nakako. Anthropologists including Elkin (1931, 1941), Tindale (1974) and Berndt (1939, 1945 and 1959) have debated the notions of tribe, horde and society to describe groups of the Western Desert Bloc. Berndt's 1959 concept of a society composed of dialect units (language groups), clans and hordes as opposed to tribe, I think, best describes the relationship amongst the Aboriginal people of the western deserts, their country and natural resources. The people of the Western Desert Bloc, including Kokatha, are semi-nomadic based on the seasonally or periodically available resources and most specifically game and water resources. When resources are scarce, larger clans dispersed and fragmented to mobile family groups to reduce risk and to survive on the available resources.

According to Tindale (1974) many alternative Anglicised pronunciations and spelling have been applied to the Kokatha and this has confused the identification of Kokatha people and their land or geographic territory. For example, some of those pronunciations include; Ku:gurda wongga, Kukatha, Kukata, Kokatha, Cocotah, Kookata, Cookutta, Kookatha, Koogatho, Kugurda, Koogurda, Koocatho, Kotitta, Kukataja, Gogada, Gugada, Kokatja (Yankunytjatjara), Maduwonga (Arabana), Madutara (Antakarinja), Keibara or Kipara (plains turkey — a derisive term), Nganitjini (those who sneak and kill by night). Kokatha pronounced as, Kakarrura, apparently applied to a 'horde' west of Lake Torrens, or Kokatha people (Tindale 1974)!

Kokatha and their traditional lands

The Island Lagoon study area lies in the south-west portion of Kokatha country. According to Tindale (1974), the Kokatha were the so-called Gawler Range tribe who lived on some of the harshest country in Australia (Figure 9), so dry that water from tree roots was necessary for survival. Tindale (1974) has provided the best description of the territory of the Kokatha as including Tarcoola, Kingoonya, Pimba, McDouall Peak then West to Ooldea, North to the Stuart range and Lake Phillipson. Tindale described the Southern boundary with 'Pankala' (Barngarla) as being the Southern edge of the Arcoona Plateau towards the Spencer Gulf. Tindale (1974), Hercus (1974, 1975) and Austin, Ellis and Hercus (1976) put Lake Torrens and as far west as Andamooka in Kuyani territory. Hercus (1974, 1975) also includes the area between Lake Torrens and Lake Gairdner, with Island lagoon in Kuyani territory but Tindale suggests that this area is part of Kokatha country. Tindale identified the Kokatha original north-western boundary with 'Jangkundjara' (Yankunytjatjara) as somewhere near 130°E longitude but identified what he called a south-east migration by Kokatha prior to 1850 into what was formerly 'Pankala' (Barngarla) territory. Tindale also indicates that Kokatha abandoned the Ooldea area, a site of high cultural significance to Kokatha, in 1917 when Yankunytjajtjara moved to the south into that area. Therefore, Ooldea marks the western limit of Kokatha territory but this significant site was shared with Wirrangu, Ngalea and other groups (Bates 1921; Tindale 1974). Historically, Kokatha country extended east to the Gawler Ranges, Lake Gairdner and Lake Torrens and north to the Stuart Range, Lake Phillipson, Mt Eba and Mt Finke (Matthews 1900; Wood Jones 1925). From the 1850's Kokatha are known to have travelled regularly to the coastal areas including, Port Lincoln and Fowlers Bay. The places or locations now known as Andamooka, the Gawler Ranges, Kingoonya, Lake Phillipson, Pimba, McDouall Peak, Ooldea and the Ooldea Range, the Stuart Range and Tarcoola are significant to Kokatha people (Bob Starkey pers. comm. 2013). Of course, by necessity in terms of resource availability, trading and cultural practice and marriage boundaries for western desert groups were somewhat fluid and often difficult to identify in a contemporary context.

Figure 14: Elkin's original interpretation of the Aboriginal groups of the Western Desert Bloc. (after Elkin 1939).

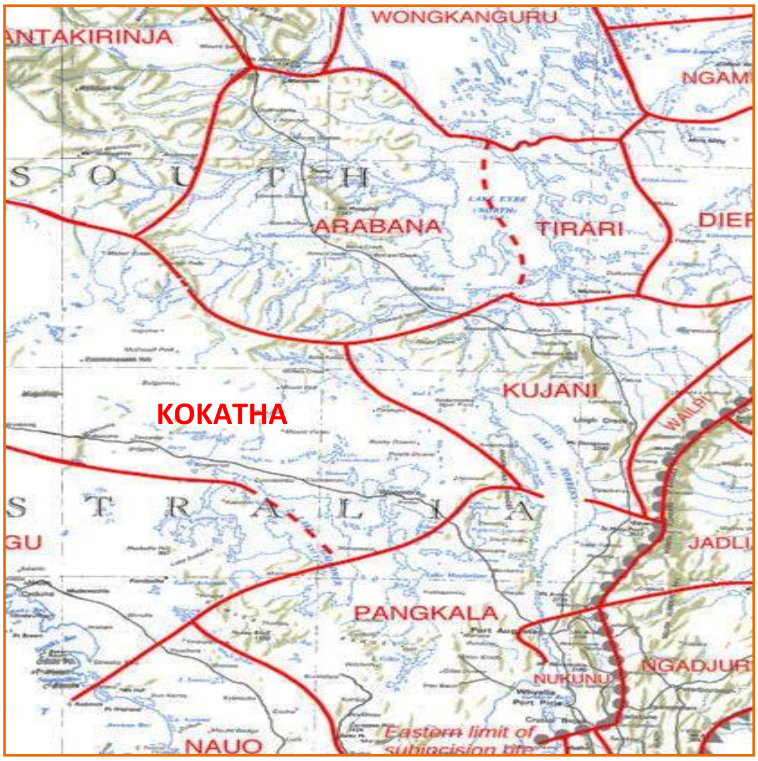


Figure 15: Map of Aboriginal Language groups with connection to the region (excerpt from 'Tribal Boundaries in Aboriginal Australia, after Tindale 1974, Courtesy of the South Australian Museum).

Kokatha people in post-contact times

Tindale (1974) and Berndt (1985) suggest that when European settlers arrived in the Gawler Ranges region in the mid 19th century, Kokatha had aleady started to expand to the south and this expansion increased as European settlement impacted on coastal groups such as the Barngarla on Northern Eyre Peninsula. Kokatha established themselves in the Gawler Ranges and also south-east to Lake Torrens. Today the region that includes Andamooka, Olympic Dam, Roxby Downs, Pimba and Island Lagoon is recognised as exlusively Kokatha country (Hagen and Martin 1983; Berndt 1983).

Berndt (1985) also suggests that at the time of European settlement, Kokatha traditionally extended into the north-west of the Gawler Ranges and were expanding to the south and south-east into Pankala (Barngarla) territory. Kokatha, today, insist that their territory extends down the eastern side of Lake Torrens and up to Stuart Creek and Wintinna and across to the eastern side of the Gawler Ranges, including Lake Gairdner (R. Starkey, personal communication, May 11, 2015).

Berndt (1985) suggests that in the post-contact period the Kokatha were moving to the south and south-east and were recorded collecting rations on the Eastern edge of their territory at Yardea, Nonning, Kokatha, Mt Vivian, Mt Eba, Coondambo, Wirraminna and South Gap. Many Kokatha continued to drift south and west into European settlements and many ended up at Koonibba Mission which was established in 1897 near Ceduna (Gara 1989).

Kokatha were employed in seasonal work such as shearing sheep and stock work, fencing and bounty hunting for Dingos on pastoral properties on their country and went ‘bush’ regularly to hunt and to practice business and ceremony. The east–west railway construction from 1917 developed contact with Europeans but the 1914/15 drought forced many Kokatha to move to settlements including Port Augusta and Iron Knob (Gara 1989). The establishment of Woomera and the restrictions that were applied to Kokatha had a significant impact on cultural activity and many important cultural items were moved to the Anangu Pitjantjatjara Yankunytjatjara (APY) lands for safe storage (R. Starkey, personal communication, March 3, 2015). Many significant sites in the Woomera, Pimba, Island Lagoon, Eucolo Creek region were severely impacted by artefact collectors. This site robbery, that included the removal of engravings from rock surfaces using mechanized equipment, has occurred from the 1950's and was particularly intense during the 1960's and 1970's (R. Starkey, personal communication, May 11, 2015).

Kokatha mythology associated with Island Lagoon

There are three known ancestral creation myths that are associated with the Island Lagoon region and specifically landscape features within Island Lagoon. Those myths reinforce the significance of Island Lagoon for Kokatha people. The stories include the Seven Sisters story, a Pleiades myth (revolving around ancestral women beings that connect to the north and south), the Wati Kutjara (Two Men Dreaming — linked to Gemini or The Twins) and the Malu Kutjara (two kangaroos) myth. As there is sensitivity around the detail of those myths it is not possible to provide more detail here except to say that Island Lagoon is culturally very significant to Kokatha.

Kokatha have been negotiating Native Title over an area that includes Roxby/Olympic Dam, Woomera, the Arcoona Plateau and Island Lagoon for many years. Kokatha native title, as part of an amalgamated claim with Barngala and Wirranga, has also been determined over the Gawler Ranges. The Kokatha Native Title claim, SAD/2009, over the area that includes Island Lagoon, Woomera and Roxby Downs, was determined on 1 September 2014 (Figure 16). The determination of the claim confers specific rights and interests to Kokatha native title holders including; the right to live and camp in the area, conduct ceremony, hunt and fish, collect food, build shelters and visit places of cultural significance. Kokatha people are actively involved in the management of their country and specifically cultural heritage sites and, as a result of the native title determination, have acquired long-term leases over several pastoral properties immediately to the east of Woomera to develop a pastoral business and for training and employment of Kokatha.

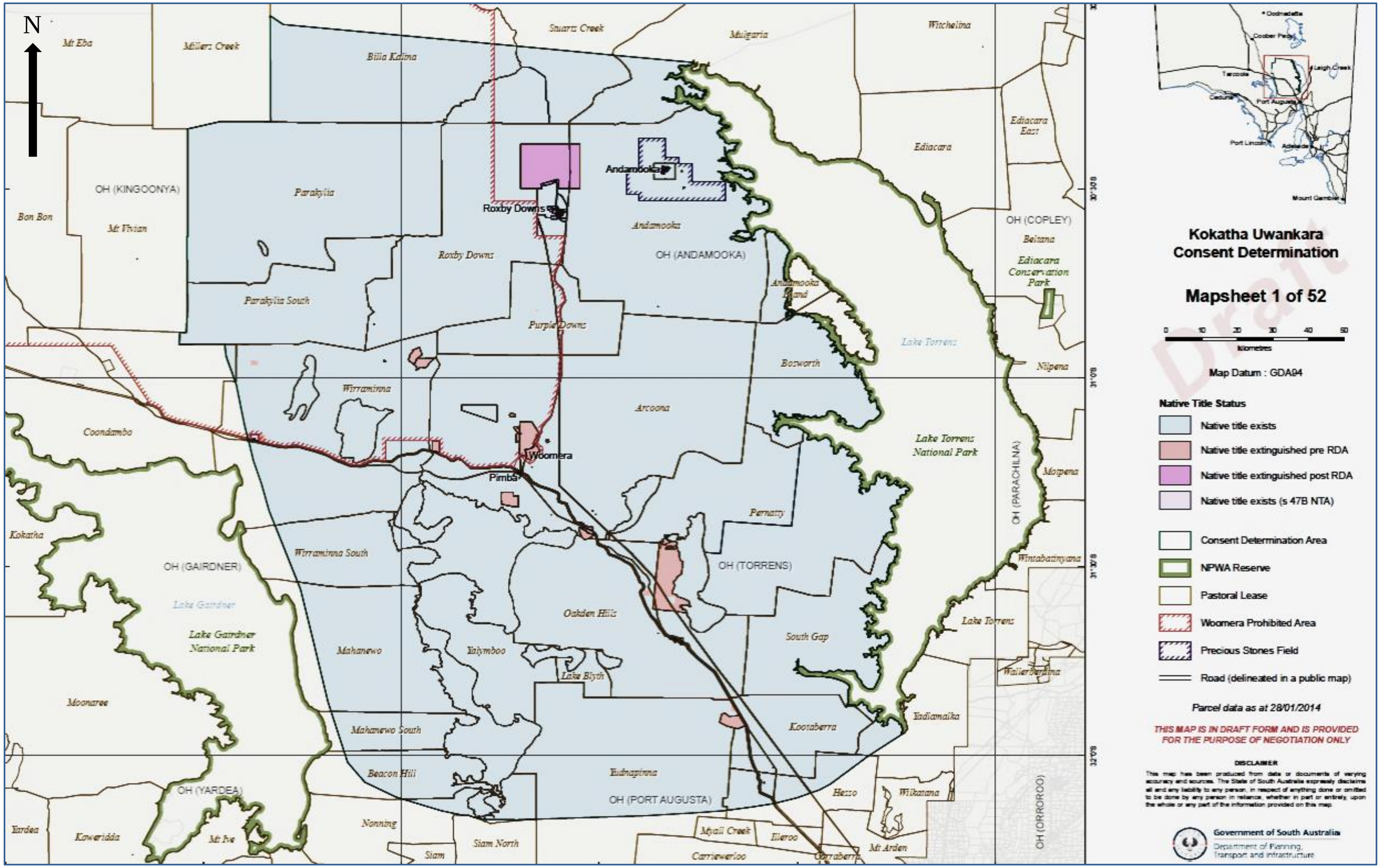


Figure 16: Kokatha Native Title Consent Determination (claim SAD 90/2009).

Chapter 5: Methods.

This chapter outlines the methods used in this research. It reviews methods for background research on Kokatha sites within the Island Lagoon region, the remote sensing strategy used to map the land-systems around the lagoon, and the protocol developed to survey and record new sites around the lagoon. The chapter also outlines the methods applied to the collection and analysis of field data.

Ethics and permissions

Aboriginal heritage sites are recorded in the Central Archive in the Department of State Development, Aboriginal Affairs and Reconciliation (DSD–AAR), subject to the agreement of Traditional Owners — in this case Kokatha. Access to this information is subject to the approval of the Kokatha Traditional Owners and Native Title holders. Approval was obtained from Kokatha through the Kokatha Aboriginal Corporation RNTBC, to access the archive of recorded sites. Details for those sites recorded on the Central Archive were analysed for information relating to the location and character of Aboriginal sites.

This project involved engagement with Aboriginal people that included consultations to record information on Kokatha and their relationship with the Island Lagoon region, sharing of traditional and mythological information and also work in the field on archaeological sites with Kokatha representatives. As Aboriginal people were involved in the project and despite the fact that this project was an archaeological project as opposed to an anthropological project, it was considered advisable to obtain ethics approval from the Social and Behavioural Research Ethics Committee (SBREC), (Flinders University). The original application for ethics approval was submitted on the first of May, 2012. Conditional approval was given on the fifth of July 2012 and a response to queries in the conditional approval, that also included a project modification request, was provided on the tenth of June 2014. The final approval for the project was received on the sixth of October 2014 when approval number 5686 was issued and the project field work commenced.

Survey strategy

The Island Lagoon research site is very large and remote area, approximately 800 sq km, with variable rugged terrain and therefore, limited and difficult access. Safe access is only possible via station tracks. There are no reported or recorded sites to the south west, west or north-west of the Lagoon in the silcrete rises and plains or on the sandplain and deflated dune complexes where, according to Kokatha sites are usually located (R. Starkey, personal communication, May 11, 2015) and also Hughes et al. (2014). Previous visits to areas west of Island Lagoon, around Lakes Acraman and Lake Gairdner, have also identified sites (Vickery, Unpublished Data), though these have not been included as part of this research project. This remoteness and difficulty of access may partially account for the lack of knowledge about Aboriginal heritage in the large area west of Island Lagoon.

Archaeological research in the arid regions of Australia into Aboriginal landscape and resource use tend to focus on culture and ecology which are interpreted by the application of models based on past ethnographic sources (Cane 1984; Veth 1993). Resource base fluctuations have an influence over the way arid sites are occupied and patterns of occupation are particularly affected by water availability and episodic rain events (Holdaway and Fanning 2014). As described earlier, the study site is in an extremely arid region and phases and patterns of occupation in the region would have been necessarily subject to climate fluctuations, seasonal events or microclimatic effects, particularly in relation to water availability, and this influenced the survey protocol that was developed for this project.

The field survey method employed here involved a hybrid approach, combining elements of the predictive model developed by Hughes (1981) at Olympic Dam, to the east of Island Lagoon with the geo-archaeological approach used by Holdaway and Fanning (2004) at Fowler's Gap in western New South Wales. As a result of archaeological investigations of 133 sites from 1980 to 2007, and an ongoing salvage program at Olympic Dam, approximately 100 km east of Island Lagoon, Hughes et al. (2011), developed a predictive model for locating sites in this arid region. This model used terrain pattern mapping based on landform type and geological regime that approximately corresponds to the landsystems described in this study that were used to identify likely sites for investigation.

Geoarchaeology is a discipline developed in the 1960's (Holdaway and Fanning 2004), and considers human behaviour in a dynamic environment (Butzer 1971). Ground Penetrating Radar (GPR), Geographic Information Systems (GIS) and chronometric dating methods are key technical tools for geoarchaeology. This technology assists in developing an interpretation of archaeological sites in four dimensions to reconstruct topography, the living environment and human ecology. In the arid regions of Australia, including Island Lagoon, the way natural processes expose, conceal, distribute or concentrate archaeological materials creates interpretive difficulties for archaeologists particularly in terms of addressing questions about settlement patterns, the use of the landscapes and natural resources. Residual land surfaces are variable and respond differently to the effects of climate, particularly rainfall events on erosion and deposition of surface material. Some of the landsystems, such as the silcrete rises, hills and plains around Island Lagoon are resistant to weathering. Others, such as the sandplains and dunes or lunette systems are very susceptible to weathering especially in recent times, following European colonisation, when rabbits were introduced, and heavy stocking rates severely impacted land cover resulting in erosion and the deflation of the Holocene dune systems. Determination of temporal scales or chronologies for Holocene surface sites is particularly difficult because of the periodic climatic variability of the Holocene and an inability to accurately date surface material as there is no clear temporal context for example, biological or organic material co-located with lithic material. Pleistocene sites can often be dated because buried artefacts can be located in association with dateable material.

According to Holdaway and Fanning (2014), surface artefact assemblages can provide some idea of what was abandoned locally, transported in and also what may have been removed from the site (Holdaway et al. 2008b; Holdaway et al. 2012) thereby providing an indication as to how and when people used the landscape and local resources. The geoarchaeological approach is one method used to effectively investigate surface archaeological sites within arid zone landscapes.

With regard to this project, the first stage of the process was to locate sites, and survey and map those sites. Key characteristics of the artefact assemblages at selected sample sites (3) within those site complexes were then sampled and recorded. Given that the location of sites on the western side of Island Lagoon was unknown the survey strategy initially applied a spatial survey approach at regional and local levels.

Because of the size, remoteness and inaccessibility of the Island Lagoon region a specific survey strategy was developed that enabled hierarchical sampling of the region to find and sample sites. The survey and sampling strategy was neither random nor systematic (Burke and Smith 2004) and can be best described as a 'land-system based predictive stratified survey and sample' approach based loosely on the strategy developed by Hughes et al. (2011). Kokatha local knowledge was also employed in the survey process to predict likely areas where sites might be located. At the sub-regional or local scale, land-systems defined by landform pattern (Speight et al. 2009) were mapped, using Google Earth at a scale of approximately 1:350,000. Vehicle transects through those elements were used to ground truth and map land-system units predicted to contain archaeological sites with particular reference to the work by Hughes et al (2011). Those specific landsystems, dune and lunette systems with associated claypans or canegrass swamps, were then searched intensively for sites by pedestrian survey.

In summary the survey strategy applied a hierarchical or stratified approach at three levels as follows;

Level 1

The first or sub-regional level applied remote sensing methods using Google Earth at a scale of approximately 1:350,000 to identify the key landscape elements in the region, drawing on the identified regional landsystem types previously determined (Table 2 and Figure 19). Those landsystem types were defined as: playa plain (lake bed), rises/hills, sand-plain and dune field/ lunette based on Speight et al. (2009). The landsystem boundaries were 'mapped' remotely into Google Earth (Figure 19) to provide a visual representation of landsystems around Island Lagoon.

Level 2

The second level incorporated the landsystem information derived at Level 1 with local Kokatha knowledge to plan a system of transects across the key land-systems that were based on station tracks that could be safely driven to effectively survey landsystems that were predicted as likely to support sites (Figure 18). The purpose of the transects was to ground truth the location and extent of landsystems identified at Level 1 and to develop an understanding of key features of those landsystems. The width of transects varied according to visibility but were generally broad swathes of approximately 0.5–1 km either side of the selected station tracks.

Level 3

At the third level, prospective units within landsystems were chosen based on Kokatha knowledge but also by applying my knowledge of preferred environments for Aboriginal campsites. In this region, those sites are usually located on sand dunes and lunettes adjacent to claypans and gilgai's, which provide shelter, firewood and water. This preferred campsite 'habitat' is traditional for Aboriginal people in this region and is very predictable in terms of in locating sites on deflated dunes (R. Starkey, personal communications, March 3, 2015). Those units were then systematically surveyed by pedestrian survey for sites and those sites were mapped in terms of extent and key features were recorded. Those features included the specific location, shape and size of the site, local environmental features such as vegetation cover and also depth of erosion and human related impacts such as rabbit or stock impact. The site type was recorded based on the presence of materials such as hearths, artefact scatters, quarries, burials and stone arrangements and the availability of natural resources, usually water and raw material for tools (Figures 21–24).

Level 4

Site complexes located during the Level 3 survey process were then sampled using 3 (replicated) 5m x 5m plots. Site 'complexes' may be defined as several artefact scatters in one discrete location that appear to have been used either by different individuals or groups at one time or, many individuals or groups over a number of years. The process of using replicate sampling was to improve the statistical robustness of the sampling process. The initial sampling protocol that was considered for sampling within sites was one of random sampling within the 3 sites selected for sampling using a random number generator; however, because the site complexes were large with a very variable density of artefacts, a 'judgement' sampling (Burke and Smith 2004) method was used. The objective for using this method was to achieve the best or most productive outcome particularly as the artefact analysis protocol was focused on artefact function, whereby the typology of artefact can be significant, it was determined to sample three of the densest surface scatters within each site complex. Another key objective was to sample at least 1% of all site complexes using this method. Artefacts within the sample plots were systematically recorded based on the parameters outlined below.

Following the mapping, recording and photographing of key elements of each site, three sites were sampled, as per the protocol previously described. Two previously unknown sites on the western side of Island Lagoon in degraded dune complexes described as Site 1 and Site 5

(Figures 23 and 27) were sampled and a previously recorded and the registered site to the SE of Island Lagoon, DSD–AAR 6235-4968 (See Figure 31) was also sampled for comparison.

The datum for any survey data in this report is GDA 94. Data was captured using a Garmin GPS, Map 62s. Maps were developed using Google Earth and ESRI ArcGIS software. Recorded site information will be submitted for registration on the AAR Central Archive when approved by Kokatha.

Artefact recording and analysis

The focus for site sampling and recording was to gather information on sites and selected assemblages in a systematic way for analysis to address the aims of the project. The protocol used was based on the approach developed by Hiscock and Hughes in 1982 to record surface artefact scatters for the Olympic Dam project (Kinhill-Stearns Roger 1982).

The principal objective for the method of analysing selected samples of artefact assemblages was to acquire data that might provide an insight into past human behaviour in the region, that is, to attempt to determine site function, how the sites were used, by whom and possibly when. Sites in this region are open surface sites, exposed by erosion over the past 100–150 years, as opposed to stratified cave sites where artefacts can be located in context and effectively dated and this limits the ability to determine the age of these open sites. Other key aspects of each site were also recorded including availability/proximity of water resources and evidence of other cultural activity such as ceremonial activity.

Mulvaney (1969) has suggested a three phase cultural sequence, an early phase of non-hafted tools, a later phase of hafted microlithic tools and more recently the use of less morphologically distinct hafted tools. Mulvaney and Kamminga (1999) identified an 'adaptive' phase where backed blades were not used and an 'inventive' phase, mid to late Holocene, which was innovative in terms of blade technology and variety.

Richard Gould (1969) applied Willey and Phillips (1958) ‘tradition’ concept to describe late Holocene artefact assemblages as including small blades and blade blanks, points and pirri points, adzes and thumbnail scrapers in an Australian small tool tradition. This tradition is also reflected at Puntjutjarpa in the Western Desert (Gould 1980). Gould (1980) also did research into the use of raw materials in the Puntjutjarpa area in terms of the relationship between raw materials, quarries and sites. The type and therefore the quality of raw material can affect the form of artefacts. According to Holdaway and Stern (2004) and Jones (1979, 1994) the shape, type and quality of raw material, and therefore the flaking and edge properties of raw material, can constrain users and influence the form of artefacts and therefore the nature of the total assemblage on sites. O’Connell (1977) also found that the main influence on the morphology of retouched flakes was raw material related.

Hiscock (1988a) argued that assemblage composition is related to its position in the landscape and the distance from raw material. Raw material type and availability has the greatest impact on artefact form and therefore function. This is very relevant in relation to the type of raw materials used to make particular artefacts on the Island Lagoon sites and therefore the composition of the assemblages.

Kamminga (1978, 1982) also tried to link edge type with function but, with the exception of adzes, was not able to make any real connection between edge type and function/use. Function/use therefore, is not necessarily directly related to a specific form and of course, tools may be used for multiple applications.

Given this background, the approach to artefact recording was to take the opportunity to record as much information as possible about specific artefacts in the site assemblages regardless as to whether the data was used for this project. Data collected included both morphological and functional attributes (formal and functional attributes).

The information recorded included: the type of raw material used in artefact manufacture; the amount and type of debitage; artefact dimensions, and; specific key attributes relating to termination, flake edge angle and platform type. Work by Hughes et al. (2014) relating to the local geology of this region and the application of this geological material to manufacture stone tools was very useful in this context. Information on 'breakage' was also recorded for analysis to attempt to determine the amount of site usage, breakage being an indicator/measure of trampling on sites (Holdaway and Stern 2004; Holdaway and Fanning 2014). Artefacts were also classified into types broadly reflecting use categories such as hammer stones, hand choppers, grindstones or millstones and bases, engravers, scrapers, thumbnail scrapers, utilised flakes, points and pirri points. Any evidence of retouch on points, scrapers and flakes was also recorded as a possible indicator for tool types that have their origins in the late Holocene and human behavioural change, also reflected in the use of hafted tools (Kamminga 1982; Mulvaney 1975; Mulvaney and Kamminga 1999; Gould 1969, 1980). Details relating to backed blades, cores and flake cores were recorded and cultural information was also noted including such things as the amount of pitting on hammer stones. The dimension of all artefacts was recorded with a particular focus on scrapers and points as a potential method to assist classification. For example, Flood (1970), suggested that points below 60mm in length should be considered to be pirri points. Point and scraper size that typically fit within the size classes found in toolkits of the Australian small tool tradition could assist in dating the sites to the late Holocene period.

This information was recorded onsite using a template developed in Excel (Appendix 1). The template enabled the recording of the following details relating to the site and plot; site ID, plot ID, location (UTM), date and recorder. Artefacts were numbered and assigned to a type based on McCarthy et al (1946) and Holdaway and Stern (2004) using common attributes, as detailed previously. The sampling protocol also enabled maximum site densities to be determined for comparison between sites.

Analysis involved a basic comparison of a number of key components of samples within sites and a broader comparison of key components between sites. Those components included all those elements considered to be key artefacts usually found 'toolkits' in the Australian small tool tradition primarily, small blades, points and pirri points, adzes and thumbnail scrapers (Tables 5 - 13). As indicated earlier, other factors that were compared included such things as the amount of breakage, particularly of points and pirri points in an attempt to determine the level of visitation or site use.

Limitations of the Methodology

The main limitation of the methodology adopted for this survey related to the size and remoteness of the area with the difficulty of access that limited the capacity to survey effectively to locate sites. Archaeological sites had a low density of cultural materials and their distribution was generally restricted to specific landsystems that were very discrete in the broader landscape. Other information, such as data relating to the vegetation communities around the lagoon, was very unreliable as the mapping for this region, particularly to the south-east of the lagoon, is not complete and this impacted on the capacity to accurately determine landsystem boundaries.

As indicated earlier, the sites were all open or exposed surface sites and it was impossible to accurately determine the age of sites because of the lack of any context that might have enabled the sites to be dated. Due to the nature of the study the scope of this project did not include the location and excavation of hearths, as part of the archaeological method, to potentially provide a chronology. This imposed an additional limitation on the project.

Chapter 6: Results

This chapter summarises the results of the field work including the stratified survey protocol to identify landsystems that were likely to contain sites, site locations within specific landsystems, and the outcomes of the site sampling strategy.

Field Surveys

Three field trips were conducted with Kokatha representatives between 25 February and 3 March, 11 May and 16 May, and 8 June and 12 June, 2015. The purpose of the field trips was to implement the survey strategy described earlier and to sample sites that were located during the survey. The survey area was accessed using four wheel drive vehicles via Oakden Hills, Mahanewo and Wirraminna stations (Figure 17) with the initial survey following pre-determined transects into prospective land systems around Island Lagoon using station access tracks (Figure 18). Six site complexes were located during the initial survey (Figure 21). The second field trip focused on surveying and mapping sites 1 to 6 that were located during the first field trip (Figure 21). The final field trip involved the sampling and recording of three site complexes, two on the western side of Island Lagoon and the previously recorded site to the SE of Island Lagoon. Figure 17, below, indicates the planned survey route using station access tracks.

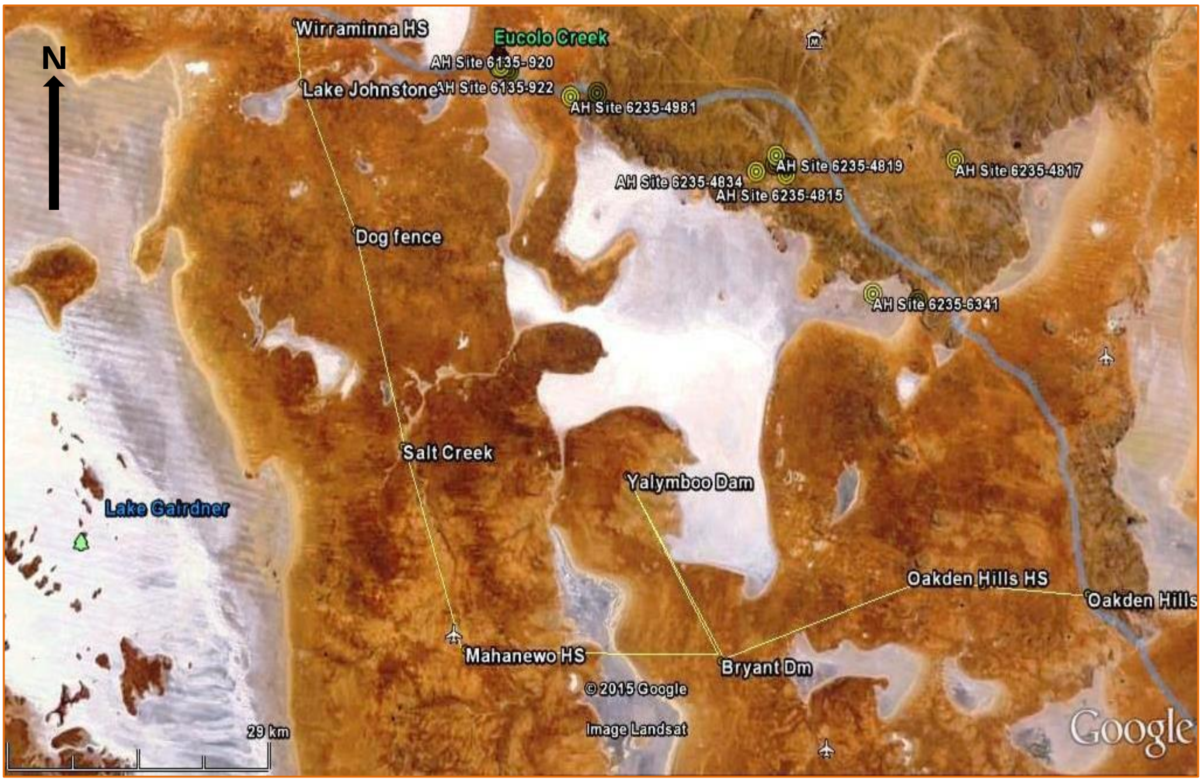


Figure 17: Planned (original) route along station tracks - field trip 1 (25 February to 3 March 2015) (Image – Google Earth).

Survey transects

Figure 18 indicates the five transects that were driven through several land systems on the western side of Island Lagoon. Those transects were between 5 kms and 30 kms in length, and enabled a more systematic and focused approach to searching prospective landsystems for sites.

Figure 18: Survey transects (Level 2 of survey – ground truthing of prospective landsystems), field trip 2 (11- 16 May 2015) (Image – Google Earth).

Mapped Landsystems for Island Lagoon

Figure 19 illustrates the key mapped landsystems for Island Lagoon including; playa plain (the lake bed), silcrete rises/hills, sandplain and dunes and lunettes. As indicated earlier, landsystems were mapped remotely using Google Earth at an approximate scale of 1:350,000 and ground truthed using transects along station tracks (Figure 18).

Figure 19: Mapped landsystems of Island Lagoon. (Image – Google Earth).

Site complexes

As a result of the first Level 2 surveys (field trip 2), six previously unknown sites were located (Figure 20). The sites are described as 'site complexes' because they are relatively large (from 2.5 – 20 hectares) and diverse with regard to artefact density. All sites were located in landsystem 4, the dune and lunette system, adjacent to small canegrass swamp and claypan systems between the dune systems and silcrete rises and plains. The figures and images that follow provide descriptions of all sites.

Figure 20: Newly discovered and mapped sites at Island Lagoon.

Figure 21: The location of the nine sample plots. (Selected at sites 1 (new) 5 (new) & 7 (DSD-AAR Registered Site).

Site sampling and analysis

As discussed earlier, the initial sampling protocol that was proposed involved the selection of sample plots within sites using a random sampling process. When the sites were eventually located, this approach proved to be unworkable due to their size and great variation in artefact density. Because the aim of the sampling process, as detailed in Chapter 5, was to determine what raw materials were used to manufacture artefacts, artefact typology and morphology including dimensions (length, width and thickness) along with the number of artefacts (or fragments) in nominal tool use categories, this approach was abandoned. As the preferred alternative, all plots on all sites were selected, by judgement, on the basis of the densest and most diverse sectors of each site to increase the potential to access the largest amount of material for analysis. Table 4 provides the locations of the nine sample plots within the three sites selected for analysis and those plot locations are also included in Figures 23, 27 and 31.


Figure 22: Kokatha representatives Andrew Starkey (above right), Mick Starkey and Glen Wingfield (above left) surveying sites.

Site and sample plot locations

Table four, below summarises site and sample plot location data.

Site and plot number	Landsystem	Point (GDA94)	Easting	Northing
Site 1 plot 1 plot 2 plot 3	Dunes and lunettes (4)	SE corner SE corner SE corner		
Site 2 plot 4 plot 5 plot 6	Dunes and lunettes (4)	SE corner SE corner SE corner		
Site 3 plot 7 plot 8 plot 9	Dunes and lunettes (4)	SE corner SE corner SE corner		

Table 4: Details for locations of sample plots within sites.

Site one, with Sample Plot locations

Site 1 plots

Site one with sample plots 1, 2 & 3 (Figures 20, 21, 23, 24, 25 and 26 and Tables 4, 5, 6 and 7), is an extensive site complex of approximately 7.0 ha with variable artefact density within the site. Artefact density (all artefacts including debitage), averages 26 per sq. m. for plots (average for all plots) on this site. This site has five canegrass swamps or gilgai's that capture and hold water for several weeks at a time following episodic rainfall events. The site is immediately adjacent to a silcrete plain with excellent material for tool making. The site, however, has been extensively impacted by the development of station water infrastructure, including water catchment dams, tracks and other infrastructure to manage stock. This infrastructure was established when the old Yalymboo Station was established in the 1850's. The artefact assemblages that were sampled within the site generally have similar composition in terms of the broad types of artefacts that were recorded including; cores, blocks, hammer stones, hand choppers, grindstones, flakes, scrapers, points and pirri points.

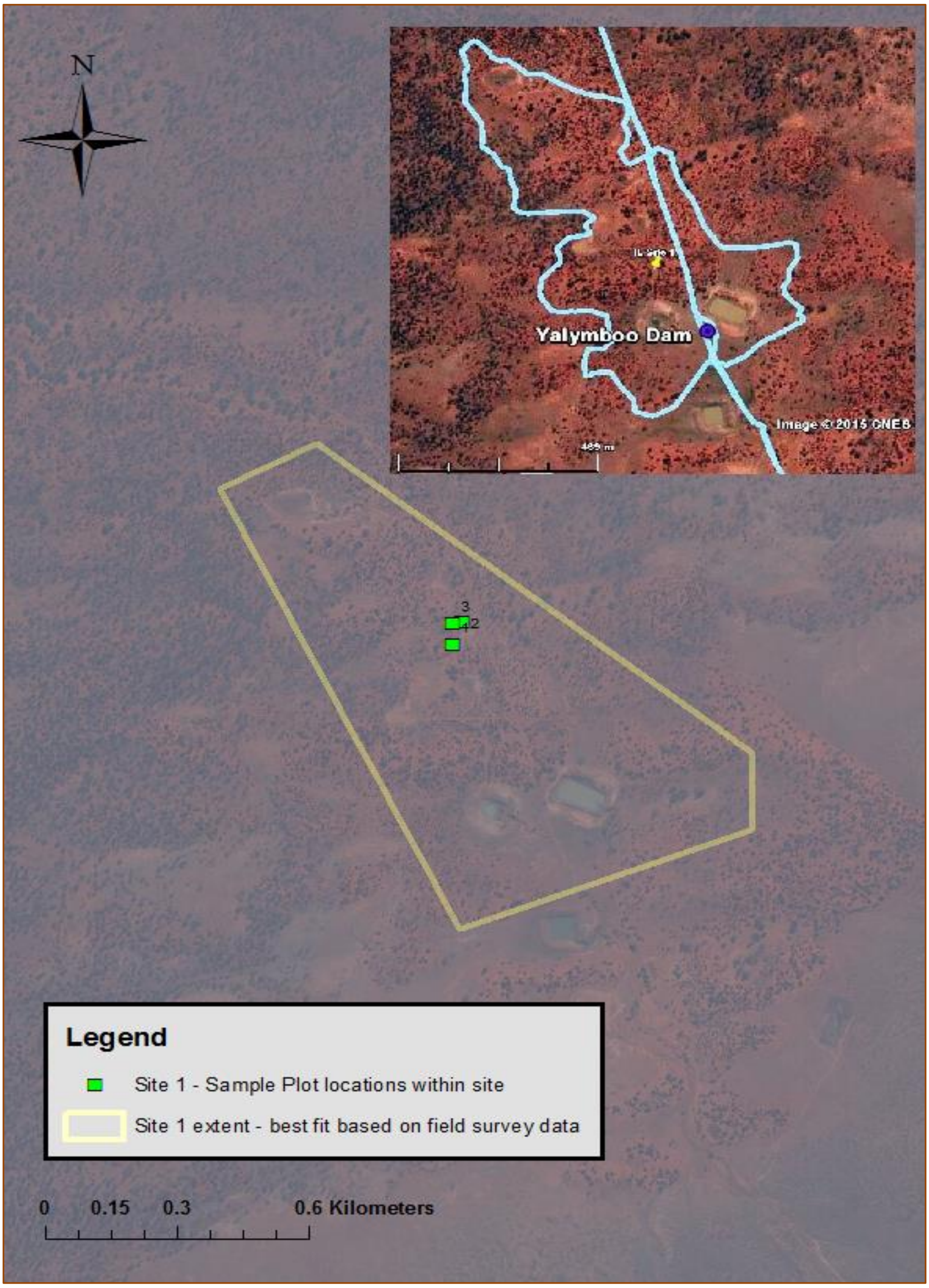


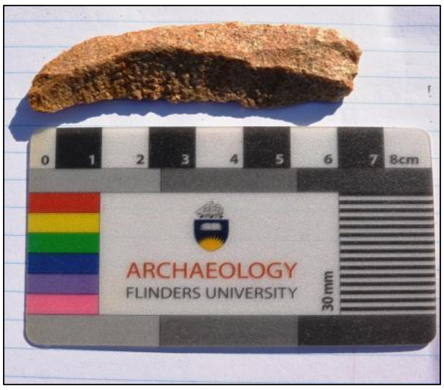
Figure 23: Site 1 extent (Landsystem 4) - with sample plot locations. The inset (blue line) displays the actual surveyed site boundaries.

Site 1 – Sample Plot 1

Site 1: Plot 1	**Typology (total artefacts – 29)**										
Descriptive characteristics	Core	Hammer Stone	Hand Chopper	Grind Stone	Burren engraver	Scraper	Thumbnail Scraper	Flake Core	Utilised Flake	Point	Pirri Point
Termination Feather									1	1	4
Hinge					1	3	1	1	7		
Indeterminate	4	1	1	2		2					
Flake edge angle N/A	4	1		2					4		
< 15							1				
15-30					1						
30-45						2			2		
> 45			1			3		1	2	1	4
Platform attributes N/A		1		2							
Natural						2	1	1	4		3
Flaked	4		1		1				2	1	
Abraded						2			2		1
Break Complete	3	1	1		1	4	1	1	8	1	4
Proximal											
Medial	1			2							
Distal											
Longitudinal											
Material Silcrete	2	1	1	2	1	2			4		2
Chert	2					2	1	1	4		2
Oolitic Chert										1	
Quartzite											

Debitage: Silcrete 375; Quartzite 2; Chert 70. * Flake edge angle.

Table 5: Summary of relevant artefact attributes for Site 1 – plot 1.



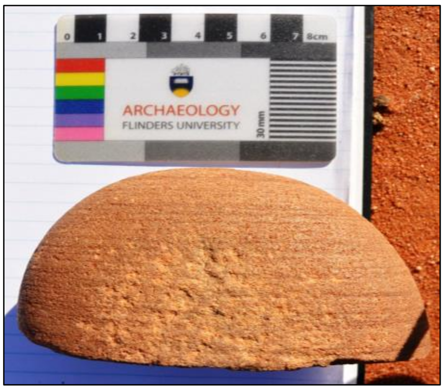


Figure 24: Site 1 - Sample Plot 1, top, with examples of artefacts; bottom left, scraper and bottom right, hammer stone (with obvious use-wear, pitting).

Site 1 – Sample Plot 2

Site 1 : Plot 2		**Typology (total artefacts – 17)**				
Descriptive Characteristics	Core	Burren engraver	Scraper	Thumbnail scraper	Utilised Flake	Point
Termination Feather						
Hinge			3	1	2	
Indeterminate	1		4**	2	2	1
Step		1				
Flake Edge Angle N/A	1					
< 15			3	3	2	
15-30		1	2**		2	
30-45			2			1
> 45						
Platform attributes N/A						
Natural			1			
Flaked	1	1	6**	3	4	1

	Abraded						
Break	Complete	1	1	7**	3	4	1
	Proximal						
	Medial						
	Distal						
	Longitudinal						
Material	Silcrete	1	1	5**	3	4	1
	Chert			2			
	Oolitic Chert						
	Quartzite						

Debitage: silcrete 75; quartzite 1; chert 13; oolitic chert 1. *Flake edge angle. NB: **A possible silcrete tula slug was identified in this plot.

Table 6: Summary of relevant artefact attributes for Site 1 – plot 2.

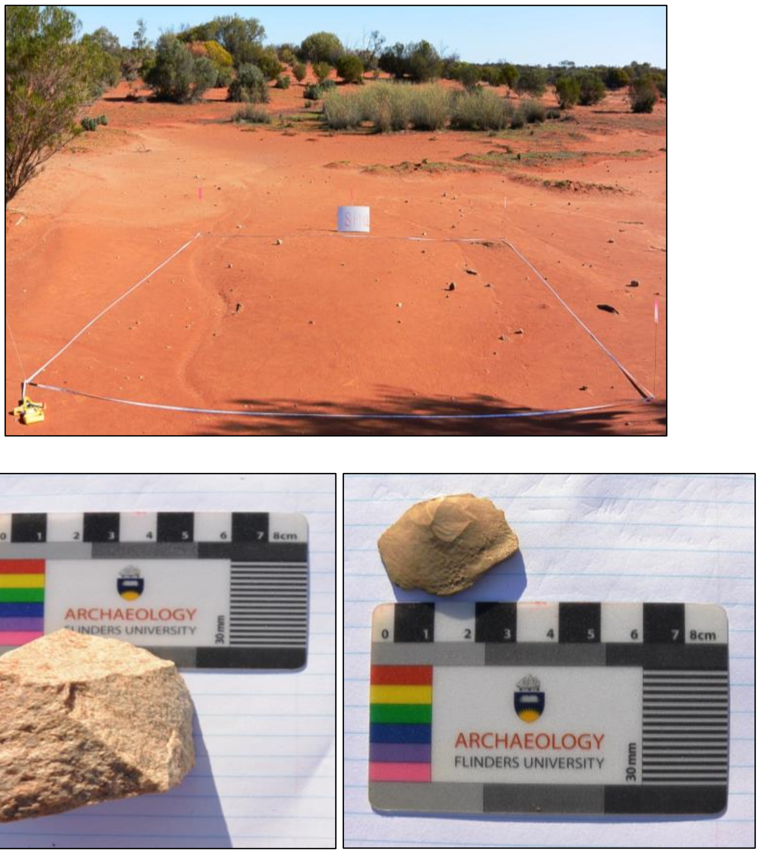


Figure 25: Site 1 - Sample Plot 2, top, with examples of artefacts; bottom left, core and bottom right, scraper.

Site 1 - Sample Plot 3

Site 1 : Plot 3	**Typology (total artefacts – 22)**									
Descriptive characteristics	**Core**	**Hammer Stone**	**Hand Chopper**	**Grind Stone**	**Block**	**Burren Engraver**	**Scraper**	**Thumbnail Scraper**	**Utilised Flake**	**Pirri Point**
Termination										
Feather						1				1
Hinge			1				3	3	3	
Indeterminate	2	1	1	1	1		3		1	
Step										

Flake Edge Angle*										
N/A	1	1		1	1					
< 15							1	1	1	
15-30							2	1	2	1
30-45			1				2	1		
> 45	1		1				2		1	
Platform Attributes										
Natural	1			1	1		1	1	1	
Flaked	1	1	1				6	2	3	
Abraded			1							1
Break										
Complete	2		2				7	3	4	1
Proximal										
Medial		1		1	1					
Distal										
Longtitudinal										
Material										
Silcrete	1		3	1	1		2		3	
Chert	1						5	3	1	1
Oolitic Chert										
Quartzite										

Debitage: silcrete 45; chert 10. *Flake edge angle

Table 7: Summary of relevant artefact attributes for Site 1 – plot 3.

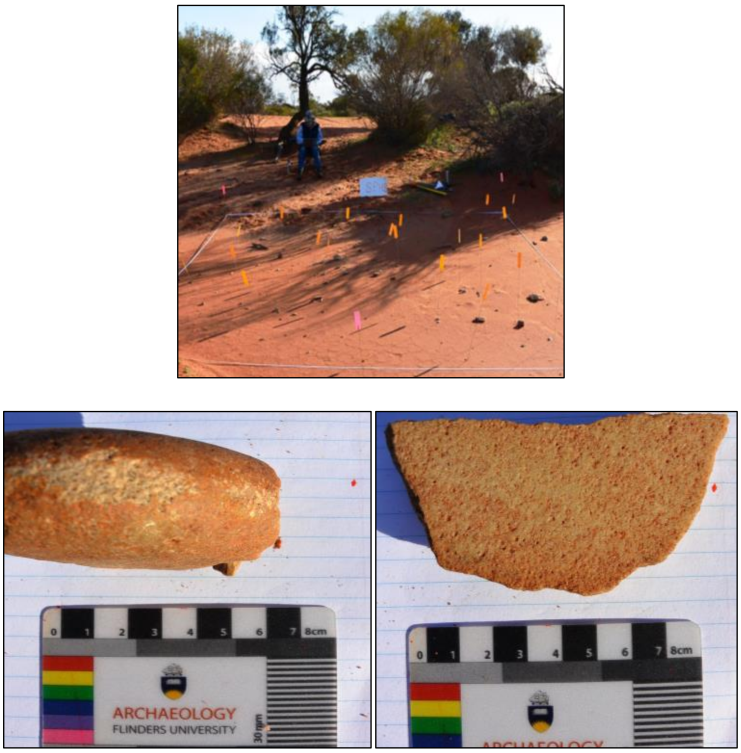


Figure 26: Site 1 - Sample Plot 3, with examples of artefacts; a hammer stone and a heavily used block.

Site five, with Sample Plot locations

Site 5 plots

Site five with sample plots 4, 5 and 6 (Figures 20, 21, 27, 28, 29 and 30 and Tables 4, 8, 9 and 10) is also an extensive site of more than 5.4 ha. This site is located on a dune complex immediately to the SW of Island Lagoon and also has 5 cane grass swamps and gilgai's to the SW of the site on the margin of the silcrete plain. Artefact density (all artefacts including debitage), averages 23 per sq. m. for plots on this site (average for all plots), slightly lower than for Site 1. The closest pastoral infrastructure is approximately 3 kms to the west of the site. There is evidence of timber cutting for fence posts on this site (Figure 7) and the site appears to have been heavily impacted by the introduced rabbit and site deflation (Figure 35).

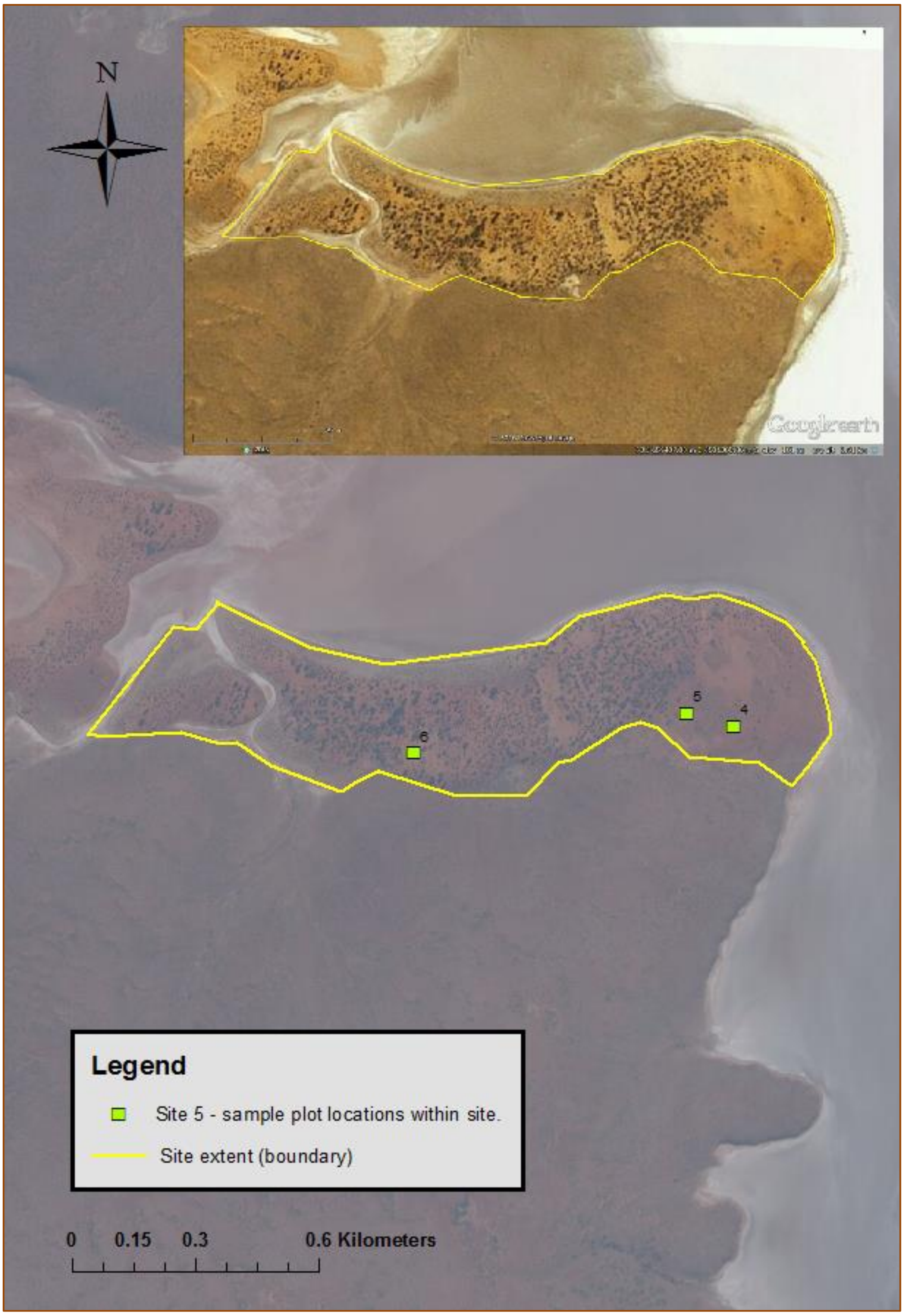


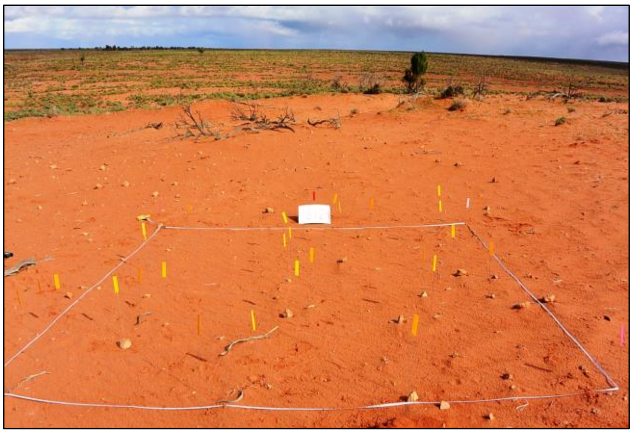
Figure 27: Site 5 (Landsystem 4) - with sample plot locations. The insert displays the actual surveyed site boundaries.

Site 5 – Sample Plot 4

Site 5 : Plot 4	Typology (total artefacts – 29)						
Descriptive Characteristics	**Core**	**Hand Chopper**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Bipolar Flake**
Termination							
Feather			1				
Hinge			4	3	3	6	
Indeterminate	5	2				3	1
Step	1						
Flake Edge Angle*							
N/A	6				1		
< 15				1		3	
15-30			4	2		4	
30-45			1			1	
> 45		2			2	1	1
Platform Attributes							
N/A							
Natural	3	1	1		1	3	
Flaked	3	1	4	3	2	5	1
Abraded						1	
Break							
Complete	6	2	5	3	2	9	1
Proximal							
Medial							
Distal							
Longtitudinal					1		
Material							
Silcrete	5	2	5	2	3	7	
Chert	1			1		1	1
Oolitic Chert							
Quartzite						1	

Debitage: silcrete 75; quartzite 1; chert 7. *Flake edge angle

Table 8: Summary of relevant artefact attributes for Site 5 – Plot 4.



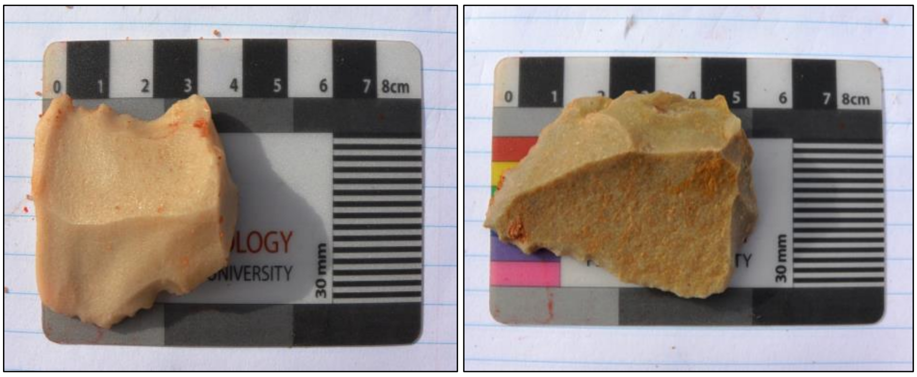


Figure 28: Site 5 - Sample Plot 4, top, with examples of artefacts; bottom left, scraper and bottom right, utilized flake (scraper).

Site 5 – Sample Plot 5

Site 5 : Plot 5 Descriptive Characteristics	**Typology (total artefacts – 7)**			
	Scraper	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**
Termination				
Hinge		1		1
Indeterminate	2	1		2
Step				
Flake Edge Angle*				
N/A				
< 15	1	2		1
15-30	1			1
30-45				1
> 45				
Platform Attributes				
N/A				
Natural				
Flaked	2	2		3
Breakage				
Complete	2	2		3
Material				
Silcrete	1			1
Chert	1	2		2
Oolitic Chert				
Quartzite				

Debitage: silcrete 70; chert 10. *Flake edge angle

Table 9: Summary of relevant artefact attributes for Site 5 – Plot 5.

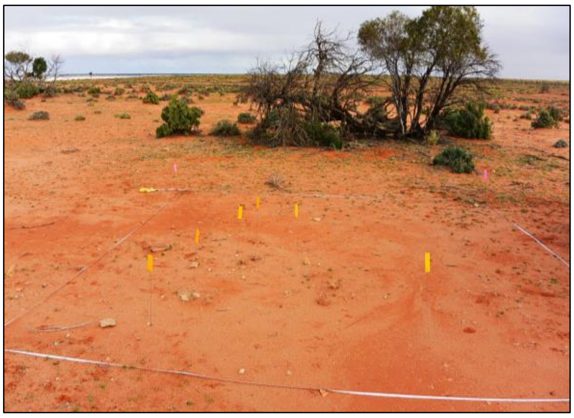


Figure 29: Site 5 - Sample Plot 5

Site 5 – Sample Plot 6

Site 5 : Plot 6	**Typology (total artefacts – 60)**								
Descriptive Characteristics	**Core**	**Hammer Stone**	**Block**	**Burren Engraver**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Bipolar Flake**	**Pirri Point**
Termination									
Feather									3
Hinge				1	19	3	4		
Indeterminate	7	2	1		5	3	8	4	
Flake Edge Angle									
N/A	7	2	1		3				
< 15				1	10	3		2	1
15-30					5	2		2	2
30-45					6	1	2		
> 45							10		
Platform Attributes									
N/A	1	1							
Natural	3	1	1		3		3	1	2
Flaked	3			1	21	4	9	3	1
Breakage									
Complete	6	2	1	1	22	5	12	4	3
Material									
Silcrete	6	2	1	1	18	3	8	2	2
Chert					6	3	4	2	1

Debitage: silcrete 296; chert 30. *Flake edge angle

Table 10: Summary of relevant artefact attributes for Site 5 – Plot 6.

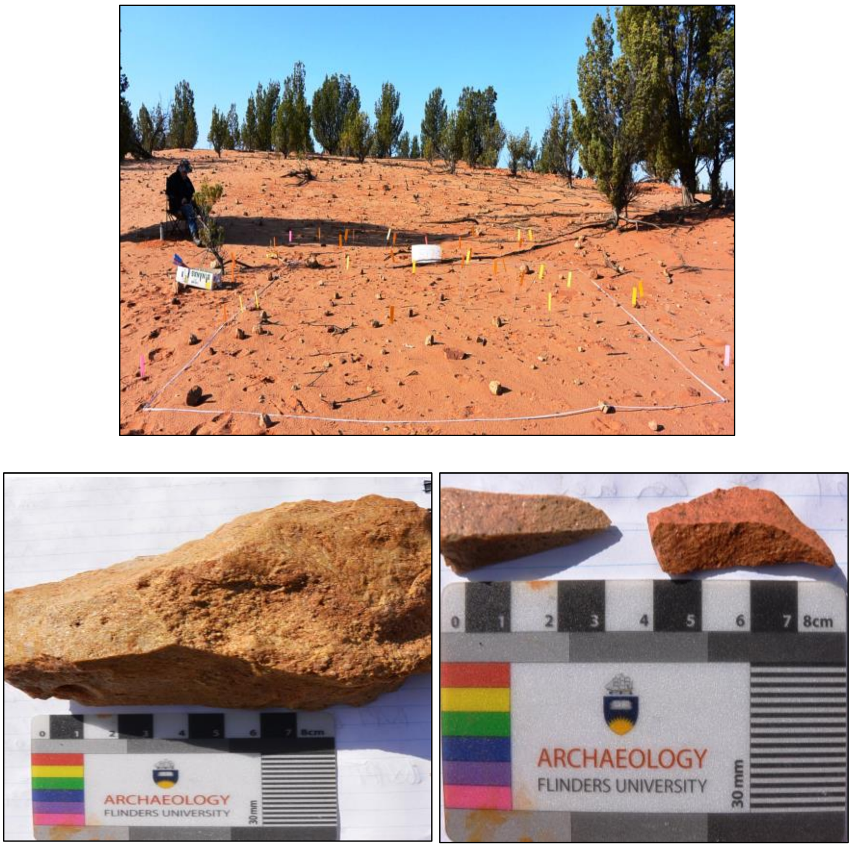


Figure 30: Site 5 - Sample Plot 6 with examples of artefacts; bottom left, hand chopper and bottom right, points.

Site Seven: DSD – AAR Registered Site 6235-4968

Site 7 with sample plots 6, 7 and 8 (Figures 20, 21, 31, 32, 33 and 34 and Tables 4, 11, 12 and 13) extends over 3 ha. The site is located in a dune and lunette system in a valley on the SE edge of the lagoon surrounded to the NE, E and SE by the Arcoona plateau, a silcrete plain. The site also has a large lagoon that would have filled with episodic rainfall. This site was reported by Ron Hewitt in 1968 and recorded by Darren Hincks in 1978 and registered in 2000. The site has been described as an 'intermediate site' between quarries on the plateau to the SE and campsites, presumably to the east where there are permanent water supplies. Hewitt (1968) and Hincks (1978) described the assemblage as including grinders, anvils, hammer stones, pirri points and 'flakes' but also described 'unusual' eroded stones and speculated that they were used in tool production. Artefact density (all artefacts including debitage), averages 29% per sq.

m. for plots on this site (average of all plots) — the highest for all sampled sites. The field work for this project also identified eroded blocks that were clearly used for grinding of lithic material possibly for the sharpening of points. A number of points with a 'triangular' section were found on this site (Figure 32). The field work also located a silcrete quarry on the site and a chert quarry on the southern edge of the site. This site exhibited the largest number of points, particularly pirri points, with the highest level of breakage of points (Figures 32, 33 and 34 and Tables 11, 12, 13 and 17, 18 and 19) and also the greatest diversity of raw material used, particularly, silcrete and quartzite.

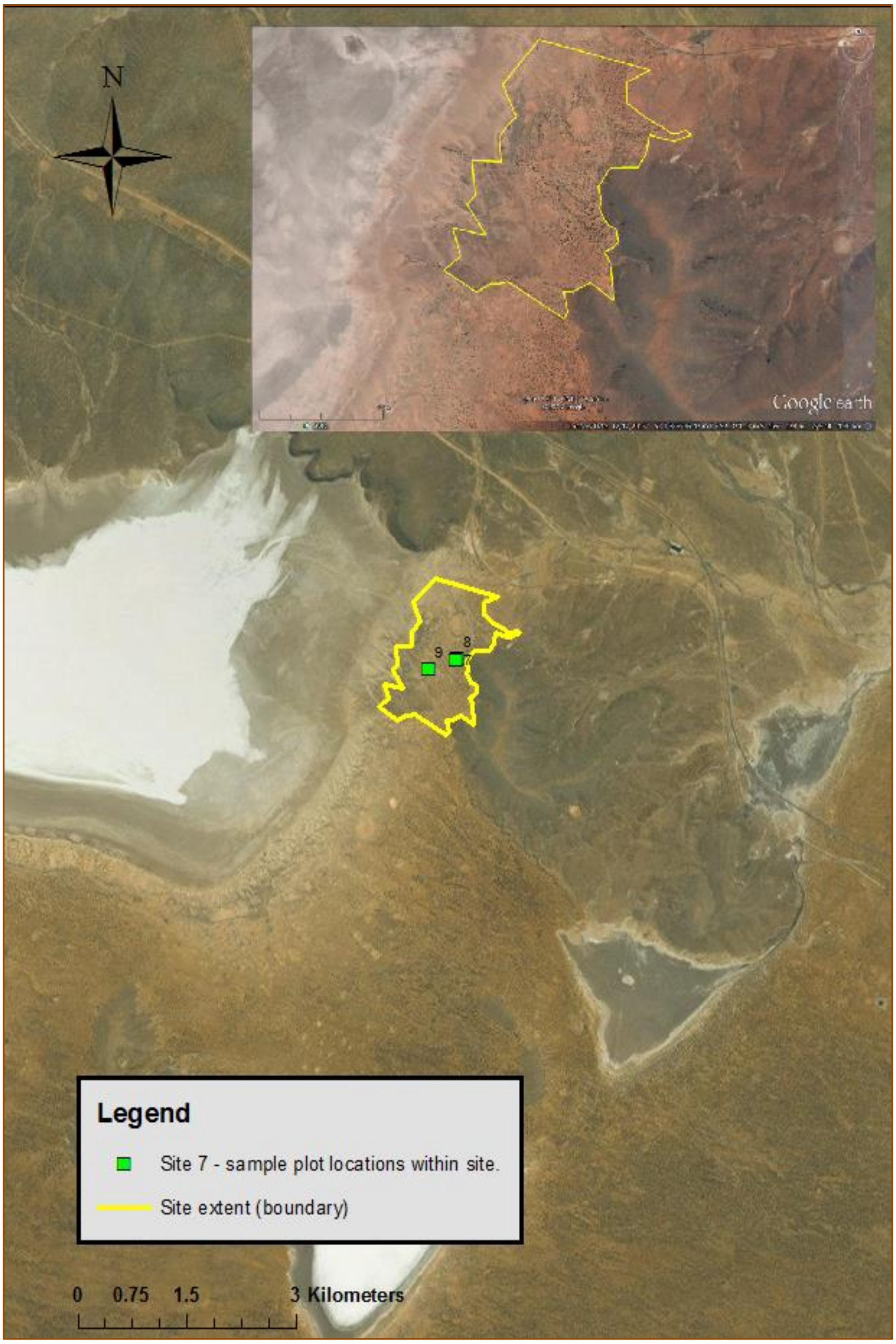


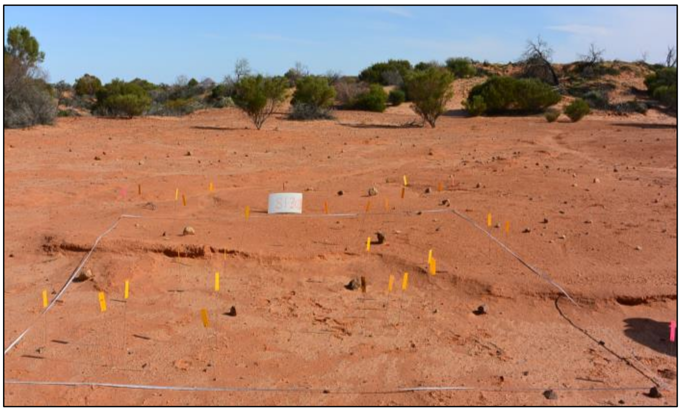
Figure 31: Site 7 (Landsystem 4) - with sample plot locations. The insert displays the actual surveyed site boundaries.

Site 7- Plot 7 (DSD – AAR Registered Site 6235-4968)

Site 7 : Plot 7 Descriptive Characteristics	Typology (total artefacts – 41)							
	Core	Grind Stone	Scraper	Thumbnail Scraper	Flake Core	Utilized Flake	Bipolar Flake	Pirri Point
Termination Feather								5
Hinge			2	1	2	1		
Indeterminate	5	2	7	7	6	1	2	
Step								
Flake Edge Angle* N/A	6	1			8			
< 15			5	7		2		1
15-30			2				1	
30-45			2	1			1	4
> 45								
Platform Attributes								
N/A								
Natural	2	2	1	1	3		1	1
Flaked	2		8	7	5	1	1	4
Abraded								
Breakage Complete	4	1	9	8	7	1	2	2
Proximal								
Medial		1						
Distal								3
Longtitudinal					1			
Material Silcrete	4	2	5	7	6	1	1	3
Chert			1	1	2		1	2
Quartzite			3					
Retouched								

Debitage: silcrete 73; quartzite 6; chert 15. *Flake edge angle

Table 11: Summary of relevant artefact attributes for Site 7 – Plot 7.



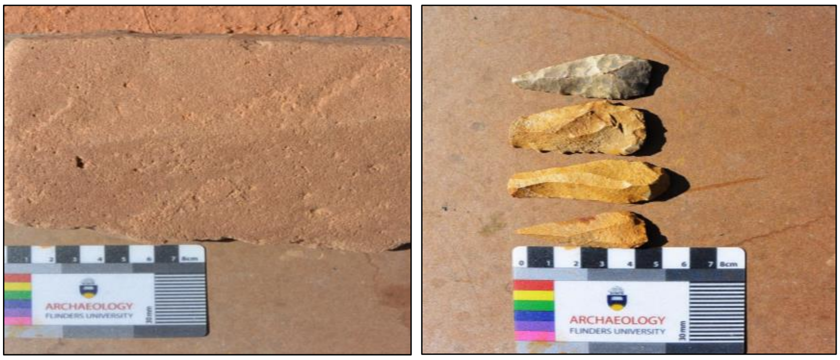


Figure 32: Site 7 Plot 7 above with examples of artefacts; grindstone (left), points and pirri points (right).

Site 7 - Plot 8

Site 7 : Plot 8	**Typology (total artefacts - 90)**							
Descriptive Characteristics	**Core**	**Hand Chopper**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Point**	**Pirri Point**
Termination								
Feather							12	1
Hinge			6			1		
Indeterminate	3	2	15	5	29	16		
Flake Edge Angle*								
N/A	3				27	2		
< 15			6	5	1	10		1
15-30			13			5	6	
30-45		1	2		1		6	
> 45		1						
Platform Attributes								
N/A					5			
Natural	2	1	4		6	4	8	1
Flaked	1	1	17	5	18	13	4	
Abraded								
Breakage								
Complete	3	2	21	4	25	16	6	1
Proximal								
Medial			1			2		
Distal							6	
Longtitudinal								
Material								
Silcrete	3	2	7		11	3	1	
Chert			14	4	15	12	11	2
Oolitic Chert								
Quartzite			1					
Retouch			1					

Debitage: silcrete 375; quartzite 0; chert 0. *Flake edge angle

Table 12: Summary of relevant artefact attributes for Site 7 – Plot 8.

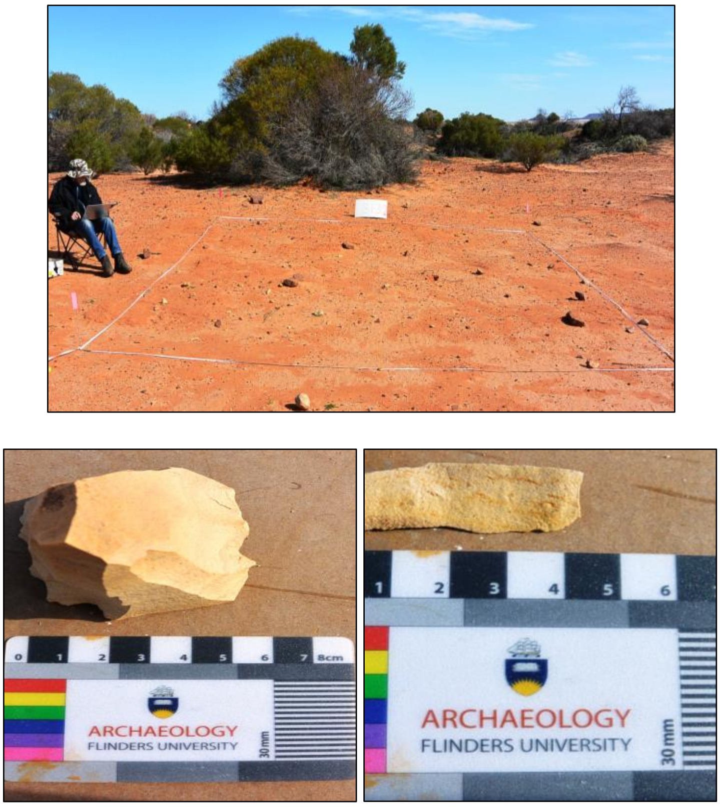


Figure 33: Site 7 - Plot 8 (top) with examples of artefacts below, core left and scraper right.

Site 7 - Plot 9

Site 7 : Plot 9	**Typology (total artefacts – 28)**							
Descriptive Characteristics	**Hand Chopper**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Point**	**Pirri Point**	**Backed Microlith**
Termination								
Feather						9	1	
Hinge				1				1
Indeterminate	1	3	3	8	1			
Flake Edge Angle*								
N/A				9				
< 15		1	3			6	1	
15-30						2		1
30-45	1	2			1	1		
> 45								
Platform Attributes								
N/A								
Natural		1	1	3		7	1	
Flaked	1	2	2	6	1	2		1
Abraded								

Breakage Complete	1	3	3	9	1	3		
Proximal						4		
Medial								
Distal						2	1	1
Longtitudinal								
Material Silcrete	1	1	1	4	1	3		
Chert		1	2	4		3	1	1
Oolitic Chert								
Quartzite		1		1		3		

Debitage: silcrete 70; quartzite 5; chert 25.

Table 13: Summary of relevant artefact attributes for Site 7 – Plot 9.

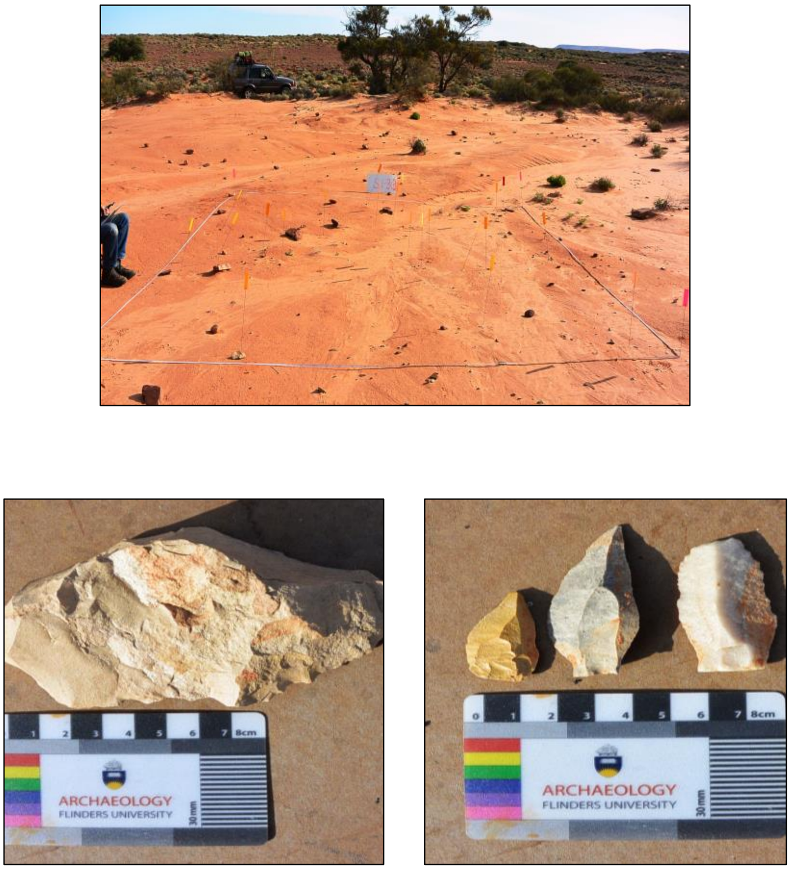


Figure 34: Site 7 Plot 9 with examples of artefacts; hand chopper above left and points above right.

Summary of results

Landsystems

All six newly discovered sites were located in the sand dune and lunette landsystem, landsystem four (Figure 19). The three sites where plots were established for the sampling of archaeological material were located in deflated dune systems (Figure 21). Those site complexes were between 2 and 5.5 hectares. This is consistent with the outcomes of work by Hughes et al. (2011) at Olympic Dam to the east of Island Lagoon in a similar environmental setting. Hughes et al. (2011) found that Quaternary Aeolian sanddunes, swales and pans and Cainozoic or Tertiary silicified or sandy deposits were where the greatest number of sites were located. The Tertiary silicified deposits also provided access to silcrete for tool making.

Comparison of data within sites (between sample plots) and between sites.

Site 1 – plot comparison/artefact analysis

Site 1 plots exhibit a suite of artefacts that include cores, hammerstones, handchoppers, grindstones, scrapers, thumbnail scrapers, flake cores, utilised flakes, bipolar flakes, points and pirri points. Blocks were not evident possibly having been reduced completely. The 'all plot percentage data' (Table 18) for this site indicates that cores, handchoppers, grindstones, scrapers, thumbnail scrapers, utilized flakes and pirri points occur at more than 5% of total artefacts with scrapers, thumbnail scrapers, utilised flakes and pirri points the most common occurring at more than 10% of the total in all plots (Table 18) – particularly in plots 2 and 3. Hammerstones, handchoppers and grindstones were not found in plot 2 but as this plot was closest to the station access track it is likely that those larger artefacts have been souvenired by station workers.

Site 5 – plot comparison/artefact analysis

Site 5 plots exhibit artefact assemblages that include; cores, scrapers, thumbnail scrapers, and utilised flakes. Handchoppers, grindstones, blocks, burrin engravers, points and pirri points are almost non-existent in plots at this site. Hammerstones occur in very low numbers in plot 6. The 'all plot percentage data' (Table 18) for this site indicates that only cores, handchoppers, scrapers, thumbnail scrapers, flake cores, bipolar flakes and pirri points occur at more than 5% of total artefacts with cores, handchoppers, scrapers, thumbnail scrapers, flake cores, and utilised flakes the most common occurring at more than 10% of the total in all plots (Table 18).

Site 7 plots

Site 7 – plot comparison/artefact analysis

Site 7 plots exhibit artefact assemblages that include; cores, hammer stones, handchoppers, grindstones, scrapers, thumbnail scrapers, utilised flakes, points and pirri points. Handchoppers, grindstones, blocks, burrin engravers, points and pirri points are in low numbers in plots at this site. The 'all plot percentage data' (Table 18) for this site indicates that only cores, scrapers, thumbnail scrapers, flaked cores, utilised flakes and points occur at more than 5% of total artefacts with cores, scrapers, thumbnail scrapers, flake cores, utilised flakes and points the most common occurring at more than 10% of the total in all plots (Table 18). A backed blade was recorded in Plot 9 on this site.

Other survey and site/plot analysis outcomes

<u>Stone arrangements</u>

This work also discovered archaeological evidence for occupation of this region other than workshop sites. As indicated earlier six sites were identified however only three sites were surveyed and sampled. Site three (not sampled) included ceremonial stone arrangements on the margins of an adjacent canegrass swamp (Figure 36).

Point size

Point and pirri point (point) size for all plots was recorded as this factor might be significant in determining whether artefact assemblages reflect the characteristics of the Australian small tool culture. Table 19 provides a summary of point sizes for all sites and plots. Sites 1 and 5 had very low numbers of discarded points with all plots within Site 7 consistently exhibiting the greatest number of points. The point size categories 30-40mm and 40-50mm contained the greatest number of points where they occurred in all plots with Site 7 plots also having points greater than 50mm. Points were generally produced from silcrete and chert raw material however a few points found in plots on Site 7 were also made from quartzite.

Breakage

Breakage of scrapers and points was also recorded as a possible measure of the level of site activity/visitation. Point and scraper samples from plots within Sites 1 and 5 exhibited a nil to zero level of breakage. Plots 7, 8, and 9 within Site 7, exhibited a very high level of breakage suggesting a high level of visitation/impact on this site.

Table 14, below, summarises data recorded in the field, relating to artefacts and Tables 15, 16, 17 and 18 provides comparative information for each of the three sample plots within sample plots at Sites 1, 5 and 7. A summary and discussion of the results follows the presentation of this data.


Figure 35: Ceremonial stone arrangement (Site 3 – not sampled)

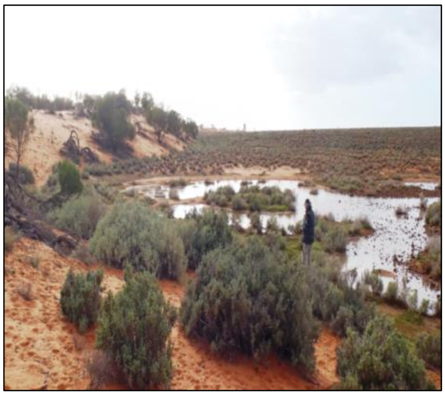



Figure 36: Examples of gilgai's, above left and canegrass swamps, above right.

Figure 37: Raw material - silcrete.

Site & Plot		Artefact Type													
		Core	**Hammer Stone**	**Grindstone**	**Hand Chopper**	**Buren Engraver**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Point**	**Pirri Point**	**Total silcrete (with debitage)**	**Total chert (with debitage)**	**Total quartzite (with debitage)**
Site 1	**P1**	4		2	1	1	4	2	1	7	1	4**	383	83	
	P2	1				1	6	3		4	1		86	18	2
	P3	2	1	1	2	1	6	3		4		1**	56	21	
Total		**7**	**1**	**3**	**3**	**3**	**16**	**8**	**1**	**15**	**2**	**5****	**525**	**122**	**2**
Average		**2.33**	**0.33**	**1.00**	**1.00**	**1.00**	**5.33**	**2.66**	**1.00**	**5.00**	**0.66**	**1.66**	**175.00**	**40.67**	**0.66**
Av/sq m													**21**	**4.88**	**0.08**
Site 5	**P4**	6			2		5	3	3	9			100	11	
	P5						2	2		3			72	15	
	P6	7	2			1	23	7	12			3**	339	47	
Total		**13**	**2**		**2**	**1**	**30**	**12**	**15**	**12**		**3****	**511**	**73**	
Average		**4.33**	**0.67**		**0.67**	**0.33**	**10.00**	**4.00**	**5.00**	**4.00**		**1.0**	**170.33**	**24.33**	
Av/sq m													**20.44**	**2.92**	**0**
Site 7	**P7**	5		2			9	8	8	2		5**	102	22	9
	P8	3			2		22	4	26	17	12	1**	402	58	1

		Core	Hammer Stone	Grindstone	Hand Chopper	Buren Engraver	Scraper	Thumbnail Scraper	Flake Core	Utilised Flake	Point	Pirri Point	Total silcrete (with debitage)	Total chert (with debitage)	Total quartzite (with debitage)
	P9				1		3	3	9	1	9	1**	81	37	10
Total		**8**		**2**	**3**		**34**	**15**	**41**	**20**	**21**	**8**	**585**	**117**	**20**
Average		**2.67**		**0.67**	**1.00**		**11.33**	**5.00**	**13.67**	**6.67**	**7.00**	**2.67**	**195.00**	**39.00**	**6.66**
Av/sq m													**23.40**	**4.68**	**0.80**

**Retouched artefact

Table 14: Summary of all relevant site and plot data.

Site & Plot		**Artefact Type**													
		Core	**Hammer Stone**	**Grindstone**	**Hand Chopper**	**Buren Engraver**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Point**	**Pirri Point**	**Total silcrete (with debitage)**	**Total chert (with debitage)**	**Total quartzite (with debitage)**
Site 1	**P1**	4		2	1	1	4	2	1	7	1	4**	383	83	
	P2	1				1	6	3		4	1		86	18	2
	P3	2	1	1	2	1	6	3		4		1**	56	21	
Total		**7**	**1**	**4**	**2**	**2**	**13**	**11**	**1**	**13**	**2**	**4**	**525**	**122**	**2**
Average		**2.33**	**0.33**	**1.33**	**1.0**	**0.66**	**4.33**	**5.33**	**0.33**	**5.0**	**0.66**	**1.66**	**175.00**	**40.67**	**0.66**
Av/sq m													**21**	**4.88**	**0.08**

** Retouch.

Table 15: Summary of plot data for Site 1.

Site & Plot		**Artefact Type**													
		Core	**Hammer Stone**	**Grindstone**	**Hand Chopper**	**Buren Engraver**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Point**	**Pirri Point**	**Total silcrete (with debitage)**	**Total chert (with debitage)**	**Total quartzite (with debitage)**
Site 5	**P4**	6			2		5	3	3	9			100	11	
	P5						2	2		3			72	15	
	P6	7	2			1	23	7	12			3**	339	47	
Total		**13**	**2**		**2**	**1**	**30**	**12**	**15**	**12**		**3**	**511**	**73**	
Average		**4.33**	**0.67**		**0.67**	**0.33**	**10.00**	**4.00**	**5.00**	**4.00**		**1.00**	**170.33**	**24.33**	
Av/sq m													**20.44**	**2.92**	**0**

** Retouch.

Table 16: Summary of plot data for Site 5.

Site & Plot		Artefact Type													
		Core	**Hammer Stone**	**Grindstone**	**Hand Chopper**	**Buren Engraver**	**Scraper**	**Thumbnail Scraper**	**Flake Core**	**Utilised Flake**	**Point**	**Pirri Point**	**Total silcrete (with debitage)**	**Total chert (with debitage)**	**Total quartzite (with debitage)**
Site 7	**P7**	5		2			9	8	8	2		5**	102	22	9
	P8	3			2		22	4	26	17	12	1**	402	58	1
	P9				1		3	3	9	1	9	1**	81	37	10
Total		**8**		**2**	**3**		**34**	**15**	**41**	**20**	**21**	**8**	**585**	**117**	**20**
Average		**2.67**		**0.67**	**1.00**		**11.33**	**5.00**	**13.6**	**6.67**	**7.00**	**2.67**	**195.00**	**39.00**	**6.66**
Av/sq m													**23.40**	**4.68**	**0.80**

** Retouch.

Table 17: Summary of plot data for Site 7.

	Artefact Type													
Plot number (total artefact)	**Core**	**Hammer stone**	**Hand chopper**	**Grind stone**	**Block**	**Burren engraver**	**Scraper**	**Thumbnail scraper**	**Flake core**	**Utilised flake**	**Bipolar flake**	**Point**	**Pirri point**	**Backed blade**
1 (total 29)	4	1	1	2		1	5	1	1	8		1	4	
% of total	13.79	3.45	3.45	6.90		3.45	17.24	3.45	3.45	27.59		3.45	13.69	
2 (total 17)	1					1	7	3		4		1		
% of total	5.88					5.88	41.18	17.65		23.53		5.88		
3 (total 22)	2	1	2	1	1	1	6	3		4			1	
% of total	9.09	4.56	9.09	4.56	4.56	4.56	27.27	13.64		18.18			4.56	
% total – all plots	10.29	3.92	5.88	5.88	4.56	4.41	26.47	10.29	3.45	23.53		4.35	9.80	
4 (total 29)	6		2				5	3	3	9	1			
% of total	20.69		6.90				17.24	10.34	10.34	31.03	3.45			
5 (total 7)							2	2		3				
% of total							28.57	28.57		42.86				
6 (total 60)	7	2			1	1	23	7	12		4		3	
% of total	11.67	3.33	6.90		1.67	1.67	38.33	11.67	20.00		6.67		5.00	
% total – all plots	14.61	3.33	6.90		1.67	1.67	31.25	12.50	16.85	33.33	5.62		5.00	

7 (total 41)	5			2			9	8	8	2	2		5	
% of total	12.20			4.88			21.95	19.51	19.51	4.88	4.88		12.20	
8 (total 90)	3		2				21	5	29	17		12	1	
% of total	3.33		2.22				23.33	5.56	32.22	18.89		13.33	1.11	
9 (total 28)			1				3	3	9	1		9	1	1
% of total			3.57				10.71	10.71	32.14	3.57		32.14	3.57	3.57
% total – all plots	9.43	3.33	2.54	4.88			20.75	10.06	28.93	12.58	4.88	17.80	4.40	3.57

Table 18: Comparative summary of the level of occurrence, by percentage, of all artefacts across all sites and plots.

Site & Plot			Point Length			
			20 – 30 mm	30 – 40 mm	40 - 50 mm	>50
Site 1	**P1**	**Point**		1		
		Pirri point	1	1	2	
	P2	**Point**			1	
		Pirri point				
	P3	**Point**				
		Pirri point	1			
Sub-total			2	2	3	
Site 5	**P4**	**Point**				
		Pirri point				
	P5	**Point**				
		Pirri point				
	P6	**Point**				
		Pirri point	1	2		
Sub-total			1	2	0	
Site 7	**P7**	**Point**				
		Pirri point		1	4	
	P8	**Point**		6	2	4
		Pirri point	1			
	P9	**Point**	2	3	3	1
		Pirri point	1			
Sub-total			4	11	13	5
TOTAL			**7**	**15**	**16**	**5**

Table 19: Point size data – all sites and plots.

	Breakage (Ratio of unbroken to broken)								
Plot	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**
Points	**5/0**	**1/0**	**1/0**	**-**	**-**	**3/0**	**2/3**	**7/6**	**3/7**
Scrapers	**5/0**	**10/0**	**9/0**	**8/0**	**4/0**	**3/0**	**17/0**	**24/1**	**6/0**

Table 20: Breakage – ratio of unbroken to broken points and scrapers.

Summary

All sites were located in the lunette/ dune systems, landsystem 4 and the sampled sites were in deflated dunes. The sampled sites included assemblages that broadly included cores, hammerstones, handchoppers, grindstones, flakes, utilised flakes, scrapers, thumbnail scrapers, points and pirri points. There was variation in assemblage composition within sites (between plots) and also between sites. Site one plots contained cores, handchoppers, grindstones, scrapers, thumbnail scrapers, utilised flakes and pirri points with scrapers, thumbnail scrapers, utilised flakes and pirri points at greater than 10% of total artefacts with no hammer stones, handchoppers or grindstones in plot two which might have been 'picked' over by recent visitors to the area. Site five had artefacts that included handchoppers, grindstones, burrin engravers, points and pirri points but they were almost non-existent in plot 6. Cores, handchoppers, scrapers, thumbnail scrapers, flaked cores and utilised flakes at greater than 10% of total artefacts. Site 7 plots included cores, hammerstones, handchoppers, grindstones, scrapers, thumbnail scrapers, utilised flakes,points and pirri points with handchoppers, grindstones, burren engravers, points and pirri points in very low numbers. In Plot 7 cores, scrapers, thumbnail scrapers, flake cores, utilised flakes and points at great than 10% of total artefacts.

Site 7 exhibited the greatest number of points and diversity of materials used that included quartzite presumably because chert and quartz quarries were located near the site. All arterfact assemblages exhibited characteristics of tools of the Australian small tool tradition from the Late Holocene period. Given the amount of activity at all sites and the relatively low level of discard of utilised or broken tools it is suggested that all sites were manufacture sites or workshop floors. Point and scraper breakage were almost non-existent on sites one and five but high on site 7 suggesting a higher rate of visitation perhaps through site vandalism or robbery in more recent times. As the site is the closest to the Arcoona Plateau which had permanent water it is likely that this site was visited more often by mixed groups of people and may have been a longer term campsite. A ceremonial stone arrangement was discovered on site three, a site that was not sampled, suggesting that some of the the sites were visited by groups of men.. The fact that all sites are associated with gilgais and cane grass swamps suggests that visitation was seasonal or periodical when water was available from those sources.

Chapter 7: Discussion

This chapter presents a discussion of the results of the field work in the context of the objectives for the thesis. This investigation included the mapping of land systems (ecology, geology and landscape features) and the survey, sampling and analysis of selected sites to attempt to provide answers to the research questions. The process has also involved investigation and comparison with other work in the desert regions including work by Cane (1984), Hiscock and Hughes (1982), Hiscock (1988a), Hughes et al. (2011), Lampert and Hughes (1987, 1988), Walshe (2005, 2012, Walshe et al. (2001) and Hayward (2012).

Cane investigated an area in the Western Desert between the Great Sandy Desert and the Tanami Desert near the Stansmore Range and Balgo. This study investigated the environment and local history and culture of the Aboriginal people, their social organisation, seasonal behaviour, site occupation and resource use and the type and functional use of stone tools. In a cultural context the Traditional Gugadja/Pintubi people of the Western Desert faced similar environmental conditions during a similar period in the mid to late Holocene as did the ancestors of the Kokatha. Although the climate and rainfall of the Balgo area is seasonal during November to April as opposed to non-seasonal in the Island Lagoon region and the mean rainfall is higher, approximately 350mm as opposed to 180mm, both groups lived in similar natural environments to Island Lagoon and faced the major challenge of surviving in a landscape with limited water resources. Both communities practise the cultural traditions of the Western Desert cultural bloc. Canes (1984)work work was able to link archaeological 'debris' in open sites of a particular typology, which were spatially and temporally separated, with specific seasonal activity.

In his work Cane (1984) also confirms the views of Bowler (1976) and Gould (1971a) that there have been no major changes in the subsistence economy (hunting and gathering or foraging) western deserts post-Pleistocene into the Holocene and for the last 5,000 years. Bowler (1976) refers to a 'cultural conservatism' that is, a period of very little cultural change, during this period in the Australian deserts. This contention is supported by the fact that Aboriginal people interviewed by Cane recognised the types of artefacts they examined from the open sites visited. Similar distinctive artefacts to those recorded by Cane in 1984, and identified by Traditional people working with Cane, such as points, have been dated in other stratified sites as being as old as 5,000 BP (Gould 1991), Hughes and Lampert 1988), Smith (2006, Veth (1996, 2006) and Walshe et al. (2001).

Cane's (1984) work provided an important, reasonably contemporary insight into how artefact assemblages in sites in the western deserts might be interpreted to help understand the character of archaeological sites in similar landscapes. The work also provided an insight into the way Aboriginal people might have occupied the area and utilised the natural resources of a region such as Island Lagoon.

Lampert and Hughes (1988) discovered the lunette on Hawker Lagoon, in the southern Flinders Ranges, and determined that the lagoon was a Pleistocene site and possibly a 'refuge' during the LGM. However Kerryn Walshe (2005, 2012) and Walshe et al. (2001, 2002) has also investigated the Hawker Lagoon playa lake site, where the most recent archaeological material, from a hearth, has been dated at 550 BP, 1,500 BP and 1,230 BP. Many artefacts were also recorded adjacent to the site including; scrapers, adzes, blades, points and cores with larger tools such as hammerstones, horsehoof cores, knives, anvils and grindstones. The tools were flaked from quartzite and silcrete. This assemblage appears, in terms of many of the components, to be similar to the assemblages found at Island Lagoon.

Hayward (2012) worked on the concept of the 'toolkit' based on an assemblage or 'hoard' decribed by Ron Hewitt (1976). This assemblage was located on the edge of the Arcoona Plateau and near the NE sector of Island Lagoon. Hayward suggested that the European concept of the 'toolkit' as developed by Binford (1977) and Bordes (1953) has been misused in the Australian context particularly in defining strategies for mobility and therefore risk reduction (Hayward

2012). Hayward is of the view that the application of the 'toolkit' concept as used to describe lithic assemblages in Australia is limited. The lithic assemblages of the Island Lagoon sites, do however, reflect the key features of a 'toolkit' in the Australian small tool tradition, as described earlier.

Landsystems and the location of sites

All six new sites located at Yalymboo Dam and Manharinga Well during this project, as well as the previously recorded and registered site at Wirrappa, were located in the deflated dune and lunette systems, Landsystem 4, IBRA GAW 3 (Figures10, 11, 12, 19 and 20 and Tables 2, 3 and 4), supporting Mulga or Native Pine woodland. It is proposed here that these systems were only established in the late Holocene at around 2,000 BP after the extreme climatic variations resulting from the effect of El Nino (Figures 19 and 20). This system has remained relatively unchanged for the past 2,000 years into the late Holocene. This is a hypothesis that requires testing through future research in the area.

The sites were all adjacent to the older drainage systems of the lagoon, silcrete plains and silcrete outcrops that formed during the late Pleistocene. Sites have been exposed in the SW sectors of those dune and lunette systems by the activity of prevailing winds. This process is assisted by the destabilisation of the more recent Holocene dunes as a result of the removal of native vegetation possibly exacerbated by the activity of feral rabbits which were introduced into Australia in 1859. Rabbits had spread across Australia and into South Australia by 1886 and into the Island Lagoon area soon after and were almost wiped out by the Myxomatosis virus in the 1950's.

The pastoral industry commenced in the Island Lagoon region during this period and rabbits, domestic stock and native marsupials have competed for resources from this time onwards. This total grazing pressure has had considerable environmental impact and caused land degradation, including the periodic removal of native vegetation exposing the dunes and lunettes to erosion and causing the surface deflation which has exposed Aboriginal sites in the region (Figure 35). The impact of total grazing pressure has been exacerbated during major drought periods in Australia from 1895–1903, 1939–45 and 1958–68 (Bureau of Meteorology 2016). It is likely that the exposure of sites in this area started following the rabbit introduction into this area which was immediately followed by the drought of 1895 – 1903.

Figure 38: Evidence of rabbit impact - Site 5, Plot 1.

The sand dune and lunette systems clearly provided excellent campsites with timber resources for shelters and wooden tool manufacture while the silcrete plains immediately adjacent to the dunes and lunettes in this area offer relatively high quality silcrete for tool manufacture. These areas also support a range of *Acacia spp*. which might have provided seed for grinding. All campsites were adjacent small canegrass swamps or gilgais that hold water for several weeks following episodic rainfall. This is significant as rainfall in this region is low (mean annual rainfall less than 185mm) and non-seasonal, usually with some precipitation (14mm to 20mm) every month.

One of the six sites contained stone arrangement on the edges of a gilgai as evidence of more extensive or regular occupation that included ceremonial activity (Figure 35). Bob Starkey (Bob Starkey pers. comm. 2013) has suggested that the circular stone arrangements have particular ceremonial significance for Kokatha men and believes that this area was possibly visited by groups of men on a periodic or seasonal basis to manufacture tools and to hunt and conduct specific rites at some of the sites.

General comparison of sites - Artefact assemblage analysis

Composition of assemblages

Site 1 and Site 7 plots exhibited the broadest diversity of artefact types that generally included cores, hammerstones, handchoppers, grindstones, scrapers, thumbnail scrapers, flake cores, utilised flakes, bipolar flakes, points and pirri points although, Site 7 had much lower numbers of cores, hammerstones, handchoppers and grindstones. Site 7 generally had a much higher percentage of points and pirri points in comparison to Site 1 and particularly in comparison to Site 5 where points and pirri points were in very low numbers. Site 5 plots exhibit artefact assemblages that include; cores, scrapers, thumbnail scrapers, and utilised flakes high percentage but a very low percentage of the larger artefact types such as cores, hammerstones, handchoppers and grindstones. The only 'backed blade' was recorded in Plot 9 on Site 7. Given the paucity of 'backed blades' across all Sites I would suggest that this artefact may have been mis-identified.

With regard to Site 1, Plot two varied significantly in artefact variety and density from the other plots, particularly hammer stones, hand choppers and grind stones. This was possibly due to the fact that Plot 2 was closest to the station access road and long established infrastructure and may have been 'picked over' by station workers. With regard to Site 5 all plots generally exhibited lower numbers of the larger artefacts such as hammer stones, hand choppers, grind stones and blocks but a higher number of scrapers, flakes cores and utilised flakes by comparison with Site 1 plots. Plots within Site 7 had the greatest variety of artefacts and the greatest densities of artefacts, particularly scrapers and points despite both Hewitt (1968) and Hincks (1978) commenting that this site had been heavily 'picked over', presumably by residents of Woomera. The most common point size (length) was between 20mm to 50mm, once again, typical of the mid to late Holocene Australian small tool tradition. Hammer stones all exhibited intense pitting or heavy usewear (Figure 26).

There was no consistent evidence of retouch on any of the tools with the exception of pirri points and perhaps scrapers, where evidence of retouch was inconclusive because edge 'work' could have occurred as part of manufacturing process. Pirri points, which were found in greater numbers on Site 7, appeared to be retouched on the ventral surface by pressure flaking, with the familiar 'leaf' shape of the typical unifacial point subgroup (Figures 32 and 34). Backed blades, also a potential indicator of a specific adaptive culture of the mid to late Holocene, were only found in Plot 9 on Site 7 but as stated earlier this might have been a mis-identification. Silcrete dominated as the preferred raw material, particularly at Sites 1 and 5, however silcrete was the preferred material at Site 7 as well but this site had a significantly greater proportion of chert and quarzite. The use of silcrete as the preferred raw material followed by quartzite, usually for hammerstones used for breaking down or flaking cores, is consistent with the outcomes of work by others at Olympic Dam to the east of Island Lagoon (Hughes et al. 2011, Hughes et al. 1973). Site 7 included both silcrete and chert quarries but there was no evidence of quarrying on Sites 1 and 5 where tools were obviously made using silcrete blocks taken from the adjacent silcrete rise. Breakage of points and pirri points was very evident at Site 7 (Table 19) but there was very little evidence of breakage at any of the other sites. Scraper breakage (Table 19) was not evident at any site. There was no evidence of hearths or burials at any of the sites that would suggest longer term occupation and perhaps provide an opportunity for dating. Heat retainer hearths are uncommon in this region and this suggests short term visitation by small bands or mobile groups of men rather than long-term camps. As indicated earlier, there is evidence of ceremonial activity, a stone arrangement, at site three, a site that was not sampled (Figure 35).

Site 1 (Yalymboo Dam) has had a significant amount of infrastructure developed virtually at the centre of the site and Site 5 (Manharinga Well) does have some evidence of construction related activity (timber cutting) and it is likely that this activity has had an impact on the integrity of the sites particularly with respect to Site 1.

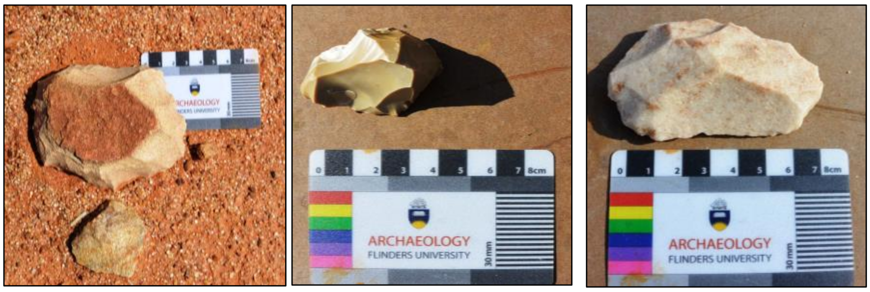


Figure 39: Artefacts manufactured from the three commonly used raw materials, silcrete (left), chert (centre) and quartzite (right).

Figure 40: Yalymboo grinder (left) and Wirrappa grinder (right).

As discussed earlier forager mobility and populations increased in the western deserts during the mid to late Holocene, M.A. Smith (1993, 2005) and Veth (1996, 2006), as did seed and bone grinding. This is assumed to be a response to the climate variability of this period. The Puntjutjarpa example indicates occupation at that site for a few periods in the early Holocene but abandonment from 4,500 BP to around 1,000 BP (Gould 1991). It seems that the response of western desert people to a harsher climate and unpredictable rainfall was to abandon high risk areas. The period for 5,000 BP to 2,000 BP was a high risk period in the arid Island Lagoon region with the attendant variable climate, severe droughts at the end of fluvial activity and the onset of ENSO with a lot of late dune building activity.

All surveyed and sampled sites consistently provided evidence of assemblages that reflect the small tool culture of the mid to late Holocene. This evidence included scrapers and points, including those suitable for working wood or hafting to timber shafts. Point length range was generally between 20mm and 60 mm. Pirri points were manufactured using pressure flaking indicative of late Holocene technology that is thought to have been adopted at around 2,000 BP (Hiscock 2006). Backed blades, a potential indicator of risk a minimisation strategy of people moving into unfamiliar landscapes with regular environmental change, were not generally evident in any of the sampled plots with the exception of one artefact that possibly exhibited characteristics of 'backing' found in Plot 9 on Site 7. This might also suggest that site occupation and use occurred after 2,000 BP. Grinders were present at different levels on all sites although the use-wear evident on those examined suggested that they were used for the grinding of points or other lithic tools or for the grinding of ochre for ceremony (Bob Starkey pers. comm., 2013) rather than seed grinding (Figure 40). This also supports the idea that the sites are post 2,000 BP when woodland probably replaced seed bearing grassland in this region and tools were manufactured for hafting to timber. Site 5, which had high numbers of scrapers and points, was in an area of Native Pine woodland, a softwood timber ideal for working into wooden implements.

Heavily pitted silcrete and quartzite hammer stones were also relatively common on sites 1 and 7 and it can be assumed that they were used in the flaking of cores and in the making of tools as the pitting can only have been caused by stone on stone impact. All sites, particularly Site 5, contained significant numbers of discarded flake cores, utilized flakes and bipolar flakes and discarded points, indicating the manufacture of tools on all sites. Discarded points are possibly either the result of accidental loss given the sandy nature of the site environments, or a surfeit of manufacture where the toolmakers chose to discard those points that were not up to standard. All sites should therefore be considered to be workshop floors and tool manufacturing sites.

Points were also used to determine the level of breakage as an attempt to assess the level of use on sites. The level of breakage of points was almost negligible on all sites with the exception of Site 7, where the ratio of broken to unbroken was very high. This would indicate that Site 7 was either visited more often or more regularly or visited by greater numbers of people or the site has been heavily impacted by site vandals from Woomera in more recent times.

Chapter 8: Conclusions and future directions

This project set out to determine two things:

- whether the distribution and character of archaeological sites in the landscape around Island Lagoon tell us specifically about the way Aboriginal people occupied the area and utilised the natural resources in the region; and
- to discover evidence for specific types of human economic activity, technology and resource use or association with biogeographic events that link occupation and a particular time period.

The process has involved consultations with Kokatha, background research, a desktop study and a search of the DSD – AAR Central Archive, field surveys with Kokatha representatives, recording of sites and analysis of selected site data. The outcomes include the discovery, mapping and recording of six sites with a relatively detailed sampling and analysis of three key selected sites. The survey protocol that was developed and applied as part of this project successfully located six new sites. As indicated earlier, Kokatha have a protocal and policy relating to the registration of their sites. Site records will be registered on the AAR Central Archive when approved by the Kokatha representatives at an appropriate forum.

The outcomes of this research and its success or otherwise, must be assessed within the context of its limited scope and the attendant difficulties of working in this remote region. In particular, limitations on field time and a lack of datable material at the sites recorded, and the lack of previous research in this region more generally, placed constraints on the work. As such, the results must be seen as being of a preliminary nature and require further field research in future. Despite that, a number of key points can be highlighted based on this work.

Firstly, the sites do exhibit characteristics of late Holocene small tool tradition and therefore provide an insight into the behaviour of Aboriginal people living in this region in the late

Holocene. It is likely that all sites were used by Kokatha ancestors to make tools from locally available silcrete, including points for woodworking and hafting. This practice is thought to have commenced in the Late Holocene, around 3,500 BP. It is likely that Kokatha travelled around the bottom of the lagoon, from permanent camps on the Arcoona Plateau, to the area to the south-west of Island Lagoon, where they could access raw materials of high quality silcrete. Those expeditions probably occurred after episodic rainfall events when water was available in the canegrass swamps and gilgai's. A small number of tools made of chert were also present at sites 1 and 5. The nearest known chert quarry is located on or adjacent to Site 7 and it is likely that this material was carried to the other sites either as raw material or as part of a toolkit. The site data provided evidence that Kokatha ancestors primarily utilised the Holocene age dune and lunette landsystems to the SW of Island Lagoon away from the immediate edge of the Lagoon. In those locations they would have been sheltered from northerly winds, had access to temporary water resources in the claypans and canegrass swamps provided by episodic rainfall events. Those sites were also close to good quality raw materials on the neighbouring silcrete plains.

This is supported by Cane's (1984) work linking archaeological 'debris' in open sites of a particular typology, which were spatially and temporally separated, with specific seasonal activity. Also work by Walshe at the Hawker Lagoon site (also a playa lake site) where many artefacts recorded adjacent to the site were similar assemblages to the Island Lagoon site (Walshe 2005). A hearth at this site has been dated at 1,230-550 BP that is the late Holocene and possibly provides a comparison with the Island Lagoon sites. Hayward (2012) worked on an assemblage or 'hoard' from the Arcoona Plateau described by Ron Hewitt (1976). Hayward suggested that the European concept of the 'toolkit' as developed by Binford (1977) and Bordes (1953) has been misused in the Australian context particularly in defining strategies for mobility and therefore risk reduction (Hayward 2012). The lithic assemblages of the Island Lagoon sites do however reflect components of what might be referred to as a 'toolkit' in the Australian small tool tradition, of the Late Holocene, possibly from a period where specific strategies, such as seasonal mobility, were required to avoid risky harsh environmental conditions.

Thirdly, the Puntjutjarpa example indicates abandonment from 4,500 BP to around 1,000 BP (Gould 1991). This suggests that the response of western desert people to a harsher climate and unpredictable rainfall was to abandon high risk areas. The period for 5,000 BP to 2,000 BP was a high risk period in the arid Island Lagoon region with the attendant variable climate, severe droughts at the end of fluvial activity and the onset of ENSO with a lot of late dune building activity. Comparison with the Puntjutjarpa work would suggest that Kokatha also perhaps became more active in the Island Lagoon region during the Late Holocene from around 1,000 BP.

Finally, this project did not find any evidence of artefacts indicative of late Pleistocene occupation such as the presence of simple, large and robust tools, horsehoof cores and large core scrapers. There is no evidence for whether the area was part of a corridor or refuge area during the late Pleistocene and LGM or whether the region was abandoned during this period. It is evident that the area between Island Lagoon and Lake Gairdner, the Mahanewo sand plain, is the harshest landscape between the Arcoona Plateau/Island Lagoon and the Gawler Ranges to the south-west. I would suggest therefore, as a result of this work, that there has been very little traditional movement of people across this barrier in the late Holocene until after the European contact period. Advice from contemporary Kokatha representatives is that expeditions to these sites from the Arcoona Plateau may have been primarily undertaken by men as part of a ceremonial process.

Future directions

Overall, this research demonstrates the research potential of Island Lagoon and the Arcoona Plateau area. Much more research is required to confirm the assumptions I have made about the occupation of the Yalymboo and Wirrappa sites. There are approximately 20 recorded sites to the east of Island Lagoon on the Arcoona Plataeu. Those sites are very diverse and many are known to be late Pleistocene and may provide an opportunity for further detailed recording and analysis and comparison with the Yalymboo sites to attempt to obtain a broader idea of when and how Kokatha used this region — a refuge or corridor.

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Appendix 1

An example of a field data recording sheet with artefact recording fields

LITHIC ARTEFACT RECORDING SHEET													
Site Number			**Plot Number**			**Location (UTM)**				**Recorder Name**			
Artefact Number					**Sheet**					**Date**			
Typology													
Tula slug			Burin - engraver			Flake rem. - angular			Flake core		**Termin.**	Feather	
Tula - part reduced			Scraper			Point			Core			Hinged	
Tula - semi discoidal			Thumbnail			Pirri point			Hand chopper			Plunge	
Tula - asymetric			Flake - bipolar			Burrin			Hammerstone			Step	
Tula - side trimmed			Flake - utilised			Blade/knife			Grind stone			Indeterm.	
Tula - Blank			Flake - other			Backed microlith			Block				
Artefact dimension		Length		Width		Thickness					**Flake edge angle**		
Retouch	Proximal			Proximal/right lateral				Proximal/rightlateral/distal					
	Left lateral			Right lat/left lateral				Prox./left lateral/distal/right lat.					
	Distal			Distal/left l lateral									
	Right lateral			Proximal/ left lateral and distal									
	Proximal/left lateral			Left lateral/distal/right lateral									
	Proximal/distal			Right lateral/proximal/left lat.									
Ret. type	Scalar						**Platform attributes**		Natural		**Breakage**	Complete	
	Stepped								Flaked			Proximal	
	Invasive								Abraded			Medial	
	Serrated								Dimension			Distal	
	Notched											Longitud.	
Raw material			Silcrete			Quartzite			Mudstone			Jasper	
			Chert			Quartz			Rock chrystal			Porcellanite	
			Oolitic chert			Sandstone			Trans chalcedony			Other	