# CHAPTER 3

# ARCHAEOLOGICAL CONTEXT

Lake Carey and its sister lakes are a significant topographic feature of southeast Western Australia, as pointed out in the previous chapter. They have been ephemeral salt lakes for all of human history, unlike some salt lakes in southeastern Australia. They have evolved distinctive landforms, often with specialized vegetation and fauna, in response to the aridity and the erratic cycle of flooding and drought that is typical of the arid zone.

How humans adapted to these uncommon environments is still largely unknown for there have been very few archaeological studies of salt lakes. In this chapter I summarize and discuss those studies and the models of settlement that have been proposed. More general settlement models derived from other research in arid Australia are also considered. The state of regional research in the Laverton region is then described and I introduce the Lake Carey archaeological data.

## Salt Lake Research

Salt lakes have been largely ignored by archaeologists, or perhaps avoided out of respect for their footwear and vehicles. In the Australian literature I have found only three published studies that consider Aboriginal settlement of salt lakes (Lampert & Hughes 1988; McNiven 1998; Williams 1998). Only one of these proposes a model of Aboriginal settlement of salt lakes in the arid zone (Williams 1998). Consequently, there is little chance of comparing the findings from Lake Carey with other studies of similar lakes. This means it is difficult to uncover common tendencies or to identify features specific to Lake Carey.

This situation is not limited to Australia. For example, in the Mojave Desert, California, where there are many intermittent playa lakes, both freshwater and saline, a study was made of previous research and patterns of site distribution. It was noted that 'archaeological sites exist along all playa margins, either associated with shorelines or dunes' (Ross 1993:chapter 7, p19). However, greater site density and site size were documented about freshwater lakes, while some 'lakes have a notable paucity of artifacts ... [and] the reason appears to have been the brackish quality of the water' (Smith 1985:119, cited in Ross 1993:chapter 7, p19). Research has, understandably but unfortunately, focussed on the larger and more numerous sites near freshwater lakes, and in assessing the requirement for further research the saline playas were given a low priority.

In Australia, there has been several decades of archaeological inquiry in the 'arid zone'; that is, the 70% of the continent where evaporation equals or exceeds precipitation (and often by a large factor). Yet next to nothing is known about large sections of it (Ross *et al.* 1992). This has not stopped some researchers from generalizing about the entire arid zone from studies in one small portion, as will become apparent when the theoretical models of arid zone settlement and subsistence are reviewed below.

In the state with the greatest number of salt lakes, Western Australia, there has been no previous research at these features apart from limited contract surveys. Most of the consultancies were at Lake Carey and conducted by me. The state of knowledge is little different in Queensland or the Northern Territory. In NSW there has been considerable work at the former freshwater lakes of the Willandra Lakes system (e.g. *Archaeology in Oceania* 1998), but little at salt lakes. Only in South Australia and Victoria has there been any published research into Aboriginal settlement of salt lakes. However, as in the Mojave Desert (Ross 1993), research has focussed on the sites beside neighbouring freshwater lakes.

## Lake Frome

At Lake Frome, in South Australia, the western and southern shores were surveyed as part of a search for Pleistocene and Kartan sites in the Flinders Ranges and adjacent deserts (Lampert and Hughes 1988). This salt lake or saline playa is 100 km long and 45 km wide (several times larger than Lake Carey). At present it rarely fills, although at various times in the early and mid-Holocene it was regularly full and for some time prior to 30,000 BP it was a permanent freshwater lake.

Very little archaeological material was found beside Lake Frome but more material and several small artefact scatters were recorded on the banks of small inflowing creeklines within one kilometre of the lake shore. At one of these sites, "Balcoracana Creek", the assemblage of over a thousand artefacts contained a small proportion (29 or 2.0%) of adzes and scrapers, similar numbers of cores and 'core tools', a few unmodified flakes and abundant quartz pieces (79.2%) (Lampert & Hughes 1988: table 1). Only two local lithologies were used for tools; silcrete and poor quality vein quartz. The site was dated on geomorphological and typological grounds to approximately 10,000 BP, and declared to be definitely older than 5000 BP largely because of the absence of diagnostic tools of the so-called 'small tool tradition' (Lampert & Hughes 1988:148).

This study did not address the issues of how and why the lake was occupied. But reading between the lines some partial answers can be discerned. Lampert and Hughes (1988:150-51) concluded that the 'main phase of human occupation of the Lake Frome shoreline occurred during early Holocene times', in a period when the lake was occasionally full (Wasson & Donnelly 1991). So Aboriginal visits were presumably directed to exploiting the resources associated with an intermittent salt lake. The few recorded sites are located beside watercourses leading into the lake, where pools of potable water probably were available in the creekbeds after heavy rains (Lampert & Hughes 1988:151). It follows that visits were made when these pools were full; that is, soon after rains when the lake was partially or wholly full.

The assemblage from site "Balcoracana Creek" gives little insight into the subsistence activities conducted by visitors to Lake Frome, but the adzes and scrapers indicate some wood-working tasks were performed, in turn suggesting that the site was, on occasions, occupied for an extended time rather than only being a 'mealtime camp'. On the other hand, the small size of the assemblage indicates that the site was rarely occupied. The same seems to be true of Lake Frome in general, or at least that half included in the survey, as so little archaeological material was recorded.

## Middle Cooper Basin

Two small ephemeral salt lakes were included in a study of the many lakes in the Middle Cooper Basin, which is located in the Strzelecki Desert in South Australia. There is 'considerable variation in the nature and types of lakes ... [and the] study was designed to examine this variability in relation to human settlement' (Williams 1998:69; 1988). Surveys were made at semi-permanent and intermittent freshwater lakes in the Coongie lakes system and at intermittent freshwater lakes in the Cordillo lakes system, as well as at the two salt lakes. The salt lakes were grouped together for discussion and analysis, which is problematic, for they are 100 km apart and in markedly different geomorphological situations.

At the salt lakes, 'Sites comprising occasional small, discrete groups of artefacts were found ... set back one or two longitudinal dunes from the lake margin, on the surfaces of small claypans' (Williams 1998:82). Most of these sites contained less than 30 artefacts with a density of much less than 1 artefact/m². No moderately large sites were found. Assemblages were dominated by artefacts made of one lithology (grey coarse-grained silcrete) with few other lithologies represented. Some formal tools, such as tulas, scrapers and points, were present, as were cores and unmodified flakes. The salt lake sites lacked fish or animal bones or mussel shells. But several termite mound hearths were found at the more remote lake, Coorie Coorie Tillie, in association with sites. A section of one hearth was dated and the humic fraction returned a date of 1150 ± 180 BP (Williams 1998:82). This is in line with the general observation that sites in the Middle Cooper lake systems are mid- to late Holocene in age.

A model of settlement, or 'archaeological site distribution', was proposed for the several systems of lakes in the Strzelecki Desert (Williams 1998:79-80, 81-3). The model was explicitly restricted to the Middle Cooper Basin because the semi-permanent freshwater lakes and occasional inflow of freshwater via the Cooper Creek are 'a strikingly unusual feature of arid areas generally' (Williams 1998:69). So unusual in fact, that ethnographic accounts speak of permanent or semi-permanent Aboriginal settlement about permanent waterholes in the Cooper Creek and frequent gatherings of a hundred or more people about freshwater lakes to fish, collect mussels, catch crayfish and waterbirds and harvest food plants on adjacent floodplains (Jones 1979; Williams 1998:77). The original settlement model developed by Williams was largely derived from ethnographic accounts then amended after consideration of the archaeological data.

Williams' model is ecologically-based and the key determinant of site location was the availability of potable water. Not only was freshwater considered essential for human occupation but it is explicitly assumed that there will be a direct relationship between water and food resources (Williams 1998:79). Consequently, the model proposes strong correlations between fresh water and the presence of sites, the density of archaeological material at sites, the range of tools in assemblages, the lithologies used and the intensity of stone reduction and re-cycling at sites.

Intermittent salt lakes have a very minor role in this settlement model. They would have been visited by small transient groups, only infrequently, because they lack potable water and the associated but unspecified food resources (Williams 1998:82-83). Only after local rains, when the salt lakes filled and salinity decreased 'might they have been used on a temporary basis as people pushed out into the dunefields after rain' (Williams 1998:80).

The salt lakes, in other words, were visited chiefly in transit to the dunefields or possibly while people hunted and gathered in adjacent dunefields. This ties in with the casual suggestion that salt lakes might have served as an aid to navigation for groups traversing the largely featureless dunefields (William 1998:80). This purported pattern was seen to be in strong contrast to more regular occupation at the freshwater lakes, as documented in ethnohistorical accounts and evidenced by a greater number of archaeological sites, their larger and more diverse assemblages and, for sites at the Coongie lakes, the intensity of reduction of artefacts (Williams 1998:85-87).

As the only published model of Aboriginal settlement of salt lakes in the arid zone, Williams' model needs to be assessed carefully in order to identify those elements which may usefully be incorporated into a model of settlement for Lake Carey.

A significant difficulty with the proposed settlement and mobility pattern concerns the timing of visits to the salt lakes. The seeds and yams that might have been significant foods attracting people to the dunefields require weeks or months to ripen or mature. They would not be available immediately after rains when the dunefields and salt lakes were accessible because of ephemeral pools. Further, the abundant surface water after rain allows game to disperse widely and would have made hunting in the dunefields difficult at that time.

For the *Pitjandjara*, the time shortly after 'rains had fallen and dispersal was possible ... would be a time of hunger ... [until] food plants came to maturity' (Tindale 1974:23). A similar pattern was observed for the *Pintubi*, who dispersed when 'the rains came ... drinking at the temporary water sources and foraging for small animals, since vegetable foods were not yet ripe' (Myers 1982:178). If, as Williams suggests, the salt lakes were only visited by people exploiting seeds, tubers and small game in the dunefields, we might expect some plant processing equipment in assemblages at Coorie Coorie Tillie. Instead, they contain a proportion of scrapers, tulas and points (Williams 1998:82). The presence of wood-working tools, particularly tula adzes that were employed for working hardwoods, suggests that people were staying for a time and engaging in time-intensive activity. This does not fit well with a model of transient occupation while *en route* to other areas for other activities.

It is more plausible to suggest that archaeological remains at remote salt lakes is evidence of people visiting those lakes to exploit their resources. A key resource was undoubtedly the ephemeral pools of water in claypans beside the salt lake (Williams 1998:82). Possibly there were also foods available in the vicinity of the lake that encouraged occupation (see Chapter 6).

Another study of Aboriginal settlement patterns in the Middle Cooper Basin took a wide-reaching approach and surveyed a range of the landforms in the district surrounding the Coongie lakes, including the dunefields, floodplains, waterholes, freshwater lakes and ephemeral claypans (McConnochie 1996). Because the study did not sample salt lakes, it will not be discussed in detail. But McConnochie (1996:135) concluded that Aboriginal occupation of the Coongie lakes system 'was not a riverine-tethered economy ... [and] occupation was not limited to the major water sources of the creeks and lakes'. Large sites were recorded near other reliable water sources, while small task-specific sites were commonly found in deflations beside ephemeral water sources in the dunefields. These low density artefact scatters had undistinguished assemblages dominated by unretouched flakes and debitage made of local stone.

Without denying the importance of the freshwater lakes, McConnochie identified a more complex and flexible settlement system; one that was geared towards 'ensuring access to reliable water sources, accessing seasonal abundances of specific resources, and maintaining access to a diversity of environments, with the camps strategically located to balance these three groups of variables' (McConnochie 1996:131). According to such a model, salt lakes in the dunefields might have had more of a role in the regional subsistence system than Williams' model allows.

### Corangamite Basin

A study of the archaeology of the Corangamite Basin, in southwest Victoria, identified the perennial lakes as a focus of settlement (McNiven 1998). A few of these small lakes are freshwater but most are 'salty', ranging from brackish to hyper-saline. Although the environment and ecology are significantly different from intermittent lakes in the arid zone, the study has many similarities with Williams' work in terms of methodology, results and the proposed settlement model.

Artefacts were found on the margins of many of the lakes, including several of the saline lakes. The frequency or density of material was found to be inversely correlated with the salinity of the lakes. No artefacts were found at the hyper-saline lakes and the largest sites were beside the freshwater Lake Colac. Nonetheless, artefacts at the saline lakes indicated 'that factors other than existence of drinkable water, such as food resources, were attracting people to these locations' (McNiven 1998:76). No details of the site assemblages were provided so it is unclear if there were differences in the assemblages found beside the saline and freshwater lakes.

An ecologically-based model of Aboriginal settlement was developed from the ethnohistorical sources and environmental information (McNiven 1998:72-4). The availability of fresh water was considered the primary determinant of site location, with food resources the secondary determinant. Under these constraints, occupation of the district fluctuated, or 'pulsed', on a seasonal cycle. Winter and spring, the 'wet' season, was when people visited to exploit the spawning fish, the huge flocks of breeding waterbirds (particularly swans) and the yam-daisy which is at peak productivity then. Ethnohistorical accounts mention moderately-sized aggregations of several hundred people beside some lakes in these months of food abundance, and these gathering were 'attended by local and specially-invited non-local group(s)' (McNiven 1998:72). In the summer 'dry' season, some groups focussed on permanent freshwater lakes and river systems, while some groups probably moved back to adjacent regions and other permanent sources of freshwater.

As with Williams' settlement model for the Middle Cooper Basin, this model assigns little importance to salt lakes, with only sparse and transient settlement proposed at these wetlands. Yet the ethnohistorical evidence indicates the importance of the large saline lakes, documenting that egg collecting at saline Lake Corangamite was a major activity in the spring months when colonies of swans nest there (McNiven 1998:72). I suspect that such colonies were a major food resource, in terms of birds, eggs and hatchlings. So McNiven's model may describe the major settlement pattern but possibly underestimates the role of salt lakes and the nesting bird colonies in the annual subsistence round.

In summation, these three studies found limited archaeological evidence for Aboriginal occupation of salt lakes, even where the lakes are perennial. Very few sites were discovered, in contrast to the situation at Lake Carey. Generally these had little archaeological material. A small proportion of adzes were recorded in some assemblages which indicates that those sites were more than just 'mealtime camps' and might have been occupied for some days. No grindstones were recorded, so seeds were not a food source at these locations. At Lake Frome and in the Middle Cooper Basin, artefacts were made of local stone, suggesting an opportunistic and casual attitude to stone procurement consistent with transitory occupation (Gould 1977b).

There is little consensus amongst the researchers on why people were visiting the lakes, however, in all three cases it was stated or implied that a shortage of potable water was a major restriction on occupation. In the Middle Cooper Basin, Williams argues that the lakes were only visited after rains by small groups *en route* to other areas. Lampert and Hughes make no suggestions as to what people were doing at Lake Frome. In contrast, McNiven was able to establish from ethnographic sources that the harvesting of swan eggs was a major annual event at Lake Corangamite.

This raises an intractable problem: if waterbirds and their nests were a major attraction at salt lakes, what would be the archaeological evidence?

No tools other than baskets or bags would be needed to collect or cook the bird eggs that were a major attraction at Lake Corangamite. Groups camping and collecting eggs, and perhaps then goslings, would leave few stone tools behind; which is the artefact distribution that was recorded (McNiven 1998). Given the friability of egg shell, the only direct archaeological evidence of this practice might be the small hearths needed to bake the eggs or cook the birds. If the eggs were eaten raw there would be even less evidence. So a survey strategy like McNiven's, which understandably focussed on stone artefacts, would overlook this major activity and it would be archaeologically invisible (cf. Flood 1988 and bogong moth exploitation). This short-coming obviously applies to the other studies, and disappointingly, also to my own.

## Research in the Arid Zone

### Settlement Patterns

Despite the immensity of the arid zone, the complexity of the environments and the paucity of research, several theoretical models of Aboriginal settlement/mobility and adaptation have been proposed. They all have two things in common; firstly, they are based on ethnographic or ethnohistorical analogy, and secondly, there is a strong emphasis on the environment as the primary determinant of cultural adaptation and on fresh water as the primary determinant of settlement patterns. This was also the case for the models proposed by Williams and McNiven discussed in the preceding section.

Ecological determinism is a common theoretical approach in Australian archaeology possibly because of the relative ease of testing it with archaeological data (Head 1986; Huchet 1991). It may be particularly appropriate for the arid zone given the strong constraints on human behaviour set by the environmental extremes (Williams 1998:70; see also White *et al.* 1990:171,183).

This approach, however, underestimates the role of social and cultural factors in shaping behaviour; factors well documented in ethnographies of desert peoples (e.g. Berndt 1972; Devitt 1988; Myers 1982; Tindale 1972) and ethnoarchaeological studies (e.g. Cane 1984; 1990; Gould 1973; Meehan 1982; O'Connell & Hawkes 1984). This remains a major shortcoming of archaeological technique and I do not propose any solutions here. A further problem is that an ecological approach needs to appreciate the climatic, biological, geomorphological and hydrological diversity of a region, and its history, if derived models are to be useful. This certainly has not been achieved in studies of Australia's arid zone. Smith (1993) has made an allied point in his critique of Veth's (1989a; 1989b; 1993) model of initial settlement of the arid interior.

That the complexity of the arid zone is often underestimated is evident from the on-going use of the term 'Western Desert' as a regional classification by some authors (e.g. Cane 1990; Gould 1991:13; O'Connor *et al.* 1998:20; Veth 1995a:733). The 'Western Desert' to which they refer stretches from 17°S to 32°S and encompasses the Laverton district and Lake Carey. Different parts of it experience summer, winter, or non-seasonal rainfall, have vegetation communities that are predominantly grasslands, Acacia shrublands or Eucalyptus woodlands, and on geomorphological grounds, are classified as piedmont desert, stony desert, sand desert or shield desert (Mabbutt 1971:72-73). This heterogeneity also applies at lower levels of classification. A good example is the Lake Carey system where there is considerable internal diversity and at the same time marked differences from adjacent areas (as detailed in Chapter 2). Figure 3.1 demonstrates the immensity of the so-called 'Western Desert', and illustrates the location of some previous research areas relative to Lake Carey.

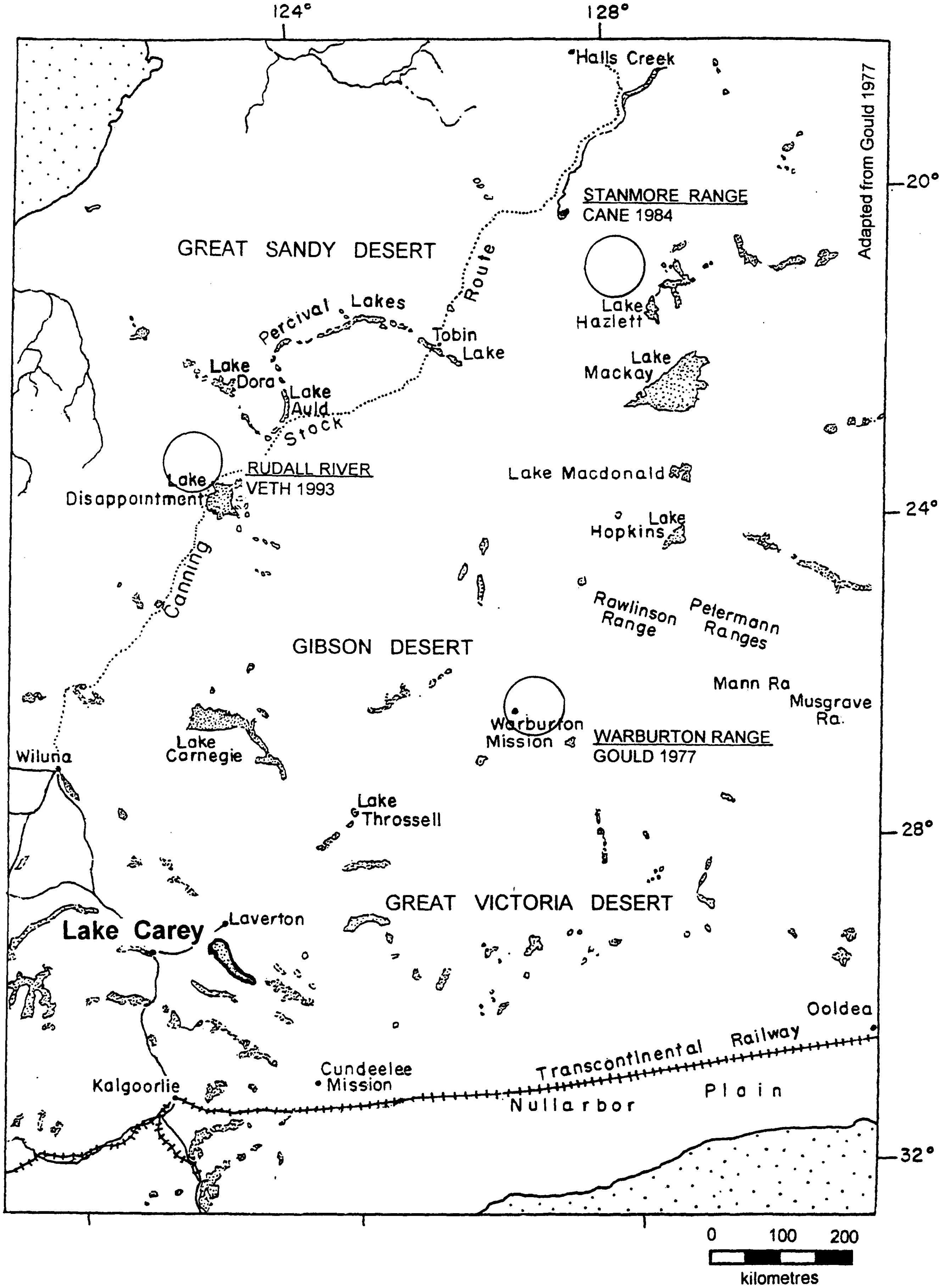


**Figure 3.1: Location of Lake Carey relative to some other arid zone study areas**

Warburton Range

One of the first archaeological researchers of Australia's arid zone visited Laverton and recorded sites near Lake Carey before moving on to Warburton in the Gibson Desert where he conducted ethnoarchaeological studies, excavated stratified rockshelters and thereby established that Aborigines were present in the arid heart for all of the Holocene. From these studies Gould (1968; 1977a; 1977b) developed a comprehensive model of Aboriginal adaptation and cultural continuity incorporating aspects of demography, subsistence strategies, settlement patterns and stone procurement. He also propagated the term 'Western Desert'.

Gould's work was a starting point for many other researchers and his settlement model shares many features with other hypotheses. The essential point for Gould was that water was a constant problem. His study area in the Gibson Desert, in common with the Lake Carey region, has an essentially non-seasonal rainfall pattern. This means that rain is equally likely in any month but is highly unreliable and unpredictable. Traditional Aboriginal water sources included rockholes and 'native wells', which were reliable but not necessarily permanent, and ephemeral pools and claypans (Gould 1977a). There are no significant creeks or rivers and no salt lakes in the region around Warburton.

The model that Gould proposed to explain Aboriginal adaptation and settlement/mobility patterns was based on a 'risk-minimizing' subsistence strategy. This involved 'rain-chasing', a reliance on vegetable staples augmented by hunting and long distance movement to avoid drought (Gould 1977a:169-170; 1991:15).

> In making a living, the Western Desert [A]borigines have adapted by combining their traditional knowledge of the local geography ... with their observations of actual falls of rain and occurrences of edible staples, an essentially random matter requiring an opportunistic response. All subsistence decisions made within this framework tend to minimize uncertainty ... Movement by groups is frequent and far-reaching and is basically random with respect to areas which do not contain usable waterholes. Groups also fluctuate in size in direct response to the local availability of water. ... But virtually no other options exist, and a hunting-and-gathering life based on any other approach, including a seasonal one, would surely fail.
>
> (Gould 1977a: 169)

The model identifies potable water as the primary determinant of site location and declares there to be a direct relationship between the permancy of water sources and the density and size of camp sites. For most of the time, small highly mobile bands would have been dispersed across the landscape opportunistically using the ephemeral and minor water sources and adjacent food resources. Small agregations of people would have occurred reasonably often in dry times at reliable water sources. Large aggregations would have been rare and occurred only when there was a combination of abundant water and food resources.

This settlement/mobilty pattern has definite archaeological correlates. Very small artefact scatters, constituting transitory camp sites, will be widely dispersed and most common where there are ephemeral freshwater sources in the vicinity of vegetable resources. Large artefact scatter sites, or base camps, with evidence of more intensive use will be restricted to reliable water sources (Gould 1977a). Assemblages at the large sites will contain many formal and 'curated' tools and a high proportion of artefacts made on stone obtained from quarries, including some from distant quarries. Assemblages at transitory camps and task-specific sites will be dominated by non-specialized artefacts made on locally available and opportunisitically exploited stone (Gould 1977b). Gould also makes the point that flaked stone tools were largely maintenance tools and 'can tell us little or nothing directly about subsistence or other activities related to the procurement of basic resources' (1980:137).

How does Gould's model apply to salt lakes, which he did not consider? Because intermittent salt lakes are not reliable sources of fresh water they will have been visited by small groups only after rain. Any visits would have been of short duration as part of the wide dispersal of people utilizing ephemeral waters. This would translate archaeologically into numerous small artefact scatters beside ephemeral claypans near the lakes, in locations with good access to food resources including sources of seed. The assemblages at these transient camp sites would contain mostly non-specialised artefacts and very few formal tools. Almost all artefacts would be made of stone from the nearest possible source.

### Stansmore Range

A number of Australian archaeologists have followed Gould's ethnoarchaeological approach in their studies in the desert. Cane's extensive work in the Great Sandy/Tanami Deserts with *Gudadja* people from Balgo is a particularly relevant example. His research primarily focused on combining economic and ecological information with the interpretations of Aboriginal informants to assess assemblage variation at numerous archaeological sites (Cane 1984). From his ethnoarchaeological research he also proposed a model of settlement/mobility for the 'Western Desert'. This model was developed from a 'case study of Aboriginal pre-contact population movement in and around the Stansmore Range ... which was a focal point for economic and ceremonial activities in the past' (Cane 1990:152). The surrounding region is principally dunefields with some sand plains. The large (salt) Lake Hazlett lies in the vicinity but was not referred to by Cane. The region experiences a predictable summer rainfall pattern although the amount of annual rainfall is unreliable.

In a variant of Gould's model, Cane sees ceremonial factors and the availability of water as the primary determinants of a settlement pattern that was seasonally cyclical. Following the summer rains, people dispersed 'widely and freely' and foraged in virtually every environmental zone and travelled to obtain resources such as stone and wood that were difficult to access under dry conditions. But if the wet season was especially good 'people travelled to fertile regions to attend large ceremonies' involving groups from adjacent regions (Cane 1990:154). Following the ceremonies and while surface waters were plentiful people returned to their estates. As the dry season progressed people fell back to the main waterholes and soaks, mostly in the ranges and hills. This was a time of small aggregations of scattered groups. By the end of the dry season these small groups congregated at the very few major and almost-permanent waterholes. They remained there until the wet season rains came. If the rains failed and the waterholes dried out the people perished or escaped to other waterholes outside of their territory (see also Davidson 1990; Gould 1991).

Salt lakes do not enter explicitly into this settlement model. Again, as with Gould's model, it can be assumed that they were marginal. They presumably would have been visited only following the summer rains when people dispersed throughout the region, including remote corners of their territory. It is also possible that the lakes were visited *en route* to the large gatherings, if they were on the way. Certainly Cane did not consider them as a source of food or water, not as centres for aggregation. Instead, the abundant resources that prompted aggregations apparently were to be found around the hills and ranges, such as the Stansmore Range (Cane 1990:154).

### Rudall River

Veth (1993[1989a]), in his study of 'settlement and subsistence in arid Australia', relied on Cane's model but followed Gould in several things. His study area was in the Rudall River region at the juncture of the Great Sandy and Little Sandy Deserts. This region is relatively close to Cane's study area. It also has a strongly seasonal rainfall pattern of summer rains.

Veth reincorporated an emphasis on plant staples and made generalisations from a specific locale to the entire 'Western Desert' (see also Smith's 1993 critique). Veth too emphasized that settlement patterns were dictated by the seasons, which determined the availibility of potable water and staple plant foods. Water was considered crucial, however, and 'The location of habitation sites is primarily determined by access to water' (Veth 1989a:188) and the 'social groupings tend to be larger, and more complex, as a function of water permanency' (Veth 1989a:187).

Veth's model of settlement/mobility follows the seasons but it is not strictly cyclical (Veth 1989a:188-90). It is built on movement to, and settlement at, three types of water resource; ephemeral, long-lasting and permanent. The model states that during and following summer rains there was a period of 'high logistical mobility' as groups used a wide range of ephemeral water sources to access all parts of their range and exploit a variety of resources. As these waters dried, groups returned to longer-lasting water sources and this generally was a time of small aggregations. However, because of the availablity of staple plant foods at this time of year, some large gatherings for ceremonies were organised at certain large water sources near these staples. As the dry season drew to a close, groups congregated at the few permanent water sources. This was a period of 'high intensity occupation' and 'low residential mobility', with intensive use of the limited resources close to these sites.

The archaeological correlates of the model are explicitly stated (Veth 1989a:190-7). They mirror and enlarge on Gould's model. Very small camp sites will occur at widely scattered ephemeral water sources, while large or 'core habitation sites' will be located near the most productive plant communities, in easy reach (<2 km) of permanent water sources. Medium-sized sites will be located near long-lasting and semi-permanent waters. There will also be definite patterns in the assemblages beside various water sources. Site assemblages at ephemeral waters will have high proportions of debitage, flake fragments and micro-flakes, but low proportions of cores and formal tools, and will be made predominantly of locally available stone. Sites at permanent waters will have 'significantly higher' proportions of artefacts made of exotic stone as well as high proportions of modified and formal tools. There will also be more categories of debitage. The mean size of all classes of artefact will be lower at 'core habitation sites' than at smaller sites, as a function of more intensive reduction. At semi-permanent water, assemblages will be intermediate between these two types.

Veth's model does not reflect Cane's findings on assemblage variation. Cane (1984:271) determined that 'there is indeed considerable variation in the composition of assemblages at major habitation sites and that this relates to the environmental and economic characteristics of different sites'.

Lower Cooper Creek

Having developed a settlement model in the Rudall River region, Veth applied it with some modifications to Aboriginal settlement on the Lower Cooper Creek (Veth *et al.* 1990). This area is well south of the Coongie lakes system and the Middle Cooper Basin, but has many ecological similarities. The adjacent landscape is predominantly extensive dunefields, there are permanent and semi-permanent pools of freshwater (in the Lower Cooper rather than in lakes) and the region experiences extended droughts interspersed by occasional floods.

Aboriginal settlement was seen as being more restricted in the Lower Cooper Creek region than in the Rudall River region. It was tethered to the riverine strip, where reliable semi-permanent and permanent pools exist and food resources are both abundant and concentrated. The adjacent dunefields were sparsely occupied because of the lack of large or reliable water sources and the dispersed nature of food resources in the largely homogenous landscape (Veth *et al.* 1990:53). Settlement patterns were weakly seasonal. Aggregations of large numbers of people occurred at permanent water sources in autumn and winter when there was greater plant food availability. At other times of the year people were dispersed along the creek system with small groups more or less permanently settled at permanent pools. For brief periods following local rains small groups made forays into the neighbouring dunefields.

The principal determinants of site location are again seen to be water and plant foods. Site size and artefact density are directly related to the permanency of potable water sources. The 'ecotone' at the boundary between the floodplain and dunefields was identified as the most productive habitat for plant foods, as well as timber for shelters and implements. Consequently, this will be where large sites are most likely to be located. Medium-sized sites are likely near semi-permanent pools and where the floodplain is narrow and has fewer food resources. Small transient camp sites will be situated near ephemeral pools in the creek and ephemeral water sources in the adjacent dunefields. Both medium-sized and small sites are common further downstream, towards Lake Eyre, while large sites are only common upstream. The complexity and diversity of assemblages will correlate with the size of the site; in effect, with the permanency of the water source.

This model is similar to that suggested by Jones (1979) from a comprehensive survey and analysis of the ethnohistorical and ecological literature. Jones proposed that movement was determined by rainfall, with small groups dispersing through the dunefields after rains to exploit the small game and plant foods there and to take pressure off resources beside the Cooper Creek. Only gradually would these groups return to the permanent waters in lakes or billabongs where plant foods and aquatic resources such as fish and waterbirds were exploited. Large gatherings were also regular events in good seasons. These were sustained by the abundance of grass seeds, both in the dunefields and on the alluvial plains (Jones 1979:98, 131).

In summary, the models of settlement for other portions of the arid zone all rely on ethnographic or ethnohistorical accounts of subsistence and settlement and focus on fresh water as the primary determinant of settlement. This was also the case for the models proposed by Williams and McNiven discussed in the preceding section. It is understandable that the availability of drinking water was seen as essential to settlement, for water is crucial to survival in the arid zone. Yet the relationship between water and Aboriginal settlement was likely to have been complex, with many different responses depending on the availability of other resources, social dynamics and cultural preferences. This is recognized by Cane's (1984) model, which identified that after good rain there were numerous options available and cultural factors rather than water availability determined settlement. Cane, unlike Gould and Veth, also identified that the composition of assemblages will be highly variable as a function of the tasks conducted on-site, not simply as a function of water permanency.

A problem common to all the theoretical models is the extrapolation from the ethnographic recent into the archaeological past. But it is not at all clear that the subsistence practices recorded at contact, or later, in these regions are a reliable guide to the bulk of the archaeological record. All the general models for the so-called 'Western Desert' (Cane 1984; Gould 1977; Veth 1993) assume there was a reliance on grass seeds as staple foods. Even if this was so, and I raise serious doubts below, a seed-based economy was probably a relatively recent development in most of the arid zone and the grindstone technology possibly was introduced only in the past one or two millennia (Smith 1989a:308-11; 1989b). This casts doubt on the possible continuity of settlement patterns and the use of ethnography to reconstruct settlement models.

## Subsistence Patterns

All of the theoretical models discussed above attempted to reconstruct the past subsistence strategies, either explicitly or as part of their proposed explanation of the settlement pattern. Only Jones (1979) in the Lower Cooper investigated in detail the food resources that, with water, were essential for settlement. Gould, Cane and Veth have documented some of the resources but like Jones, they focussed on the plant resources and identified these as staples. There is good evidence, however, that meat was a staple for many groups in arid Australia.

There was a general shift in archaeological circles in the 70s and 80s towards recognizing 'woman the gatherer' and away from 'man the hunter'. This was useful in rediscovering the importance of plant resources and women's role in the Aboriginal economy (Beck *et al.* 1989; Hallam 1986; Peterson 1978). But there are many regions on the continent without the yams or grasses that were staples for some groups. These food groups are typically summer rainfall plants and are not found, for example, in the Lake Carey district. Other seeds were used but were less satisfactory as staples.

Numerous studies have disproved Gould's (1980:62) wild assertion that 'at least 90% of the time females provided 95% of the food available to the group as a whole' (Cane 1984; Devitt 1988). Rather, it seems that seeds were a fundamental part of the traditional diet but were only used at certain seasons and perhaps only in certain years. Possibly in good seasons when other more prized foods were available very few seeds were collected. Following record rains in 1974 at Utopia, in Central Australia, the *Alyawara* 'women ignored seeds almost entirely, directing their efforts instead to cossid larvae, solanum fruits, ipomea roots, and small lizards' (O'Connell & Hawkes 1984:510). This was in contrast to their behaviour in 1972, a relatively poor season, when seeds were collected possibly because more prized foods were not available (O'Connell & Hawkes 1984:516).

A later ethnographic study at Utopia demonstrated 'the importance of meat and fats as targets of women's foraging and suggested that men and women shared similar foraging orientations. Although women obtained smaller absolute quantities of meat, both women and men were active, regular hunters' (Devitt 1988:119). Of the many possible foods available, the foods that women 'actively sought' comprised: four species of larger lizard, echidnas, witchetty grubs, honey and honey ants, three species of yams, five types of fruits and wild onions (Devitt 1988: table 4.5).

This omnivorous approach was also observed in central Arnhem Land (Meehan 1989:26). In the diet of this community 'plant and animal foods were of roughly equal importance ... [although varying] according to seasonal influences on the abundance and quality of products'. Furthermore, 'women "gather" a wide variety of goods ... such as shellfish, fish, honey ..., goannas, snakes, freshwater tortoises, small rats and mice, the eggs of saltwater turtles, geese, ducks and other birds, various larvae, crabs and freshwater crustacea' (Meehan 1989:26).

The importance of small game and particularly lizards in the diets of Aboriginal desert-dwellers has been repeatedly commented on in the ethnographic literature. For the *Pintubi* in the sand plains near (salt) Lake Mackay, Long observed that:

> Only two of the twenty groups were found to be using grass seed for flour making ... other seeds and fruit were more often available than grass seeds, the most used probably *Solanum* fruits and the quandong ... men have been seen gathering solanum and other fruits in quantity, as well as lizards and rodents. It seems reasonable to assume that the main staple in the area was lizard meat. Virtually every group met had been gathering lizards; in most instances this was the only food brought back to camp. (Long 1971:267)

Lizards were an important food in many parts of the arid zone (Myers 1982; Thomson 1975). One obvious reason is that, in Australia's deserts, 'lizards are extraordinary diverse and abundant' (Stafford Smith & Morton 1990:256). They are also relatively easily caught, either by chasing them or digging them out of shallow burrows. But other factors might have been involved. 'In a land where mammals are nearly always lean, ... lizards and the emu are practically the only sources of fat-supply and are cherished accordingly' (Finlayson 1935:38; quoted in Devitt 1988:13).

It is likely that meat, in its many manifestations from large game to small game to witchetty grubs, was a staple in the Laverton region at least part of the year. Furthermore, during those exceptional seasons when Lake Carey was full and many foods were available, highly prized animal protein and fat and delicacies probably were the main targets for men and women foragers as was observed at Utopia. Probably little effort was devoted to collecting and processing seeds, even though these would have been abundant in these good seasons (O'Connell & Hawkes 1984). In any case, the grass seeds that were a staple in the northern arid zone are not present in the region; a point emphasized in Chapter 6 where the potential food resources at Lake Carey are catalogued and assessed as potential factors in settlement patterns.

This chapter has summarized the findings of the few archaeological studies previously conducted at salt lakes in Australia. Generally very little occupation evidence was found, in marked contrast to the situation at Lake Carey, but this does not necessarily mean that salt lakes played a negligible role in Aboriginal settlement or subsistence. From the ethnographic record it is known that egg collecting from waterbird colonies was a major activity at Lake Corangamite, in Victoria (McNiven 1998). It can be assumed that where similar opportunities existed Aborigines exploited them. The archaeological evidence for these activities will, however, be very elusive.

A review of general models of 'arid zone adaptation' found that salt lakes were nowhere considered. These models typically failed to appreciate the diversity of the arid zone, with some authors extrapolating from seasonal sandy deserts to most of the interior (e.g. Veth 1987; 1993). The modelling also relied heavily on Gould's original formulation of water resources and plant foods as crucial determinants of settlement (Gould 1977a). This is too simplistic. It fails to recognize that game foods were more important staples for many desert dwellers and that Aborigines sought highly prized foods when they could, leaving the lesser valued seeds and tubers. Clearly the irregular but abundant resources of salt lakes after floods would have been attractive to Aborigines and incorporated into their subsistence and settlement patterns.

Before analysing the archaeological biophysical data, it is necessary to describe which portions of Lake Carey were included in this study and consider the methods applied in collecting and analysing the data.

# CHAPTER 4

# METHODS, SAMPLES & TAPHONOMY

In this chapter I describe the five sample areas from which site data were collected and the basic units of distribution analysis: the nine landscape units, two site types and seven size classes of sites. Some of the limitations of the data are discussed, including the role of taphonomic processes in shaping the archaeological record. Also in this chapter a key statistical tool, the association index, is introduced and defined. This was used in analysing correlations between archaeological material and landscape units (Chapter 5) as well as identifying the rarity and significance of particular types of sites (Chapter 7).

## Sampling & Survey Methodology

### Five Study Areas

#### Selection

Five areas were chosen for inclusion in this study from consideration of the dozen or so archaeological surveys conducted at Lake Carey (all but three of them by me). The basis for choice was the number of sites and the representativeness of the landforms. Large areas with numerous sites were chosen, and where necessary, additional fieldwork was performed to complete the coverage provided by the original surveys. It was considered important that the study areas include sufficient sites to minimize problems of small sample size in the analysis. For this reason, surveys on the northern shore were excluded. In terms of representativeness of landforms, the chosen study areas were widely separated and covered the eastern, southern and western margins of the lake, as well as two groups of islands (Figure 4.1). This ensured that all landforms typical of the lake system were included (see below).

There was, unfortunately, some bias in the selection of islands for the study. Access to islands is a problem, so the choice was limited to those two areas surveyed ahead of exploration, where access had been provided by air-boat or hovercraft (North Islands study area) or causeways (South Islands study area). In both cases, islands with rocky hills were included despite the rarity of such features on islands generally. Also, many of the islands included in these two study areas were close to the shore and possibly not representative of more remote islands in the centre of the lake. Nonetheless, there was a full range of typical island landforms in these study areas.

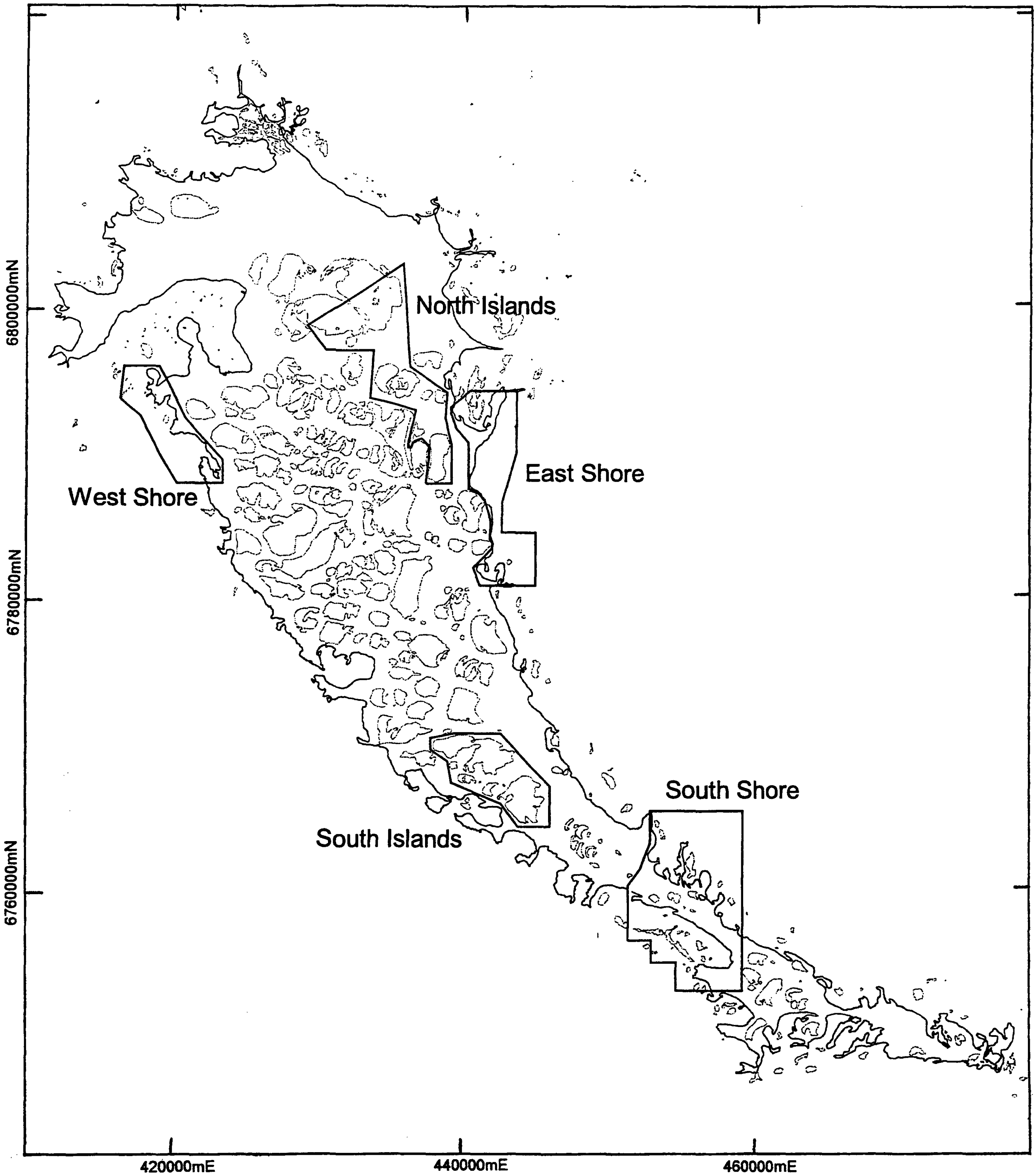


**Figure 4.1: Five study areas at Lake Carey**

Some bias might have been expected in landform representation because the original surveys were conducted ahead of exploration programs (typically gold exploration but nickel exploration on the western margin). This was not the case, because the surface landforms generally bear no relation to the underlying geology, as discussed in Chapter 2. The exception is the rocky hills. For the rest, there is a thick cover of (aeolian or water) transported sediments. It should also be noted that the surveys were not limited to particular geological occurrences but included adjacent areas of the mineral tenements with different basement geology.

Below, the five study areas are described (see Figure 4.1). Detailed descriptions of the vegetation, geology, hydrology and erosion regimes are discussed below for the nine landscape units which are the primary areal units of analysis.

<u>North Islands</u>

Seven widely separated islands lie within this area. From the northern to the southern extremity was a distance of 15 km. Included was approximately three-quarters of the largest island in the lake, known to some as Kevin Island, which is more than 3 km from the nearest shore. The other islands are considerably smaller. They are situated to the southeast of Kevin Island and closer to the shore. The North Islands area is situated in the northeast portion of Lake Carey, close to and northwest of the East Shore study area.

The smaller islands are almost exclusively composed of gypsiferous sands forming low dunes and short plains. In only a few places on the dunes is there a thin covering of quartz sand. The same landforms are common on Kevin Island. In addition, there are extensive areas of sand plains and some sand dunes fringing the shores of the island, and near the southeastern edge there is a low mafic hill.

Several small and shallow claypans exist on the sand plains but these ephemeral water sources are uncommon on the islands. Stone sources are rare and largely restricted to the hill on Kevin Island, where there are quartz pebbles in the scree and gibber on the slopes and apron. There are also two small outcrops of siliceous stone on the hill crest that had been quarried; a poor quality vein quartz and nearby, a patch of chilled-margin dolerite in contact with a black 'chert'.

The islands in this study area encompassed a total of 20.64 km², and there were 29 sites, of which 21 were on the large Kevin Island (Mattner 1996; 1997a). The combined shoreline length of the seven islands is 55.5 km, with less than a third of that consisting of embayment shoreline. The area of saltpans and claypans is 0.37 km².

<u>South Islands</u>

This area encompassed five islands; two large ones known to some as Treasure Island and Angelfish Island, and three very small adjacent islands. They are located near the southwestern shore, with less than 1 km of lakebed between Angelfish Island and the shore. From the northwest edge of Treasure Island to the southeast edge of Angelfish Island is 9 km. The former Linden township is 7 km south of the islands. The Red October gold mine is situated within the study area, on the lakebed between the two large islands.

Most of Treasure Island is composed of a series of kopi dunes with low-lying plains or saline flats in the swales. In the eastern part, there is a prominent, rounded mafic hill with a thin covering of gypsiferous sands and quartz sands about its base. Similarly, Angelfish Island is composed of aeolian gypsiferous and quartz sands with small rocky hills on the southeast margin, several kilometres from the shore. The three small islands are solely composed of gypsiferous sands forming dunes and flanking plains.

No claypans or other long-lasting water sources exist on the islands. The only possible water sources are highly ephemeral: a few tiny pools in short, rocky drainage lines running off the mafic hills, or small erosion scalds on the plains. Knappable stone is largely limited to the sparse quartz gibber around the hills but a small outcrop of crystal quartz on the easternmost edge of Angelfish Island was quarried (see Chapter 5).

The five islands had a combined area of 14.05 km². The combined shoreline length totaled 46.7 km, of which less than a third is embayments. Inclusive of a crystal quartz quarry, 21 sites were recorded (Mattner & Quartermaine 1996a).

East Shore

This area extended north from the so-called Freshwater Swamp to a point west of Jubilee Well and encompassed several large saltpans and three embayments of the lake. The study area had maximum dimensions of 13 km NS and 9 km EW, and the Sunrise and Sunrise Dam minesites are within it. The islands close to the shore were excluded from the study area.

A large part of the study area comprises shoreline features, such as saline flats, sand dunes and prominent kopi dunes about the embayments. A small ironstone knoll with abundant scree is the only hill. This is near the misleadingly called Freshwater Swamp, which is an embayment of the lake and saline. After flooding it fills with freshwater from several minor drainage lines that converge on this interdunal low point and slowly becomes brackish. The plains near the shore are primarily composed of gypsiferous sands while further inland there are extensive sand plains and, near the rocky knoll, several small areas of colluvial plains. The gibber on the colluvial plain and on portions of the adjacent alluvial plains was the only source of knappable stone, for the ironstone from the knoll is unsuitable.

Two moderately-sized claypans were located in the area; one close to Freshwater Swamp and the other several kilometres to the north. This latter claypan, Sunrise Dam, is one of the places where, as recounted in Chapter 1, Mrs Sullivan camped as a child while walking around the lake (see also Plate 1.1).

The study area encompassed 30.64 km². The few saltpans and claypans covered an area of 0.25 km². The shoreline length was 35.9 km, with more than half of this contributed by embayments, including Freshwater Swamp. There were 114 sites in the area (Mattner & Quartermaine 1994a; 1994b; 1994c; 1994d; 1995a; 1995b; 1995c; 1996a; 1996b; 1997a; 1997b; 1997c).

South Shore

This area was positioned near the southern end of the lake, where is it very narrow. Only one kilometre separates the eastern and western shores and crossing the lake on foot at this point would have been reasonably easy. The study area had maximum dimensions of 13 km NS and 8 km EW. The abandoned Bindah Mine is within the area and the former Linden town 10 km to the west. Several very minor islands were excluded from the study area.

Both margins of the lake comprise extensive plains at this point and have many similarities. Nonetheless, the basic dichotomy between the rocky eroding western lake margin and the alluvial prograding eastern margin still applies, although less obvious or pronounced than further north. The western margin consists of both colluvial and alluvial plains, while in the southwest corner there is a low lateritic plateau and breakaway, with several saltpans at its base. The eastern margin is predominantly sandy alluvial plain, with some low kopi dunes flanking the shores of the lake. There are many narrow embayments on the eastern shore, and small claypans are common beside the embayments and on the adjacent plains.

The numerous small claypans on the eastern margin and two larger claypans on the western margin are the major water sources in the study area. There are also small ephemeral sources, chiefly in erosion scalds on the plains. Two shallow and small rockholes are situated on the edge of the lateritic breakaway in the southwest of the study area. These might have been reliable but are very limited water sources. Knappable stone is absent from the eastern margin but there is a sparse gibber of quartz and ironstone in the southwest. Sources of knappable stone probably exist in the hills to the west.

The study area contained 24 sites (Mattner 1998) in an area of 49.94 $km^2$. The shoreline was particularly long, at 60.2 km, with embayment shorelines constituting over half of this total. The area of saltpans and claypans, 0.74 $km^2$, was also relatively large.

### West Shore

This area was situated about 18 km due west from the East Shore study area, on the opposite lake margin. In the north it encompassed a large circular embayment and it extended south-southeast for 9 km. The area had a maximum width of 3 km, perpendicular to the shoreline. Pyke Hill is located in the southeast portion, near a peninsula jutting into the lake.

The northern part of the study area was chiefly composed of alluvial and colluvial plains, with several low rocky hills and ridges. The shoreline is predominantly sand dunes but in some places the hills reach to the lake edge. In contrast, the shoreline in the south is mostly formed by hills and there are few sand dunes. The hills and ridges dominate the southern portion and there are several parallel ridges, with very little open plain between them but with a few short drainage lines and small alluvial fans at the lake edge. The mafic hills and ridges are relatively high in this region of low relief and offer vistas across the lake. The ubiquitous scree extends on to the plains and the lake edge.

Amidst the rocky hills there are numerous small outcrops of highly siliceous stone. Many of these sources were quarried but in addition to these there are large areas with a gibber containing quartz pebbles. Numerous small ephemeral pools are available after rain in the rocky drainage lines amongst the hills and ridges. In addition, there are several small claypans on the plains, and a chain of moderately-sized claypans in the northwest corner of the study area. One of these, Landing Ground Claypan holds water for months after good rain (pers. obs.).

The study area covered a total of 20.09 $km^2$, which includes 0.47 $km^2$ of saltpans and claypans. The shoreline length was 22.0 km, with one third contributed by embayments. In all, 60 sites were recorded in this area, of which one quarter were quarries (Mattner 1997b; Mattner & Corsini 1998a; 1998b).

## Survey Strategies

Surveys in all five study areas were performed using a stratified sampling design and employing systematic, meandering, pedestrian transects. Areas were categorized in terms of their potential for sites using aerial photos, maps, initial reconnaissance in a vehicle and previous experience.

Transects were spaced 100 m apart in areas with some potential for sites and at 200 m intervals in areas with low site potential. Occasionally, where initial transects had shown there was very little likelihood for sites, transect spacing was increased to 400 m intervals. Transects were generally aligned east-west so as to be at right angles to the major environmental zones and the trend of the lake shore. Each transect was considered to cover a band 20 m wide, within which there was almost complete identification of archaeological material because of the uniformly high surface visibility. In walking the transects a meandering path was followed to ensure that any features of interest close to the transect's alignment were searched.

At features with high potential for sites targeted searches were also made. These areas included the crest and base of sand and kopi dunes, the margins of creeklines and drainage lines, dunes flanking claypans and saltpans, plus the crests of any hills or ridges and patches of outcrop. Such features were easily identified, often from maps and aerial photos prior to fieldwork, or during the transects. The combined strategy of purposive and systematic searches ensured a high rate of site discovery.

## Artefact & Assemblage Classification

Defining what is a site is difficult, particularly at Lake Carey. Before entering onto that slippery ground, it is necessary to state that for the purposes of this study and the original surveys, a cluster of artefacts was designated a site when there were more than five artefacts in close spatial association. Usually this was considered as 4 $m^2$, but strict area or density limits were not applied because these were deemed unnecessarily pedantic. There is little and often no natural stone on the lake margins or islands, so stone artefacts are conspicuous and the size and extent of surface artefact clusters were easily identified. Only in a few places, such as on sand dunes, are isolated artefacts common. Elsewhere there is negligible background scatter.

Generally, tallies were made of a sample of the site assemblage; recording artefacts by class and lithological type. This was efficient and allowed for characterization of assemblages and sites. Sample units, typically quadrats with sides 5 m or 10 m, were positioned non-randomly in concentrations so that the largest number of pieces would be included. It was assumed that these purposive samples would contain the widest range of artefact and lithological types. This non-random sampling strategy meant some statistical tests are precluded.

All artefacts in samples were classified according to type and lithology, with artefact classification essentially following Hiscock (1989) with only slight modification. Particular implement types are discussed in Chapter 5, where their distribution is analysed. Lithologies were only identified in the field; that is, no samples were studied under microscope or in thin-section. Any inaccuracies introduced by this approach were reduced when the recorded lithologies were condensed into 10 lithic types or categories in the database. For example, various cherts were observed on assemblages but only two types were entered in the database; chert from "Mt Weld Quarry" and other cherts.

The number of artefacts in assemblages was generally estimated from consideration of the densities recorded in the sample quadrat(s) and inspection of the site. Exact site size was difficult to determine for several reasons. Artefacts were sometimes buried in the sands, and in this case, small pieces would probably be under-represented. Recognition of quartz and ironstone artefacts was occasionally difficult because of the pattern of fracturing in these rock types, which does not always result in easily recognizable signs of flaking. Also, where samples were recorded, there was no direct method of calculating assemblage size from the samples, because non-random sampling was used.

Site Classes

To better understand the patterning of archaeological sites across the lake system, sites were classified by site type, or function, and then divided into classes based on assemblage size. There were only two types of recorded site: artefact scatter and quarry. Both types were divided into arbitrary size classes that were essentially exponential in size.

The size classes sought to make divisions between the large number of small assemblages so that minor differences between intensity of site use could be identified. The size of assemblages were tabulated and graphed, then size classes were arbitrarily set that recognized clustering in the size range. The size classes varied for artefact scatters and for quarries. This was warranted because of the very different nature of these types of sites, with high rates of debris and discard at quarries. Artefact scatters were divided into four classes and quarries into three classes, as follows:

Artefact Scatter

i) very small (AS1): 50 or less artefacts;
ii) small (AS2): between 51 and 500 artefacts;
iii) medium (AS3): between 501 and 5000 artefacts;
iv) large (AS4): between 5000 and 50,000 artefacts.

Quarry

i) very small (Q1): 100 or less artefactual pieces;
ii) small (Q2): between 101 and 1000 artefactual pieces;
iii) medium (Q3): between 1001 and 10,000 artefactual pieces.

## Analysis Methodology

### Landscape Units

Simply comparing the numbers and types of sites in the five study areas tells us something about these areas but nothing about why sites exist there. Studies have shown that many factors influenced where sites were situated in the landscape (e.g. Lilley 1985; Moya Smith 1988) and naturally the factors vary for different site types. Chief amongst these were landscape characteristics (including soils, vegetation, slope) and proximity to resources (such as water, food and stone). On this basis, it is possible to divide the lake landscape into units that would have had some relevance to the Aboriginal occupants.

The landforms in the lake system were divided into nine categories. These nine landscape units included seven types of dry land, plus two types of intermittently inundated land where no sites were found or would exist. These nine units are described in detail below but the Lakebed & Saltpan and Drainage Features units will not feature in the subsequent analysis of site distribution.

My classification scheme for the lake and its environs was based on previous local and regional studies. The solitary geomorphological study at Lake Carey concerns only a portion of the East Shore study area (Callen 1995) and so generalized models of salt lake (or playa) systems were also consulted (Hardie *et al.* 1978; Shaw & Thomas 1991). Several environmental and ecological studies have been conducted but each has adopted an individual landscape classificatory system and this hinders direct comparison (Brearley *et al.* 1997; Hall & Milewski 1994; Mattiske Consulting Pty Ltd 1994; 1998; Ninox Wildlife Consulting 1995; Pringle *et al.* 1994). Yet there are similarities between these systems, all of which divide the area of study into a series of distinctive floral or faunal associations. These associations are also associated with topographic features, such as dunes,

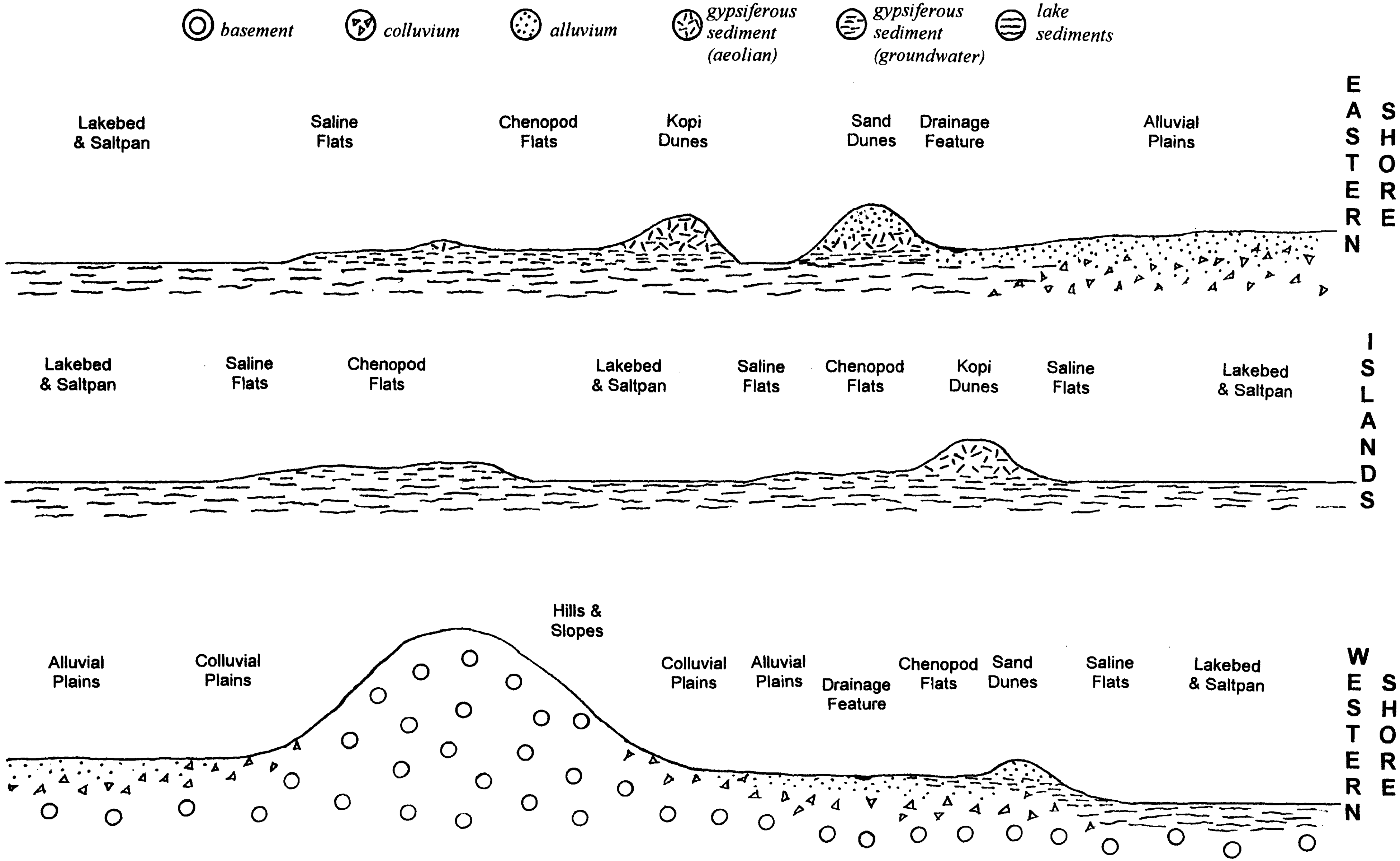


**Figure 4.2: Schematic representation of the 9 landscape units at Lake Carey**

(vertical scale exaggerated)

saline flats or alluvial plains, and from these associations I identified nine landscape units. My classificatory system also recognized the importance of elevation in a landscape that is subject to extensive flooding. It only covers the landscape of the lake, islands, lake margin and adjacent plains. It does not describe the outer portions of the lake basin. The categories would be applicable to most of the intermittent salt lakes in southeast Western Australia.

The nine landscape units are summarized in Table 4.1 and approximate comparisons with other classificatory systems are given in Table 4.2. The position of the landscape units relative to one another and in the lake system is illustrated in Figure 4.2.

Table 4.1: Landscape classification system

| **Landscape Units** | **Summary Description** |
|---|---|
| Lakebed & Saltpans | hyper-saline mud on lake or in saltpans; bare or with samphires |
| Kopi Dunes | gypsiferous aeolian dunes, with sparse trees and low shrubs |
| Sand Dunes | aeolian sand dunes (with kopi dune at core); with mulga, chenopods & grasses |
| Saline Flats | low-lying mud flats, occasionally inundated, with low halophytic shrubs |
| Chenopod Flats | extensive aeolian (& alluvial) plains; with chenopod savanna |
| Alluvial Plains | alluvial plains & wanderrie dunes; with chenopod savanna or mulga woodland |
| Drainage Features | claypans, saltpans or broad washplains; with chenopods |
| Hills & Slopes | hills & ridges covered by scree; with trees, large shrubs & chenopods |
| Colluvial Plains | extensive colluvial & alluvial plains with gibber; chenopods & tussock grasses |

Table 4.2: Comparison of landscape classification systems

| | Vegetation units of Brearley *et al.* (1997) | Landform units of Hall & Milewski (1994) | Carnegie land system categories of Pringle *et al.* (1994) | Sedimentological sub-environments of Hardie *et al.* (1978) |
|---|---|---|---|---|
| Lakebed & Saltpans | *not described* | *part of* Salt Lake Feature | Lake beds | Ephemeral Saline Lake |
| Kopi Dunes | Low Woodland A & Open Low Woodland A | *part of* Salt Lake Feature | Kopi dunes | *not described* |
| Sand Dunes | Mulga Woodland | *part of* Salt Lake Feature | Dunes | *part of* Windblown Dune Field |
| Saline Flats | Dwarf Scrub C | *part of* Salt Lake Feature | *part of* Saline plains | *part of* Dry Mudflat |
| Chenopod Flats | Low Heath C | *part of* Salt Lake Feature | *not described* | *not described* |
| Sand Plains | Low Woodland A | Sandplains | Lake margins & Sandy banks | *part of* Alluvial Fan & Sandflat |
| Drainage Features | *not described* | Drainage Line | Drainage zones | *not described* |
| Hills & Slopes | Low Woodland B; Open Woodland B; Low Shrub B | Hills & *partly* Breakaway | *not described* | *not described* |
| Colluvial Plains | *not described* | Undulating Plains | *not described; partly* Hardpan plains | *not described* |

An important point to remember in subsequent chapters is that the landscape units are often small areas (several hectares), that tend to be linear and which are situated close to other landscape units. This means that people camped on one landscape unit were in proximity to many other landscape units. In the course of daily forays from a camp site people would probably cross most of the landscape units, even if they were focussing their foraging activity on one particular unit. The close juxtaposition of landscape units is apparent in Figure 4.2.

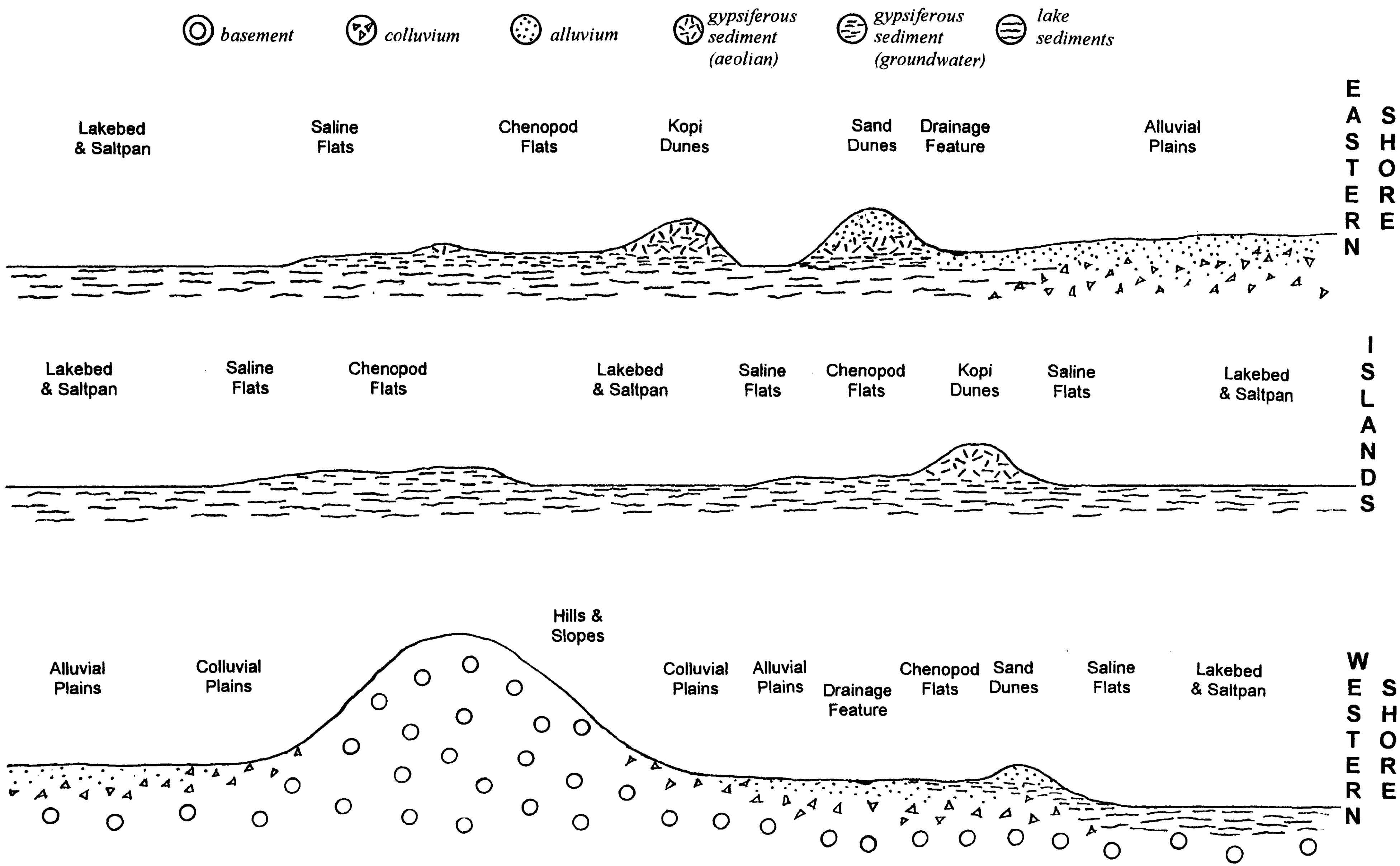


**Figure 4.2: Schematic representation of the 9 landscape units at Lake Carey**
(vertical scale exaggerated)

**Description of Landscape Units**

The physical and biotic characteristics of the nine landscape units are described here and this will assist others in identifying the units in the field (see also Plates 4.1 – 4.8). Within each description there is a brief reference to the exploitable resources that the unit contains, such as water, stone and food. More details of the available resources are presented in Chapter 6, where I describe and assess them as potential factors in Aboriginal occupation and the distribution of sites.

It should be remembered that the lake formed in the Pliocene and the current landforms date to the late Pleistocene. They have been relatively stable since then, while the current climatic conditions and vegetation cover have probably been in place since the early Holocene (see Chapter 2). Therefore, these landscape units describe the land that Aboriginal occupants were familiar with.

Lakebed & Saltpans

This unit encompasses the hyper-saline mud of the lakebed, of the embayments and the numerous small saline depressions in interdunal swales. These flat expanses are largely devoid of vegetation and are composed of muddy sediments with high proportions of salts. There is no stone, except for the rare places where scree from rocky hills has spilled onto the lakebed. This unit is occasionally subject to flooding followed by gradual drying. When full the lake surface is covered by a thin body of water which is between a few centimetres and half a metre deep, and rarely more than a metre.

Fringing the lakebed and saltpans are vegetated mudflats that are less than 50 cm above the lake floor. These comprise dark clays that are extremely saline and which are occasionally inundated and waterlogged. The characteristic vegetation is samphire (*Halosarcia* spp.), with some low heath species (e.g. *Frankenia*) on slightly higher ground.

The mudflats occur as a band along almost all of the shoreline, including around the islands. They range from a few metres wide, at the base of hills or abrupt kopi dunes, to hundreds of metres where the shore is flat, especially on the eastern and northern margins. The mudflats are common in the lake embayments where there is a gradual rise in elevation to the Saline Flats unit; for example, in Freshwater Swamp; and surrounding some islands. Minor occurrences of mudflats with samphire are also found on the edge of some of the saltpans adjacent to the lake.

There is no possibility for archaeological sites on this landscape unit. No-one would choose these muds for a camp, activity area or anything else, for they are occasionally waterlogged, sometimes slippery and clinging, and always hyper-saline. There are no resources here that were part of the Aboriginal diet or subsistence economy, as far as is known.

Kopi Dunes

Kopi dunes are composed of pale grey gypsiferous aeolian deposits from the lakebed. In addition to the gypsum content, there are sands and silts and other mineral salts. The surface of the dunes is a coarse hardened crust but sub-surface kopi can be very powdery. The dunes are porous and percolating rainwater dissolves some gypsum, occasionally producing 'kopi karst' features, such as rillen surfaces and sink-holes. The dunes vary in form and size but generally are parallel with the shoreline and frequently exist as a series of parallel dunes. Prominent dunes can form bluffs up to 10 m high with steep eroded sides. More often, the dunes are broad gentle rises several metres high. In some places, the kopi is exposed in the swales between the dunes and forms a 'pavement'.

There is very little vegetation on the kopi deposits. The dune crests and slopes typically have a sparse to very sparse cover of native pine (*Casuarina cristata*) and/or kopi mallee

(*Eucalyptus striaticalyx*), with little or no groundcover. Where kopi is exposed in the interdunal swales or extends into the Mudflat landscape unit, there is a sparse cover of low halophytic shrubs, including *Halosarcia*, *Maireana* and *Zygophyllum* species.

Kopi Dunes are a characteristic feature of the eastern margin of the lake but are uncommon on the northern and western margins. The islands on the lakebed are partially or wholly composed of kopi dunes, frequently in a series of parallel, sickle-shaped dunes. These appear to be barchan dunes, formed under northwesterly winds. As mentioned in Chapter 2, these dunes were formed in very arid periods during the last two glacial maxima. Water erosion and to a lesser extent wind erosion are shaping the dunes. In some places it is apparent that overlying sand deposits have eroded away or been reworked.

Only rarely is water found associated with these dunes. This can occur when an impervious clay layer forms in a depression and the result is an ephemeral claypan. Otherwise these dunes are porous and waterless. Being aeolian in origin there is typically no stone on the dunes, although in a few places dunes have partially covered a patch of mafic outcrop. Knappable stone does not occur and any exceptions are either small gastroliths introduced by emus or artefacts and manuports.

## Sand Dunes

Long sand dunes commonly exist on the margins of the lake or behind the kopi dunes. These are generally composed of red to brown aeolian quartz sands that are unconsolidated, non-saline and acidic. The sand dunes almost always rest on kopi dunes, with the sand cover ranging from centimetres to metres in thickness. Sometimes the kopi core is exposed in the deflation hollows that pockmark the dunes. The sand dunes are typically longitudinal and parallel to the shoreline but sometimes they form as lunette dunes around claypans or saltpans, or as low dunes on the plains.

Sand Dunes are a common landform on the margins of the lake and the islands. On the western and northern margins and rocky islands the dunes often comprise the shore. On the eastern margin and most islands the sand dunes occur in conjunction with or behind the shoreline kopi dunes. Erosion is actively shaping the dunes and this has probably increased recently from over-grazing. Wind erosion excavates deflation hollows on the lee side of dunes, particularly when vegetation cover is removed. Water erosion contributes to this process.

The dunes generally are well vegetated and support a cover of sparse low woodland with sparse shrubs and grasses. The understorey component is primarily low chenopod shrubs (bluebush and saltbush) with a variety of other species (including edible *Solanum* spp.) and a suite of grasses, and in spring, wildflowers. There are tall shrubs of various sorts (e.g. *Acacia*, *Senna* spp.). The overstorey is typically of mulga trees with occasional *Hakea preissii* (needlebush), *Santalum spicatum* (sandalwood) and *Pittosporum phylliraeoides* (desert willow).

Some of the plant species were important foods in the Aboriginal diet, particularly those shrubs and trees with fruits, seeds or larvae. There is no stone on these aeolian dunes. The only exceptions are small emu gastroliths or artefacts and manuports. Nor are there generally any water sources on the dunes but claypans (and saltpans) are common in the interdunal swales.

## Saline Flats

Low-lying areas close to the lake shore are usually salt-affected. These Saline Flats generally merge with samphire mudflats on the shoreline and are also commonly found in the swales behind the shoreline dunes. In some cases, narrow saline flats have formed on former drainage features leading into the salt lake. The soils are gypsiferous sands and clays and are poorly drained. There is no gibber or outcrop on the flats.

The saline soils support a low heath (less than 30 cm) of mainly *Frankenia* species, or dwarf chenopod shrubland, of mostly bluebush. There are very few grasses. Large shrubs or trees only grow in sandy 'islands' on the flats. There is typically no water sources in this landscape unit and any ephemeral pools are saline. There is also no stone of any sort.

## Chenopod Flats

These flat or slightly undulating plains generally are located between shoreline dunes and alluvial plains. In some places they fringe saline depressions. These plains typically have alkaline soils. Watercourses are uncommon but very small claypans or deflation scalds are reasonably common. These are only minor and very ephemeral water sources.

The vegetation cover is typically chenopod shrubland savanna, consisting of salt bush (*Atriplex* spp.) and bluebush (*Maireana* spp.). There are sparse grasses and few shrubs. The chenopod shrubs attract grazing kangaroos as well as sheep.

Chenopod Flats are commonly found on the islands and on the eastern and northern margins of the lake. They can be extensive and are the predominant landform on many islands. They are uncommon on the western margin.

There is generally no natural stone or gibber on these plains on the eastern, southern or northern lake margins. But plains on the western margin have a sparse gibber of quartz and other stone in parts further from the lake. Wind and water erosion appear to be slowly deflating the surface and in some places the saltbush and bluebush shrubs sit on small mounds.

## Alluvial Plains

Extensive alluvial plains are a major landform surrounding the lake. They have little relief and are mostly composed of brown or red quartz sands that have been extensively reworked. The sands can be deep or else form a thin mantle over hardpan (duricrust). Low and very broad sand dunes are common on the plains. These are less than 1m high, characteristically support denser vegetation and are known as 'wanderrie dunes'. Watercourses are uncommon but include broad washplains without defined channels and occasional incised creeklines. In places there are chains of small claypans or saltpans along infilled drainage lines. Because of the low relief heavy rains can produce unchannelled, unconfined sheetflow across the alluvial plains.

The vegetation cover is either chenopod savanna, on low-lying plains, or on better drained soils, open mulga woodland with an understorey of chenopods and tussock grasses. Patches of open grassland are found in some places, especially on the islands. In spring, the Alluvial Plains often have a rich cover of wildflowers. The wanderrie dunes typically have a denser cover of mulga and mixed large shrubs with an understorey of grasses.

Alluvial Plains are most commonly found on the eastern side of the lake, where they extend for many kilometres eastward from the shore. They are also common on the northern margin and in patches on the larger islands. On the western side of the lake, there are numerous small areas of alluvial plain interspersed between the hills and shore.

Most of the claypans in the lake system are located on this landscape unit. Other water sources include occasional gilgais and pools in watercourses. There is little or no stone on the plains close to the lake or on the islands but on the extensive plains east, north and south of the lake there is a gibber of quartz, silcrete and other stone.

## Drainage Features

Sizeable watercourses are rare in the region and these generally broaden and become ill-defined washplain, or floodplain, close to the margins of the lake. Small, braided drainage lines are common amongst the hills and adjacent plains. These are shallowly incised and some lose their channels on reaching the plains. Others reach the salt lakes, either via the creeklines or the washplains. Only after considerable rains will the watercourses flow but subsequently, remnant pools provide surface water for varying periods of time. At some locations in the large creeklines water can be found for longer periods by digging in the gravels in the creekbed. Large and small watercourses are more common on the western side of the lake than on the plains on the eastern and northern margins.

Mulga thickets line the defined watercourses, even very minor ones. Occasional river gums grow on the large creeklines. The thickets thin then disappear where the creeklines and drainage lines disperse on the plains or near the margins of the lake. Generally, the heavy bedload of the drainage features comprise small gravels and coarse sands with no cobbles for knapping.

## Hills & Slopes

This unit comprises the low hills and ridges with scree and thin soils, plus the rock-strewn pediments. Almost none of the outcrop on the hills and ridges is suitable for knapping, apart from some vein quartz and rare patches of chalcedony, crystal quartz and a very-fine grained 'chilled margin' dolerite. Such outcrops were targeted for exploitation by Aborigines and were the main sources of quarried stone. Water sources are uncommon in the hills and ridges, although very small ephemeral pools can be found after rains in the rocky drainage lines leading out of the hills.

The vegetation cover varies with the composition of the soils developed on the rocky slopes. Mafic hills and ridges generally have thin soils and sub-angular scree and support Acacia woodland or shrubland. Native pine and *Eremophila* shrubs are also common, while the sparse groundcover consists of tussock grasses and low shrubs; chiefly varieties of bluebush.

On the western lake margin and some of the islands there are prominent rounded hills and ridges with skeletal soils. They are formed by outcrop of mafic, and to a lesser extent, ultramafic rocks. These can be as much as 30 m above the plain or lakebed. Sharp ironstone ridges are common on the southwestern lake margin, surrounded by dense scree. This landform unit is rare on the eastern margin but the exceptions include a low ironstone knoll northeast of Freshwater Swamp. Generally, the gibber found on the alluvial plains derives from the scree on these hills.

## Colluvial Plains

This unit comprises colluvial and alluvial plains with a moderate to dense cover of gibber. These plains have a limited distribution close to the lake but are very extensive in the surrounding regions. Near Lake Carey, they commonly surround hills and ridges, especially on the central western and southwest lake margins. The gibber on the plains is of mixed lithologies, depending on the adjacent outcrop or scree and invariably contains a component of quartz pebbles.

Like the Alluvial Plains, which they often adjoin, the Colluvial Plains support either chenopod savanna of saltbush and bluebush species, or less commonly, open mulga woodland with a sparse understorey of chenopods and grasses. There are few water sources apart from the occasional small claypan or erosion scald. Small ephemeral pools sometimes form in small drainage lines that flow from the hills and ridges.

Plate 4.1: Landing Ground Claypan beside Lake Carey

Plate 4.2: Kopi Dune landscape unit

Plate 4.3: Sand Dune landscape unit

Plate 4.4: Saline Flats landscape unit

Plate 4.5: Chenopod Flats landscape unit

Plate 4.6: Alluvial Plains landscape unit

Plate 4.7: Hills and Slopes landscape unit

Plate 4.8: Colluvial Plains landscape unit

**Landscape Units & Study Areas**

Most of the landscape units are common to all five study areas but the proportions vary considerably. There are also differences consistent with the selection of study areas from around the lake to ensure a representative sample of all landforms. Table 4.3 sets forth the proportions of each landscape unit in each of the study areas, as determined by measuring the areal size of units from grided aerial photos, with the subdivisions checked during fieldwork.

Table 4.3: Landscape units in the five study areas, by area (ha)

| | North Islands | South Islands | East Shore | South Shore | West Shore |
|---|---|---|---|---|---|
| Kopi Dunes | 238 | 414 | 413 | 218 | 8 |
| Sand Dunes | 233 | 130 | 321 | 594 | 229 |
| Saline Flats | 895 | 396 | 766 | 534 | 61 |
| Chenopod Flats | 227 | 171 | 789 | 1198 | 286 |
| Alluvial Plains | 365 | 119 | 624 | 2312 | 492 |
| Drainage Features | 37 | 6 | 25 | 74 | 47 |
| Hills & Slopes | 69 | 166 | 18 | 64 | 740 |
| Colluvial Plains | 0 | 3 | 108 | 0 | 146 |
| Totals | 2064 | 1405 | 3064 | 4994 | 2009 |

**The Association Index Statistic**

A major objective of the analyses in Chapter 5 is to identify patterns in the distribution of sites and certain artefact types across the landscape units. This aims to reveal patterns of past settlement. Absolute numbers of sites in landscape units could not be used for this because the landscape units are of different sizes. Instead, it is necessary to use relative measures, such as site density, where the number of sites is reduced to a number per unit area ($km^2$). As useful as that is, the numbers do not immediately indicate if the site density is high or low. To do that, they have to be compared with other densities.

An association index provides an alternative measure. This score is a ratio derived by dividing the proportion (%) of a dependent variable by the proportion (%) of an independent variable. The association index shows the strength of association or correlation between the two variables being considered.

In more concrete terms, the proportion of sites (%) in a landscape unit (dependent variable) divided by the proportion of the landscape unit (%) in that sample (independent variable) gives a score that indicates the propensity for sites in that landscape unit. If sites were distributed evenly or randomly across all landscape units, then the proportion of sites would match the proportion of the land area, giving an association index of 1.00. A score greater than 1.00 indicates that sites are more common in a landscape unit than if they were uniformly or randomly distributed, and the higher the value, the more sites are likely to be situated in this unit. On the other hand, the closer the value approaches 0.00 the less likely it is that there are sites in that landscape unit.

The great advantage is that the association index identifies the strength of correlation between the dependent and the independent variables, and this is intuitively apparent from the size of the score. The propensity for sites in landscape units is particularly useful in predicting the prevalence of sites in other areas surrounding the lake. The association index can also be used to study the distribution of certain artefact types or lithological types, as demonstrated in Chapter 5, and identify uncommon or rare site occurrences, as discussed in Chapter 7.

## Taphonomic Processes

No study of open or surface sites can ignore the effect of post-depositional events in shaping the archaeological remains. These taphonomic forces include cultural and natural processes but it is the latter that have had most impact on sites at Lake Carey.

The principal cultural factor disturbing sites would have been reoccupation by Aboriginal groups and possible recycling of stone material at sites. In the past century there has been negligible cultural disturbance, except near Freshwater Swamp. All the land about the lake is pastoral lease and so is largely left undeveloped. And sites are either so inaccessible or inconspicuous that with very few exceptions no-one would have been collecting artefacts and distorting the assemblages. The principal exceptions are the large sites near Freshwater Swamp, where exploration crews were working prior to the archaeological surveys but even here a number of grindstones were found. As these are the item most souvenir collectors are likely to recognize and remove, this proves the sites were largely untouched.

The effect of non-cultural forces has been far greater, not only in destroying or disturbing sites but also in 'creating' sites. The role of taphonomic processes in destroying archaeological information has been well documented (e.g. Hiscock 1985; Stockton 1973), particularly in sandy surface sites (Lancaster 1986; Wandsnider 1988). At Hawkers Lagoon, in South Australia, the taphonomic effects of wind erosion were studied for several years. The researchers concluded 'that many "sites" in the arid and semi-arid areas of Australia, and maybe elsewhere, do not display their original depositional pattern or, in the case of open sites, even expose a palimpsest of "living floors"' (Cameron *et al.* 1990: 68). Similar observations have been repeatedly made for archaeological sites in other arid areas (e.g. Butzer 1982; Ross 1993).

These considerations of taphonomic disturbance are most applicable to artefact scatters and are less relevant for quarries at Lake Carey. Quarry sites are generally at outcrop and rest on rocky surfaces. The rocky substrate reduces the effects of wind erosion and turbation from soil or biological processes. They are often protected by distance or elevation from water erosion or flooding. Nonetheless, some disturbance is likely over time.

### Loss & Creation of Sites

I am certain that few, if any, of the sites in the study areas are undisturbed by taphonomic processes. It is much harder to identify the proportion of 'sites' that are a creation of those forces. A discussion of how 'sites' are created in this environment follows after a brief discussion of the disturbance and destruction of sites.

Erosion is active at the lake and certainly will have been a major factor working on sites. Wind erosion has formed much of the shoreline landscape and particularly the kopi and sand dunes, as pointed out in Chapter 2. The wind is also eroding these dunes, and the rate has increased because of recent overgrazing and loss of vegetation cover. Nonetheless, there will always have been periods of active wind erosion when vegetation cover was lost during the extended droughts that are common in this region. Sites and artefacts on the dunes are prone to be buried by mobile sands and sediments, while artefacts will move relative to each other, disrupting any spatial patterning (Cameron *et al.* 1990). Other landscape units are less affected by wind erosion, although deflation or mobilization of the surface sands can bury or expose archaeological material.

The effects of water erosion are much harder to gauge. Major flood events occur perhaps once a decade and at these times there is a tremendous volume of water reaching the lake system. The very low relief, however, significantly reduces the water velocity and much of the water flows as sheetwash across the plains and washplains. This might have disturbed site assemblages on the low-lying chenopod flats and the alluvial and colluvial plains, with displacement of smaller artefacts. Only beside watercourses or drainage features might there be significant movement or reworking of assemblages. Because of their elevation, sand and kopi dunes will be largely undisturbed by flooding, but where the aeolian sediments are unconsolidated sheetwash could be a contributing erosional factor (Butzer 1982:102).

Whatever the role of water erosion, wind is the primary and constant erosional force in this environment. This is especially so on the sand and kopi dunes, where it has carved numerous deflation hollows. Typically, these deflations are small, shallow and found on the leeward (eastern) slope of dunes. Many of the artefact scatters were found in these features and it is possible that some clusters of artefacts have arisen from the removal of sand and the concentration of artefacts, rather than because the deflation location was a locus for Aboriginal activity.

Sorting out the role of taphonomic processes in the formation of the artefact scatter 'sites' is difficult. This is apparent from Table 4.4, which summarizes details of artefact scatters recorded on sand and kopi dunes in the East Shore study area and their relationship to deflations in the dunes.

Table 4.4: Artefact scatters and deflations in dunes (East Shore)

| | Sand Dunes | | Kopi Dunes | | Totals | |
|---|---|---|---|---|---|---|
| | no. | % | no. | % | no. | % |
| Sites not associated with deflations | 5 | *8.6* | 3 | *14.3* | 8 | *10.1* |
| Sites larger than deflation | 11 | *19.0* | 7 | *33.3* | 18 | *22.8* |
| Sites same size as deflation | 21 | *36.2* | 5 | *23.8* | 26 | *32.9* |
| Sites smaller than deflation | 21 | *36.2* | 6 | *28.6* | 27 | *34.2* |
| Totals | 58 | *100.0* | 21 | *100.0* | 79 | *100.0* |

Of the 79 artefact scatters recorded on the dunes, 58 were on the sand dunes and 21 on the kopi dunes. Two-thirds (53 or 67.1%) of these were roughly the same size as, or smaller than, the deflation in which they were found. This was particularly the case for sites on the sand dunes, with 42 (72.4%) sites wholly contained in deflations. These sites could have been 'created' by taphonomic processes, with the artefacts being brought into spatial association because the sand or gypsiferous sediments in which they were situated had been removed. In contrast, only one tenth of the sites were not associated with deflations, and slightly less than a quarter (18 sites or 22.8%) extended beyond the boundaries of deflations. This is, it is reasonable to assume that one third of these sites were not directly a product of exposure or concentration by erosion.

While there is a strong association between deflations and artefact scatters on the dunes, suggesting that many were the result of erosional forces, it must also be stressed that there were many deflations on the dunes in which no artefacts were found. I estimate that well over half the deflations I inspected had no artefactual material. But this was highly variable, with sites in almost every deflation on particular sand dunes and only occasional sites in deflations in others. This suggests that deflations might play a dual role. They might 'create' scatters by the coalescence of isolated artefacts thinly spread through the dune sediments but they might also expose some artefact scatters previously covered by mobile sands.

There is another, rather different and problematic possibility. Deflations make good campsites. They are slightly sheltered from winds by virtue of being on one side of the dune, they are elevated above the plains, which on occasion are water-affected, and they have floors that are clear of vegetation and partly flat. Resources are also close by, although all the landscape units are in close proximity to one another. So deflations might have been chosen as campsites, and artefacts are clustered within and adjacent to them because they had been discarded in a more or less discrete area.

But a serious problem arises if it is assumed that all artefact scatters in deflations are places people camped. This requires that the deflations be stable for hundreds or thousands of years, or only expand but never diminish. Whether this is possible is uncertain but clearly the sands are mobile and hollows could be partially refilled and revegetated under slightly different weather patterns or a run of good seasons.

In light of these problems it may seem warranted to disregard artefact scatters on dunes at Lake Carey as a useful archaeological site type. Some information can be salvaged from these clusters, however, if the right questions are asked. Movement of artefacts on the dunes is in the order of metres. That means artefacts are near where they were discarded. It follows that any clusters of artefacts are a sample of the artefacts discarded close to where they are found. In other words, the clusters of artefacts reflect Aboriginal activities in a localized vicinity, although not necessarily in the place where the 'site' is located.

In part for these reasons I have avoided analysis of assemblages or comparisons between assemblages. Rather, analysis at the assemblage level was concentrated on the presence or absence of certain artefacts or lithologies. Nonetheless, I have used the terms 'artefact scatter' and 'sites', for there are no reasonable alternatives. And it is, I am relieved to say, beyond the scope of this thesis to resolve the theoretical and practical problems touched on here.

## Sites vs 'Sites'

A final but important point must be made. Clusters of artefacts have *ipso facto* existence as 'sites'. They are visible evidence of past Aboriginal activity and the appropriate legislation requires that scatters of artefact be registered and protected as relics. In this sense, the actual manifestation (cluster of artefacts) will remain the basic unit for management almost irrespective of the archaeological meaning. This logic is followed in many other situations in Australia, with the recording and registration of artefact scatter 'sites' on floodplains beside creeks, and sometimes on levee banks, where water erosion has obviously reworked the scatter. This is, admittedly, a default definition arrived at for pragmatic and practical reasons. Yet it has to be considered where the management of the archaeological resource is an objective, as in this project.