CHAPTER 5

DISTRIBUTION OF ARCHAEOLOGICAL MATERIAL

To arrive at an understanding of the distribution of sites at Lake Carey, it was first necessary to analyse the distribution in the sample. Details of sites in the five study areas are presented and compared to reveal similarities and differences between the archaeological remains from around and on the lake. Then the distribution of sites across the seven landscape units is analysed. This was a recursive process, first determining the relationships of landscape units with sites, then with site types and finally with site classes. Each level of analysis reveals consistencies and anomalies in the distribution of sites which allows a finer-grained understanding of site occurrence. This has consequences for heritage management, including the identification of rare and representative sites.

The presence of implements and key lithologies on artefact scatter sites is also analysed. This reveals something of the activities performed at sites across the lake system. Importantly, it also provides information on the movement of stone resources and hence people around the lake and to the islands. This goes a long way to resolving the question of what role the islands played in the movement of people across the lake. At the end of the chapter the question of the antiquity of occupation is discussed. The excavations at a site in the East Shore study area are described and C-14 dates presented. An argument is made for regarding the landscape at Lake Carey as essentially stable for the period of Aboriginal occupation and for the existence of a single landuse system.

Sites in 5 Study Areas

The great majority of sites in the five study areas were artefact scatters (230 sites or 92.7%), with the remainder being quarries (18 or 7.3%). Interestingly, there were no other site types. No scarred trees, clusters of *wiltja* (traditional wooden shelters), stone arrangements, art sites or rockshelters were recorded, although these types of sites are known to exist in the wider district. There were also no burials. The numbers and proportions of the various types are presented in Table 5.1.

Table 5.1: Proportions of site types in 5 study areas

	artefact scatters		quarries		Totals	density
	no.	%	no.	%		sites/km²
North Islands	27	*93.1*	2	*6.9*	29	1.43
South Islands	20	*95.2*	1	*4.8*	21	1.50
East Shore	114	*100.0*	0	–	114	3.75
South Shore	24	*100.0*	0	–	24	0.49
West Shore	45	*75.0*	15	*25.0*	60	3.06
Totals	230	*92.7*	18	*7.3*	248	

Artefact Scatters

Most of the 230 artefact scatters had small, undistinguished assemblages with little evidence of specific activities. A few had larger assemblages but even these were small on a regional scale. For example, the largest sites were several orders of magnitude smaller than major 'base camps' on the plateau 15 to 20 km east of Lake Carey, or in the granite hills near Yundamindra Homestead to the west of the lake.

Two of the artefact scatters included other components. The remains of several *wiltja* (traditional wooden shelters) were found at "Bindah Mine 1B". These were recent, as indicated by historic rubbish including food tins and a sheet of corrugated iron, and most likely erected since WWII. Clearly these structures were not associated with the stone tools that exist at the same location. The other site, "Bindah Breakaway 1A", includes two rockholes (gnamma holes) on the edge of a low lateritic plateau. Knapping centres or core reduction areas were preserved at some sites but generally were not obvious. One very small site, "Pyke Hill Shore 4", probably was used only for core reduction but for the analysis it was included with other artefact scatters.

While artefact scatters are always in the majority, the proportions were not the same in all study areas. In the East Shore and South Shore, all recorded sites were artefact scatters (see Figure 5.1). Similarly, in the North and South Islands study areas, artefact scatters constituted over 90% of sites. The West Shore was markedly different, with artefact scatters only constituting three-quarters of recorded sites (45 of the 60 sites).

A characteristic feature of the artefact scatters is their small size, as is apparent from Table 5.2. The smallest site in the study contained only 7 artefacts. The largest ("Lake Carey East 1") contained possibly 50,000, but this was based on an estimate of sub-surface material. The largest surface site ("Lake Carey East 9") only had an estimated 15,000 artefacts. The median size for artefact scatters was a mere 50 and the interquartile range of 132 demonstrates that there was little variance from that size range. Further, the size range was reasonably similar across all five study areas and the median sizes of assemblages were always low.

Table 5.2: Assemblage sizes for artefact scatters in 5 study areas

Site Type	no. of sites	range	median size	interquartile range
North Islands	27	10 to 500	50	87
South Islands	20	11 to 3000	33	29
East Shore	114	7 to 15,000*	50	116
South Shore	24	40 to 5000	200	550
West Shore	45	20 to 5000	100	150
Totals	230	7 to 15,000*	50	132

* excludes the estimate for sub-surface artefacts at "Lake Carey East 1"

When the artefact scatter sites are divided into size classes (Table 5.3), some of the variability in assemblage size is more readily apparent. In three of the study areas, very small sites (AS1) are more numerous than any other class of site. This is the case for the North Islands, South Islands and East Shore areas. In the other two study areas, very small artefact scatters (AS1) are less common than small artefact scatters (AS2). This suggests there were small but noticeable differences in the intensity of site use between the study areas, with brief, more transitory occupation of sites on the eastern lake margin and islands than on the western and southern margins.

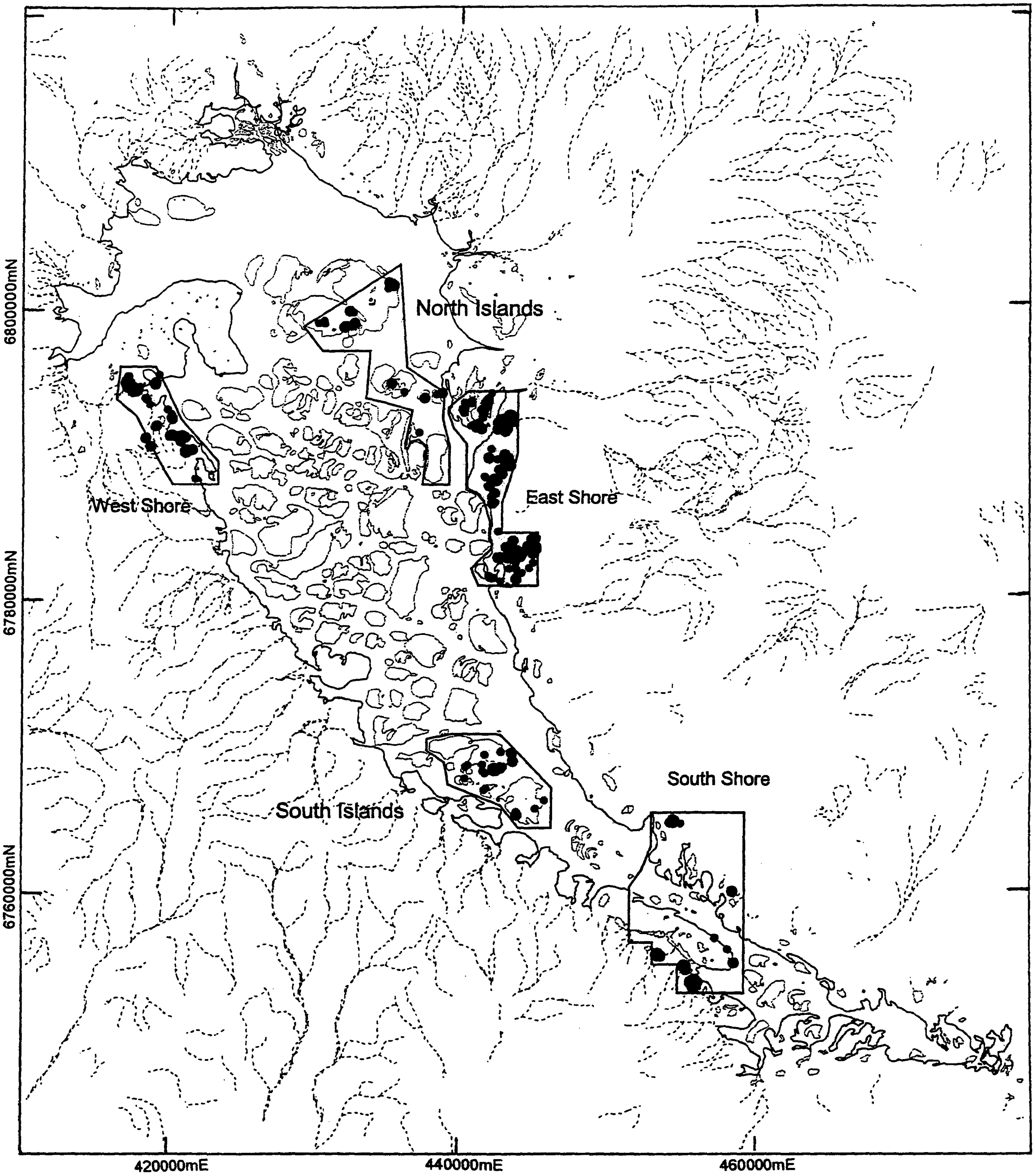

Figure 5.1: Distribution of artefact scatters in 5 study areas

Table 5.3: Numbers of classes of artefact scatters in 5 study areas

	large (AS4) >5k	medium (AS3) 501 - 5k	small (AS2) 51 - 500	v. small (AS1) <51	Totals
North Islands	0	0	10	17	27
South Islands	0	1	3	16	20
East Shore	2	5	42	65	114
South Shore	0	6	13	5	24
West Shore	0	4	24	17	45
Totals	2	16	92	120	230
%	*0.9*	*7.0*	*40.0*	*52.2*	*100.1*

Quarry Sites

Of the 18 quarry sites, 17 were hard stone reduction centres (following the definition and classification system of Hiscock & Mitchell 1993). At all of these, there was *in situ* core reduction and the assemblages were dominated by knapping debris. None of these 17 quarries had evidence of camping or other cultural components. Core reduction areas, or knapping centres, indicate that knapping was conducted on-site. One quarry was exceptional. Site "Con Islands 1" was a source of crystals of quartz, and it will be discussed in detail below. There was also a very small artefact scatter at the base of the hill on which this quarry was situated.

Curiously, quarries were present in both study areas encompassing islands; two quarries in the North Islands areas and one quarry in the South Islands area. This is not typical, because the great majority of islands are formed of aeolian sediments without natural stone. In both of these study areas, however, there are some islands with large hills and mafic outcrops where the quarries were found. Other than on such hills, there is no potential for quarries on islands in the lake.

Table 5.4: 18 quarries by study area, lithology and size

	number of quarries *(%)*	lithologies used	size or range of sizes
North Islands	2 *(11.1)*	1 x chert & chilled-margin dolerite 1 x quartz	500 500
South Islands	1 *(5.6)*	1 x crystal quartz	200
East Shore	0	–	–
South Shore	0	–	–
West Shore	15 *(83.3)*	8 x chalcedony 3 x jasperoidal laterite 2 x chilled-margin dolerite 1 x rhyolite (felsic volcanic) 1 x quartz	20 to 1000 200 to 500 20 to 100 5000 9000

The quarries exploited a wide range of lithologies, as can be seen from Table 5.4. The most common lithology targeted for tools was chalcedony (generally white but also white to clear opaline silica). Chalcedony was exploited at eight (44.4%) of the 18 quarry sites. There were three quarries (16.7%) at sources of jasperoidal laterite (a form of 'silcrete' formed as a weathering product on ultramafic rock). Chilled-margin dolerite, a very fine-grained dolerite formed at the contact margin between the intruding dolerite and the 'country' rock, was exploited at three quarries (16.7%). Two of these were several hundred metres apart, exploiting the same band of rock. The third example was on the lake, on Kevin Island, where the chilled-margin dolerite and a black 'chert' outcrop together. Both lithologies were exploited. This was the only chert outcrop in any of the study areas. In appearance it strongly resembles darker examples of the grey chert from "Mt Weld Quarry". In addition to these sites, there were two quarries at outcrop of white vein quartz (constituting 11.1% of quarries) and one rhyolite quarry (5.6%).

The great majority of quarries (15 of the 18, or 83.3%) were situated in the West Shore area (see Figure 5.2). Most were at small subcrops or outcrops in the mafic hills and ultramafic hills. Seven of the eight chalcedony quarries were situated there. Not all the outcrops and subcrops of chalcedony in these hills were exploited, however, possibly because of flaws or failings in the stone. The other three quarries are located in the North Islands and South Islands areas, as mentioned previously. No quarries were situated in the East Shore or South Shore study areas and this is a logical consequence of a lack of suitable outcrop.

A characteristic feature of the quarries is their small size as indicated by the median size of 350. The smallest quarry in the study had only 20 pieces and half of the quarries contained only a few hundred pieces. The largest of the 18 quarries, "Pyke Hill NW 9", only contained an estimated 9000 artefactual pieces. This is relatively small by regional standards. Some 50 km to the northwest, several quarries ten times larger have been recorded (Mattner & Corsini 1998a). It can be noted that the mean assemblage size, 1074 pieces, was considerably larger than the median value because of two quarries with 5000 or more pieces.

The size of the quarries was not directly related to the lithology exploited. While the largest quarry is at a quartz outcrop, the only other quartz quarry is small, with an estimated 500 pieces. The quarries that exploited chilled-margin dolerite or jasperoidal laterite were all small, and at least in part, this was because the outcrops are small. The chalcedony quarries ranged in size from 20 to 1000 pieces, with a median size of 100. Again, this is partly attributable to the small size of outcrops.

An alternative explanation for the generally small size of quarries is that occasional visitors to the lake system were often unaware of their existence. This is possible because the outcrops are small and inconspicuous and situated in hills with little to attract Aboriginal activity. Exploitation of these quarries most likely occurred on an accidental or opportunistic basis, when people were in the vicinity foraging for food. This supposition is supported by assemblage data in the Northern Islands study area. Artefacts of the high quality black chert from the quarry on Kevin Island are uncommon in site assemblages and absent from many (9 of the 18 artefact scatters), even though there is a shortage of stone on the island.

Because of the small sample size, and the predominance of quarries in the West Shore area, there are no apparent trends in the distribution of the size classes across the five study areas (Table 5.5).

Table 5.5: Numbers of classes of quarries in 5 study areas

	medium (Q3) 10k - 1k	small (Q2) 100 - 1k	v. small (Q1) <100	Totals
North Islands	0	2	0	2
South Islands	0	1	0	1
East Shore	0	0	0	0
South Shore	0	0	0	0
West Shore	2	6	7	15
Totals	2	9	7	18
%	*11.1*	*50.0*	*38.9*	*100.0*

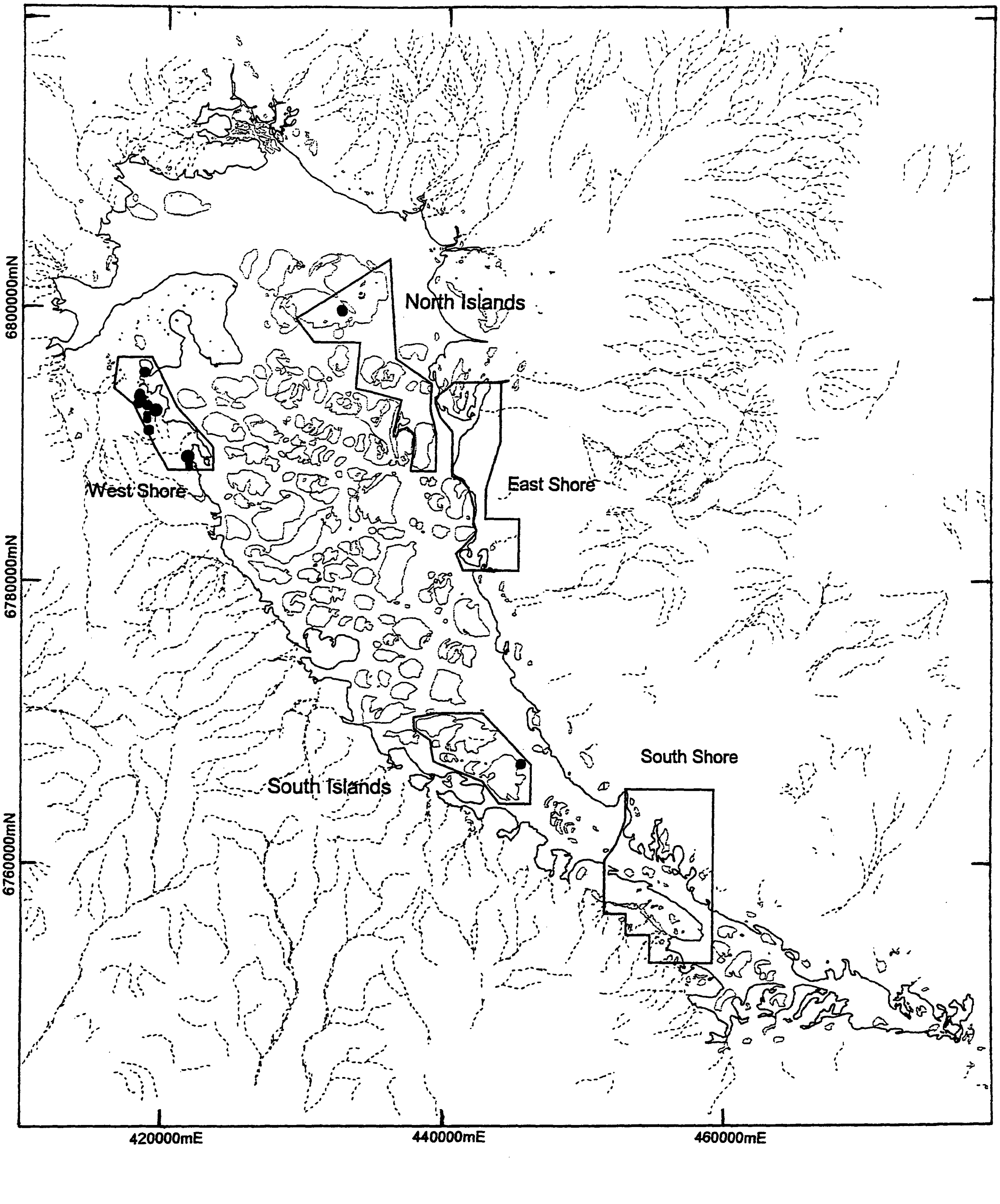

Figure 5.2: Distribution of quarries in 5 study areas

The distribution of sites and site classes has so far been considered in relation to the five study areas. While demonstrating several similarities, this comparison also highlighted some of the differences between study areas; particularly in the distribution of quarry sites and the size classes of artefact scatter sites. In part these differences are attributable to the various proportions of landscape units within the study areas, as will now be considered.

Sites in 7 Landscape Units

Each of the study areas contain a range of landforms with associations of soils, topography and vegetation communities. These have been classified into nine landscape units, of which seven are terrestrial and will be used in the following analysis, and two are types of wetland and are excluded from the analysis. The units were fully described in the preceding chapter.

Data on the size and proportional area of each landscape unit and the number and proportion of sites is presented in Table 5.6. Values are also given for site density and the association index.

Table 5.6: Proportions of sites and area for 7 landscape units, with association indices (a.i.) and site density

Landscape Unit	Total Area km²	%	Total of Sites no.	%	Site Density sites / km²	**a.i.** %Sites/%Area
Kopi Dunes	12.91	*9.7*	31	*12.5*	2.40	1.29
Sand Dunes	15.07	*11.3*	130	*52.4*	8.60	4.64
Saline Flats	26.52	*19.9*	3	*1.2*	0.11	0.06
Chenopod Flats	26.71	*20.0*	22	*8.9*	0.82	0.45
Alluvial Plains	39.12	*29.3*	29	*11.7*	0.74	0.40
Hills & Slopes	10.57	*7.9*	21	*8.5*	1.99	1.08
Colluvial Plains	2.57	*1.9*	12	*4.8*	4.67	2.53
Totals	133.47	*100.0*	248	*100.0*		

Before discussing details, I want to remind readers of the usefulness of the association index statistic defined in Chapter 4. Table 5.6 lists the site density and the association index for each landscape unit and it can be seen that these two values are directly related. The important difference is that the index score is a measure of the degree of association. For example, a density of 1.99 sites/km² for the Hills & Slopes unit has less meaning than the equivalent association index of 1.08, which indicates that the number of sites in that landscape unit is close to that expected if sites were evenly or uniformly distributed over all landscape units.

It is clear from the association indices that sites were common or very common in certain landscape units. Sand Dunes had an index score of 4.64 and this very high value reflects that over half of the sites (52.4%) were recorded in this unit, although it constituted only one ninth (11.3%) of the land in the five study areas. This high index score is an important finding. For example, it indicates that there is a high probability that archaeological sites will be found in this Sand Dune unit in parts of the lake system outside the study areas. A high score was also recorded for Colluvial Plains (2.53).

The association index for Kopi Dunes (1.29) shows that sites were only slightly more common on these dunes than if they had been randomly or evenly distributed in the landscape. The case of Hills & Slopes has been mentioned. However, most sites in this particular landscape unit were quarries, so the patterning of sites certainly is not random or uniform. This point is taken up below.

Several landforms had low association indices, and one scored extremely low. The unit Saline Flats scored 0.06, which reflected that only 3 sites were found in this unit, although it constituted one fifth (19.9%) of the land in the study areas. This is logical, given that this landscape unit is low-lying with powdery sodic soils, stunted halophytic vegetation and no trees for shade or firewood. Low scores were also calculated for the Alluvial Plains (0.40) and Chenopod Flats (0.45) landscape units. These are common landforms; combined they constituted one half (49.3%) of the five study areas, so the low frequency of sites is an important finding for the management of sites.

These index values are a useful guide to the likely occurrence of sites within the various landscape units. But they are only a guide and some caution needs to exercised. Local circumstances can be more important than generalized predictions based on the indices. This will be enlarged upon below but can be also illustrated from the above figures. For example, the Colluvial Plains unit had a high association index (2.53), but this was strongly influenced by the existence of five sites on this landscape unit near Freshwater Swamp. This most likely reflects the abundance of sites around Freshwater Swamp rather than a propensity for sites in the Colluvial Plains unit. However, those five sites are much larger than the average site size, so the situation is complex.

Site types by landscape units

Particular site types are common on certain landscape units and uncommon on others and naturally enough artefact scatters and quarries are usually found on different landscapes. This patterning is apparent from Table 5.7.

Table 5.7: Proportions of artefact scatters and quarries in the 7 landscape units, with their association indices (a.i.)

	% Area of units	Artefact scatter no.	*% of AS*	**a.i.**	Quarries no.	*% of Q*	**a.i.**	Total no. of sites
Kopi Dunes	*9.7*	31	*13.5*	1.39	0	–	0.00	31
Sand Dunes	*11.3*	130	*56.5*	5.00	0	–	0.00	130
Saline Flats	*19.9*	3	*1.3*	0.07	0	–	0.00	3
Chenopod Flats	*20.0*	21	*9.1*	0.46	1	*5.6*	0.28*	22
Alluvial Plains	*29.3*	27	*11.7*	0.40	2	*11.1*	0.38*	29
Hills & Slopes	*7.9*	7	*3.0*	0.38	14	*77.8*	9.85	21
Colluvial Plains	*1.9*	11	*4.8*	2.53	1	*5.6*	2.95*	12
Totals	*100.0*	230	*99.9*		18	*100.1*		248

* index score may be unreliable because of small numbers involved

Artefact Scatters

Artefact scatters were more widely distributed than quarries and were recorded in all seven landscape units. Nonetheless, there was a very strong tendency for these sites to occur within the Sand Dunes unit (130 or 56.5% of the 230 artefact scatters). This was reflected in the very high association index (5.00). Furthermore, no quarries existed there, so this landscape unit is both rich in sites and these are exclusively artefact scatters. The only other landscape unit with a high association index was Colluvial Plains (2.53). As previously noted, the correlation of sites with this landscape unit is partly because of its proximity to Freshwater Swamp, and it is uncertain if this pattern would be common elsewhere around the lake margin.

Several units had very low scores. The Hills & Slopes unit, where most quarries were situated, contained few artefact scatters and this is reflected in the association index (0.38). The Alluvial Plains (0.40) and Chenopod Flats (0.46) units also had low scores, indicating a strong negative correlation or scarcity of artefact scatter sites on these landscape units.

The association index for the Saline Flats unit was extremely low (0.07). This is important beyond emphasizing the unsuitable conditions for camping within this low-lying landscape. It means also that artefact scatters on this uninviting landform are highly unusual. They have a degree of significant because of their scarcity, and being outliers, may be instructive in questions of site location and function.

Quarries

Patterning is most pronounced for quarry sites, with 14 of the 18 quarries located within one landscape unit; Hills & Slopes. This is logical given that outcrop is concentrated within this unit, which only constituted a relatively small part of the study areas (7.9%). Consequently the association index for quarries in this unit was extremely high (9.85). Strong negative correlations were also apparent. No quarries were recorded in the Kopi Dunes, Sand Dunes or Saline Flats units. Again this is logical, for these landforms are composed of aeolian sediments without outcrop. This negative correlation can be considered reliable, given the relatively large areas of Kopi Dunes, Sand Dunes and Saline Flats searched during the study (in sum 54.5 km^2).

Two quarries were located in the Alluvial Plains unit and one in each of the Chenopod Flats and Colluvial Plains units. The association index for Colluvial Plains (2.95) was high, indicating there are likely to be quarries within this unit elsewhere around the lake. The very low association indices for the Alluvial Plains (0.38) and Chenopod Flats (0.28) highlight the very low potential for quarries in these units. Conversely, it indicates that outcrops of siliceous stone were utilized where available. Probably this was not determined primarily by the quality of the stone source but more by the availability of other stone (Gould 1977b). As a consequence, the uncommon and small quarries found in the Alluvial Plains and Chenopod Flats landscape units would be relevant for studies of stone procurement strategies.

Site Classes by Landscape Units

So far the presence and frequency of quarries and artefact scatters on the various landscape units has been discussed. This can be further broken down to reveal patterning in the distribution of various size classes. This data is presented for four classes of artefact scatters in Tables 5.8a & b, and for three classes of quarries in Table 5.9. Differences between these scores and the scores given above for artefact scatters and quarries as a group (Table 5.6) provide an indication of the distribution of various size classes of sites. The same general trends were noted but some interesting differences were revealed.

Classes of Artefact Scatter

A principal finding was that at least half the sites in each of the four size classes were located within the Sand Dunes unit. No other landscape unit had such consistent presence of sites and only one other unit had all four classes (Colluvial Plains). For the Sand Dunes unit, the association indices for all four classes were high and surprisingly similar. The indices for very small artefact scatters (4.65), small scatters (5.49), medium scatters (4.97) and large artefact scatters (4.42) are close to the value for all artefact scatters in this unit (5.00). This demonstrates that artefact scatters of all size classes are strongly correlated with this landscape unit. This finding has consequences for management and site protection, although there are other measures of site representativeness that need to be considered, including assemblage attributes.

Table 5.8a: Proportions of 4 classes of artefact scatters in the 7 landscape units

	AS1 <51		AS2 51 – 500		AS3 501 – 5k		AS4 5k – 10k		Totals	
	no.	%	no.	%	no.	%	no.	%	no.	%
Kopi Dunes	24	*20.0*	7	*7.6*	0	–	0	–	31	*13.5*
Sand Dunes	63	*52.5*	57	*62.0*	9	*56.2*	1	*50.0*	130	*56.5*
Saline Flats	1	*0.8*	1	*1.1*	1	*6.3*	0	–	3	*1.3*
Chenopod Flats	11	*9.2*	9	*9.8*	1	*6.3*	0	–	21	*9.1*
Alluvial Plains	16	*13.3*	10	*10.9*	1	*6.3*	0	–	27	*11.7*
Hills & Slopes	4	*3.3*	2	*2.2*	1	*6.3*	0	–	7	*3.0*
Colluvial Plains	1	*0.8*	6	*6.5*	3	*18.7*	1	*50.0*	11	*4.8*
Totals	120	*99.9*	92	*100.1*	16	*100.1*	2	*100.0*	230	*99.9*

Table 5.8b: Association indices for 4 classes of artefact scatters in the 7 landscape units

	AS1 <51	AS2 51 – 500	AS3 501 – 5k	AS4 5k – 10k	All AS
Kopi Dunes	2.06	0.78	0.00	0.00	1.39
Sand Dunes	4.65	5.49	4.97	4.42*	5.00
Saline Flats	0.04*	0.06*	0.32*	0.00	0.07
Chenopod Flats	0.46	0.49	0.32*	0.00	0.46
Alluvial Plains	0.45	0.37	0.22*	0.00	0.40
Hills & Slopes	0.42	0.28*	0.80*	0.00	0.38
Colluvial Plains	0.42*	3.42	9.84	26.32*	2.53

* index score may be unreliable because of small numbers involved

The distribution of the four size classes in the Kopi Dunes, Sand Dunes and Colluvial Plains landscape units is also instructive. No medium (AS3) or large (AS4) artefact scatters were recorded within Kopi Dunes; that is, no sites with assemblages larger than 500 pieces. Within this unit three-quarters (24 or 77.4%) of the sites were very small (AS1), with 50 artefacts or less. This is indicated by a relatively high association index score (2.06) for this class of site, which is higher than the score for all sites in the Kopi Dunes (1.39).

High to very high association indices were associated with the three larger classes of artefact scatters in the Colluvial Plains unit, indicating a correlation between this landscape unit and these larger sites. In contrast, a low score or negative correlation was recorded for sites with less than 50 pieces. The indices for very small (AS1) and large (AS4) sites, however, can not be considered reliable as they derive from one site in each case.

This patterning on the Colluvial Plains unit is in marked contrast to observations in the region, where few artefact scatters have been recorded on the colluvial plains, unless associated with watercourses, gilgais or other ephemeral water sources. In part, the pattern is related to sites on the colluvial plains near Freshwater Swamp, as previously mentioned. But it also may be related to the slight elevation of this landform in an environment that is occasionally flooded. The presence of gibber that could be knapped might have been an additional factor in a district with few sources of stone.

Classes of Quarries

The strong correlation of quarry sites with the Hills & Slopes landscape unit remains strong when the distribution of the three size classes is considered (Table 5.9). Very small and small quarries within the Hills & Slopes unit had extremely high association indices (10.85 and 9.85 respectively).

It is difficult to draw other conclusions from the data because only one size class was recorded in the other landscape units. It is interesting, however, that the single examples in the Chenopod Flats and Alluvial Plains units were small quarries (Q2), rather than very small quarries (Q1). This suggests that these quarries were used several times or else were used reasonably intensively if only visited once. This seems reasonable given the general lack of alternative stone sources on the surrounding plains.

Table 5.9: Proportions of 3 classes of quarries in the 7 landscape units

	Q1 <101			Q2 101 – 1k			Q3 1k – 10k			All Q sites
	no.	%	a.i.	no.	%	a.i.	no.	%	a.i.	a.i.
Kopi Dunes	0	–	0.00	0	–	0.00	0	–	0.00	0.00
Sand Dunes	0	–	0.00	0	–	0.00	0	–	0.00	0.00
Saline Flats	0	–	0.00	0	–	0.00	0	–	0.00	0.00
Chenopod Flats	0	–	0.00	1	*11.1*	0.56*	0	–	0.00	0.28*
Alluvial Plains	0	–	0.00	1	*11.1*	0.38*	1	*50.0*	1.71*	0.38*
Hills & Slopes	6	*85.7*	10.85	7	*77.8*	9.85	1	*50.0*	6.33*	9.85
Colluvial Plains	1	*14.3*	7.53*	0	–	0.00	0	–	0.00	2.95*
Totals	7	*100.0*		9	*100.0*		2	*100.0*		

* index score may be unreliable because of small numbers involved

For three levels of analysis (site, site type and size class) it has been shown that sites are differentially distributed relative to seven landscape units. The degree of association has been established and in some cases there is a marked positive or negative correlation that provides a sound basis for extrapolating from the sample results to the entire lake system. This is taken up in the final chapter.

The analysis so far has not considered the relationship between site location and the intermittent wetlands that are the characteristic feature of the lake system. So now I turn to look at the role of Lake Carey and the surrounding saltpans and claypans in the pattern of site distribution.

Sites, Shorelines & Saline Wetlands

Although the lake fills rarely, it becomes a long-lasting wetland after flooding, as do the many saltpans and claypans fringing it. These ephemeral wetlands attract flocks of waterbirds, some of which nest on the shores. These offered Aborigines opportunities for collecting eggs and hatchlings and hunting adult birds, at a time when water was abundant and access to the lake was good.

To test if these intermittent wetlands were foci for Aboriginal occupation, I measured the length of shorelines and compared these with the presence of sites in each study area. In addition to the lake shoreline, measurements were made of the shorelines of embayments and saltpans (Table 5.10). An embayment was defined as a section of lake enclosed on three sides by land.

Table 5.10: Length of shorelines (in km) for 5 study areas

	lake shoreline	embayment shoreline	saltpan circumference	no. of sites
North Islands	39.2	16.2	14.0	29
South Islands	32.5	14.3	0.0	21
East Shore	16.7	19.2	20.6	114
South Shore	27.3	33.0	47.2	24
West Shore	14.8	7.3	3.6	60

These figures need to be adjusted to account for the different size of each study area. This was done by dividing the length of shorelines by the area of land, which gives a figure representing length of shorelines in kilometres per square kilometre of study area. These values are presented in Table 5.11.

Table 5.11: Proportions of shorelines and sites relative to land area for 5 study areas

	Site Density sites / km²	Lake Shoreline km / km²	Embayment Shoreline km / km²	Combined Shoreline km / km²	Saltpan Circumference km / km²
North Islands	1.4	1.9	0.8	2.7	0.7
South Islands	1.5	**2.3**	**1.0**	**3.3**	*0.0*
East Shore	**3.8**	0.6	0.5	*1.0*	0.7
South Shore	*0.5*	*0.5*	0.7	1.2	**1.0**
West Shore	3.0	0.8	*0.4*	1.1	0.2

NB figures in **bold** are the highest values, those in *italics* are the lowest
Combined Shoreline = Lake Shoreline + Embayment Shoreline

The surprising result, for me at least, was that there is no obvious association between the shoreline lengths and the density or frequency of sites. That is, the number of sites per square kilometre of land in each study area shows no clear relationship with the length of lake shoreline, embayment shoreline or their combined length, nor with the circumference length of saltpans. Several examples emphasize the point.

The shortest lake shorelines per square kilometre of land were recorded in the South Shore and East Shore study areas (0.5 and 0.6 km/km^2 respectively), yet these two areas had the lowest and highest density of sites (0.5 and 3.8 sites per km^2). A similar lack of consistent relationships is apparent for the circumferences of saltpans. The same proportional lengths (0.7 km/km^2) were recorded for the North Islands and East Shore study areas but they had the second lowest and highest density of sites (1.4 and 3.8 per km^2 respectively).

Birds nesting on shorelines at salt lakes prefer the islands, or so it seems (Burbidge & Fuller 1982). If only the North Islands and South Islands study areas are considered, there are still no clear associations. The density of sites was very similar for these two areas (1.4 and 1.5 per km^2 respectively), but the lake shoreline for the South Islands area was 21% longer than for the North Islands and the embayment shoreline was 25% longer. On the other hand, there were no saltpans in the South Islands area. So clearly there is no possibility of a direct association between sites and this type of intermittent wetland feature.

This analysis shows there is no direct association between the presence of sites and the shoreline lengths of the saline wetlands. This would seem to argue against a linkage between Aboriginal occupation and the exploitation of resources of the intermittent wetlands, such as nesting waterbirds. But the analysis is probably too simplistic. The measurement of shoreline length fails to reflect other factors that would have been important. As demonstrated above, sites are particularly common on dunes. It is my observation that dunes close to embayments commonly have sites along their length, while sites are not common beside embayments without dunes. This may be related to the need to camp on elevated ground during lake-full times.

Assemblage Analysis

Distribution of Implements

This thesis is principally concerned with identifying and explaining the distribution of archaeological sites. Artefacts were not a major focus of the investigation, nonetheless, some analysis of the assemblages is warranted for what is revealed about subsistence activities at sites. This strengthens the interpretation of the observed distribution of sites and contributes to the goal of developing models of subsistence and settlement patterns.

The artefact analysis concentrated on the presence or absence in assemblages of certain diagnostic implement types or lithologies. Biases and lack of representativeness in the assemblage data, coupled with problems of site disturbance and 'creation' (as discussed in the previous chapter), precluded detailed analysis of assemblages. Furthermore, there are many variables that determined the composition of assemblages (Hiscock 1985; 1989; McBryde 1977; O'Connell 1977) and to identify and delineate these factors and their role in assemblage variation about the lake is a separate study.

The diagnostic implements chosen for analysis were adzes and scrapers, blades and grindstones. Backed pieces were also included, although there is uncertainty about their use. More mundane tools, such as unmodified flakes, cores and various classes of debitage were not considered. A measure of the prevalence of the implements was obtained by using association indices. These were calculated by dividing the percentage of sites with an implement type (dependent variable) by the percentage of sites in the area under consideration (independent variable).

Adzes & Scrapers

These tools had some unifacial retouch on one or more margins and macroscopic step flaking. The adzes were almost all tulas, with the working edge parallel to the striking platform. The scrapers were mostly utilized flakes, with very few core scrapers. It is certain that scrapers and adzes were primarily, but not exclusively, used for wood-working. Their presence can be assumed to indicate the maintenance or manufacture of wooden implements at the sites and the tula adzes were most likely to have been used for working hardwoods, such as mulga (M. Morwood, pers. comm.). It is most unlikely that these hafted tools were replaced but not used on the sites because high quality stone suitable for adzes or scrapers is rare around the lake.

Scrapers and adzes were recorded on 34 of the 230 artefact scatters. In addition, a chopper was recorded on one site. These 35 assemblages with wood-working tools (15.2% of all artefact scatters) ranged in size from 12 to 15,000 artefacts. The median size was 200 artefacts and the inter-quartile range was large at 900, indicating that these implements were common on small (AS2) and medium-sized sites (AS3). Generally there were few examples on sites; more than a third (37.1%) of the sites had one or two examples only. On large sites, the proportion was usually less than 2%. This is well below the figure of 5% that Cane (1984:264) declared to be the level above which wood-working activities were important at a site. It seems certain that wood-working was not a major activity at any site, and so these tools were probably used for maintenance rather than the manufacture of wooden implements.

Sites with wood-working implements were common in all five study areas (Table 5.12), with association indices of close to 1.00 (the value matching uniform distribution). But distribution by landscape units was far from even. No sites with wood-working tools were recorded in the Chenopod Flats unit, although 9.1% of the artefact scatters were present within this unit and few were located in the Alluvial Plains or Kopi Dunes units (a.i. of 0.49 and 0.64 respectively). Sites with these implements were strongly correlated with the Colluvial Plains unit (a.i. of 2.98). They were also common in but not strongly associated with the Sand Dunes unit (a.i. of 1.16).

Table 5.12: Distribution of sites with wood-working tools

	North Islands	South Islands	East Shore	South Shore	West Shore	Totals	**a.i.** for units
Kopi Dunes	1	1	1	0	0	3	0.64
Sand Dunes	4	1	10	3	5	23	1.16
Saline Flats	0	0	1	0	0	1	2.23*
Chenopod Flats	0	0	0	0	0	0	0.00
Alluvial Plains	0	0	2	0	0	2	0.49
Hills & Slopes	0	0	0	1	0	1	0.97*
Colluvial Plains	0	1	3	0	1	5	2.98
Totals	5	3	17	4	6	35	
a.i. for study areas	1.22	0.99	0.98	1.10	0.87		

* index score may be unreliable because of small numbers involved

Not surprisingly, this patterning of sites with wood-working implements partly reflects the occurrence of timber. Mulga trees and Acacia shrubs are common in the Sand Dunes and the Colluvial Plains units, which had even or high association indices, but largely absent from the Kopi Dunes and the Chenopod Flats units. However, factors other than the presence of timber were involved in the observed distribution because the Alluvial Plains unit, where there is an abundance of mulga trees, had a very low score. This supports the earlier observation that wood-working implements were most probably used for maintaining rather than manufacturing wooden tools.

Blades

Artefacts with parallel edges, trapezoidal or triangular cross-section and roughly twice as long as they were wide were recorded as blades. These tools are generally viewed as specialized cutting tools but they might also have been used for final smoothing of spears. The proportion of blades on sites will also reflect the quality and size of the raw material, as their manufacture requires good quality stone and cores that are sufficiently large to allow for some degree of knapping loss by way of preparation.

Blades were recorded on 47 of the artefact scatters (20.4%). These sites ranged in size from 10 to 15,000 artefacts. The median size was 100 artefacts and the inter-quartile range was 258; that is, the majority of site were very small (AS1) or small (AS2). More than a third of sites had only one recorded blade, while many sites had several. Only at one site, "Con Islands 17", were blades numerous (7.7% of a non-representative sample positioned in an artefact classification).

Sites with blades were irregularly distributed across the five study areas (Table 5.13). They were more common on the East Shore (a.i. of 1.33) than anywhere else but were reasonably common in the South Islands area. Sites with blades were uncommon in the three other study areas;

the association indices for the North Islands and West Shore areas were low (0.73 and 0.65 respectively), and very low for the South Shore area (a.i. of 0.41).

Table 5.13: Distribution of sites with blades

	North Islands	South Islands	East Shore	South Shore	West Shore	Totals	**a.i.** for units
Kopi Dunes	0	0	5	0	0	5	0.79
Sand Dunes	3	1	15	1	6	26	0.98
Saline Flats	0	0	1	0	0	1	1.62*
Chenopod Flats	0	0	4	1	0	5	1.16
Alluvial Plains	1	0	4	0	0	5	0.91
Hills & Slopes	0	3	0	0	0	3	2.13
Colluvial Plains	0	0	2	0	0	2	0.90*
Totals	4	4	31	2	6	47	
a.i. for study areas	0.73	0.98	1.33	0.41*	0.65		

* index score may be unreliable because of small numbers involved

The uneven distribution was also apparent but not so pronounced across landscape units. Sites with blades were found on all units but were less common on the Kopi Dunes, Alluvial Plains and Colluvial Plains units (a.i. of 0.79, 0.91 and 0.90 respectively). On Sand Dunes their distribution was consistent with a uniform distribution (a.i. of 0.98). In contrast, sites with blades were highly correlated with the Hills & Slopes unit (a.i. of 2.13). Oddly, all three sites with blades on this landscape unit were recorded in the South Islands area. This seems unlikely to be a coincidence but nothing else about the sites provides an explanation for this anomaly.

It is unclear what role blades might have had in the subsistence activities conducted at the lake. They were, however, not common on sites and almost always constituted only a small fraction of assemblages so whatever their role, it was minor.

Grindstones

It is axiomatic that grindstones were used for grinding seeds, possibly for processing other plant foods, such as tubers or nuts, and sometimes for grinding ochre. Although many grindstones at Lake Carey were probably used for seed grinding, some others were used for markedly different purposes. I considered that large blocks tentatively identified as grindstones at sites "Pyke Hill NE 4" and "Con Islands 15", and which exhibited patches of slight smoothing on otherwise rough, ill-suited surfaces, were used like rasps or sandpaper to smooth wooden tools. Such usage was noted when the tips of digging sticks were ground on stone slabs to sharpen them (Thomson 1975). Another grindstone fragment at "Upsilon 8B" was heavily reduced and probably had served only as a core and not as a grindstone at that site.

A total of 11 basal grindstones, five basal fragments and six top-stones were recorded on assemblages. The basal grindstones were slabs of local stone with no evidence of thinning. They lacked grooves, instead having an area of polish in a slight concavity on one or two surfaces. Following Smith (1988b) these were mortars not millstones, and would have been more likely used for grinding hard *Acacia* seeds rather than grass seeds. The top-stones were fist-sized pebbles and, again after Smith, were pestles rather than mullers.

These grinding implements were recorded on 15 sites (6.5% of artefact scatters) and constituted a tiny proportion of the recorded artefacts. Grinding bases and pestles were found on three sites; complete basal grindstones on only four sites, basal fragments on six sites and only pestles on two sites. They were all made of local stone, often available with several hundred metres of the sites, so little effort or planning was needed to bring them to site. This is a complete record, for there had been little opportunity for souvenir collectors to reach the great majority of sites. And it indicates that activities requiring grindstones were only a minor component of the subsistence tasks performed at the lake.

The 15 sites with grinding material ranged in size from 46 to 15,000 artefacts. The median size was only 300 and the inter-quartile range was 1655. These figures indicate that such implements were common on small sites (AS2) as well as larger sites (AS3 and AS4). Their distribution is illustrated in Table 5.14.

There were definite patterns in the distribution of sites with grinding material. None were present in the North Islands and South Islands study areas, while there was a strong correlation with the South Shore study area (a.i. of 3.85). This was the only area with a definite correlation. Grinding material was also present on sites in the West Shore area but these were no more common than if uniformly distributed (a.i. of 1.02), while in the East Shore area, there were fewer such sites than if they were evenly distributed (a.i. of 0.81) and fewer than I had expected given the high site density.

The frequency of sites with grinding material appeared to be strongly patterned in regards to landscape units but this was partly a result of small sample size. For example, there was a high correlation between these sites and the Hills & Slopes unit (a.i. of 2.23), but only one such site was recorded in this landscape unit. Similarly, the association index of 1.40 for Colluvial Plains was the result of one site, "Lake Carey East 9", and is unlikely to be a good guide to the presence of such sites on colluvial plains elsewhere around Lake Carey.

Some scores are reliable indicators given the larger sample sizes. Sites with grinding material are no more common in the Sand Dunes unit than would be expected if these sites were evenly distributed (a.i. of 1.06). Also, the low association indices for the Kopi Dunes and Chenopod Flats units (0.50 and 0.74 respectively) demonstrate a strong negative correlation between these landscape units and such sites. In these two cases, only one such site was recorded in the unit yet there are sufficient other sites there to confirm that the low scores are valid.

Table 5.14: Distribution of sites with grinding material

	North Islands	South Islands	East Shore	South Shore	West Shore	Totals	**a.i.** for units
Kopi Dunes	0	0	1	0	0	1	0.50
Sand Dunes	0	0	1	5	3	9	1.06
Saline Flats	0	0	0	0	0	0	0.00*
Chenopod Flats	0	0	0	1	0	1	0.74
Alluvial Plains	0	0	6	0	0	2	1.14
Hills & Slopes	0	0	1	0	0	1	2.23*
Colluvial Plains	0	0	1	0	0	1	1.40*
Totals	0	0	6	6	3	15	
a.i. for study areas	0.00	0.00	0.81	3.85	1.02		

* index score may be unreliable because of small numbers involved

Only some of the observed patterning in the distribution of sites can be readily explained. The absence of grinding implements from sites in the North Islands and South Islands areas was expected given the effort required to carry weighty grindstones across the lakebed. What was not expected was the prevalence of grindstones on sites in the South Shore area. There is no obvious reason for this, as the vegetation communities are not noticeably different from other study areas, nor were the grindstones from one (local) source. Two of the sites were in the site-complex about

"Bindah Breakaway 1", with its small rockholes, but the other sites were widely separated from this water source and from each other.

Backed Pieces

The only backed implements recorded on the sites were backed blades and eloueras. These were small tools manufactured from a segment of blade and having nibbled retouch around one thicker edge. They would have been hafted but their exact function is unclear. Backed piece are one of the few chronological markers in Australian artefact typologies but it is far from certain when they began being made and when they ceased to be used (Bowdler & O'Connor 1991; Dortch 1977). In any case, it is likely to have differed between regions across the continent and there are no dated sequences for the Goldfields region that can answer these questions.

Backed pieces constituted a very small percentage of recorded artefacts, typically with only one or two examples per site. But they were recorded on 41 of the 230 artefacts scatters (17.8%). The site assemblages ranged in size from 15 to 15,000, with a median size of 100 and an inter-quartile range of 325. These statistics indicate that backed pieces were common on very small (AS1) and small (AS2) sites.

These distinctive artefacts were found on sites in all five study areas (Table 5.15). The sites were reasonably evenly distributed across the study areas, with association indices ranging from 0.84 in the South Islands area to 1.17 in the South Shore area.

Table 5.15: Distribution of sites with backed pieces

	North Islands	South Islands	East Shore	South Shore	West Shore	Totals	**a.i.** for units
Kopi Dunes	0	1	1	0	0	2	0.36
Sand Dunes	4	1	10	4	8	27	1.17
Saline Flats	0	0	2	0	0	2	3.77*
Chenopod Flats	1	0	1	1	0	3	0.80
Alluvial Plains	0	0	3	0	0	3	0.62
Hills & Slopes	0	1	0	0	0	1	0.80*
Colluvial Plains	0	0	3	0	0	3	1.52
Totals	5	3	20	5	8	41	
a.i. for study areas	1.04	0.84	0.98	1.17	0.99		

* index score may be unreliable because of small numbers involved

The distribution of sites across the landscape units was far from even. Very low association indices were scored for the Kopi Dunes and Alluvial Plains units (0.36 and 0.62 respectively), while the indices for Chenopod Flats and Hills & Slopes were also low (both 0.80). Sites with backed pieces were relatively common in the Sand Dunes (1.17) and Colluvial Plains (1.52) units but these were not strong correlations. A high score was recorded for Saline Flats (3.77) but this was unduly influenced by the small number of sites in this unit.

With no certainty about the function of these implements it is hard to know what their distribution on sites means in terms of Aboriginal subsistence. On the other hand, their reasonably even distribution across all study areas indicates that those activities were conducted in all parts of the lake system, including islands, over the period when these implements were in use.

Site Classes & Artefact Types

Implements such as adzes and scrapers, blades, grindstones and backed pieces were recorded on 95 of the artefact scatters (41.3%) in the five sample areas. Their presence was largely independent of one another, as Tables 5.16 makes apparent. Only three sites had examples of all four implement types; those sites with the largest assemblages ("Lake Carey East #1 & #9") and a small non-descript artefact scatter ("Upsilon 3A"). Only eight sites had examples of three of these implement types together, while 18 sites had two types. Sixty six of the 95 sites on which implements were recorded contained only one type.

Table 5.16: Numbers of sites with certain implements

	with wood -working tools	with blades	with grinding mat.	with backed pieces
with wood-working (N=35)	*35*	12	4	16
with blades (N=47)	12	*47*	5	15
with grinding material (N=15)	4	5	*15*	8
with backed pieces (N=41)	15	15	8	*41*

There was a correlation between assemblage size and the proportion of sites with implements (Table 5.17). Both large artefact scatters (AS4) had all four implement types, as mentioned. Three-quarters of the 16 medium-sized sites (AS3) had implements. Of these, one third had only one implement type, another third had two implement types and the other third had three types. Slightly more than half the small artefact scatters (AS2) had implements but more than two-thirds of these had only examples of one implement type. However, one of these small sites also had all four implement types. Only one quarter of the very small artefact scatters had implements and only one type was recorded on almost all of these.

Table 5.17: Proportion of classes of artefact scatter sites with implements

Site Class	Number of Implement Types 1	2	3	4	Totals
AS1 (N=120)	26	2	1	0	29 (24.2%)
AS2 (N=92)	36	12	3	1	52 (56.5%)
AS3 (N=16)	4	4	4	0	12 (75.0%)
AS4 (N=2)	0	0	0	2	2 (100.0%)
Totals	66	18	8	3	95

That implements were more common on larger sites is no surprise but their presence on small and very small artefact scatters is noteworthy. Such small assemblages would usually be considered evidence of ephemeral visits. So the presence of implements, which are tools with some specialized purpose, is anomalous. Furthermore, of the medium-sized sites (AS3), half had no implements or only one type. Although far from firm evidence, this suggests that site size may not be a good guide to the length of site occupation or the subsistence activities conducted at sites around Lake Carey. This question will be raised again in the next chapter.

Distribution of Lithic Types

The lithological information contained in assemblages can be used to identify economic decisions about stone procurement and the movement of people, generally by tracing the movement of particular stone types from known sources. This latter approach was usefully employed here to reveal some patterns in movement of people around the lake and across the islands.

Exotic Stone

Artefacts manufactured on exotic stone were rare or perhaps absent from sites at Lake Carey. Exotic stone was defined as lithologies that came from sources outside the Lake Carey and Laverton district. Not all sources of knappable stone in this district are known but the major quarries have been identified. The great majority of stone in the assemblages came from local, lake-side sources or from known quarries which are within a 30 km radius of the lake and well within *Waljen* territory. That means there is no reason to assume trade was involved in the movement of raw materials for tools.

The apparent absence of tools made of exotic stone is significant and reveals much about the role of Lake Carey in the regional settlement system. This is discussed in Chapter 7, but to ease the suspense it can be mentioned here that the lack of exotic stone indicates that Lake Carey was not a major centre of aggregation (cf. Cane 1990).

Local vs Foreign Stone

What constitutes local or foreign stone varies for each of the study areas. For this analysis, foreign stone was defined as those lithologies available in the district but not present within each study area.

Some artefacts made of foreign stone were present in all study areas (Table 5.18). Interestingly, this was also the case for the West Shore area where there were numerous local sources of reasonable quality stone. In this study area, slightly over half (53.3%) of the artefact scatters had some foreign stone component. In the other four study areas, the proportion of sites with foreign lithologies ranged from two-thirds (North Islands) to all sites (South Shore). This is logical given there were very few local sources of stone.

Table 5.18: Artefact scatters with local or/and non-local stone in 5 study areas

		only local stone		some foreign stone	
		no.	%	no.	%
North Islands	(N=27)	10	*37.0*	17	*63.0*
South Islands	(N=20)	1	*5.0*	19	*95.0*
East Shore	(N=114)	25	*21.9*	89	*78.1*
South Shore	(N=24)	0	–	24	*100.0*
West Shore	(N=45)	21	*46.7*	24	*53.3*

The situation in the South Shore area is instructive. The only local source of stone was the quartz pebbles in the gibber, so a high proportion of foreign material would be expected. Nonetheless, no assemblages of only quartz artefacts were recorded there, despite the availability of this lithic type, the absence of alternatives and the occurrence of all quartz sites in each of the other four study areas. Part of the explanation for this anomaly may be that this was a transit area, with people bringing stone from several sources as they moved across the lake at this, one of its narrowest points.

It is also instructive to consider the difference in stone use between the North Islands and South Islands study areas. Both these areas have similar geology and landforms, and few sources of knappable stone, but all artefact scatters in the South Islands area have a foreign stone component, while this is the case for only two-thirds of the sites in the North Islands area. This difference in stone use and procurement is also evident in the relatively high proportion of sites with only quartz artefacts in the North Islands (5 of 27 compared with 1 of 24 for the South Islands). It is likely that this reflects the greater isolation and remoteness of the North Islands area rather than any difference in subsistence activities.

Key Stone Types

The movement of key lithic types is a good guide to the movement of people to and around the lake, although not all questions can be resolved. In Table 5.19, the presence of artefacts of certain lithologies on sites in the five study areas is illustrated.

Table 5.19: Presence of artefact scatter sites with certain lithologies in 5 study areas

		North Islands	South Islands	East Shore	South Shore	West Shore
Mt Weld Quarry	no.	0	0	47	2	0
Chert	%	–	–	*95.9*	*4.1*	–
(N=49)	a.i.	0.00	0.00	1.93	0.10	0.00
Coarse-grained	no.	1	16	52	22	16
Silcrete	%	*0.9*	*15.0*	*48.6*	*20.6*	*15.0*
(N=107)	a.i.	0.08	1.72	0.98	1.98	0.77
Chilled-margin	no.	10	3	0	0	18
Dolerite	%	*32.3*	*9.7*	*0.0*	*0.0*	*58.1*
(N=31)	a.i.	2.76	1.11	0.00	0.00	2.96
All Quartz	no.	9	1	14	0	1
or all - 1	%	*36.0*	*4.0*	*56.0*	*0.0*	*4.0*
(N=25)	a.i.	3.08	0.46	1.13	0.00	0.20
Crystal Quartz	no.	0	2	0	0	0
(N=2)	%	–	*100.0*	–	–	–

"Mt Weld Quarry" Chert

Of all the foreign stone, the high quality grey chert from "Mt Weld Quarry" (MWQ) was the one I considered would be most useful in tracing the movement of people around and across the lake. But this situation was complicated by the later discovery of a chert quarry on Kevin Island. This blackish chert resembled some of the darker chert from "Mt Weld Quarry" and calls into doubt some of the early artefact recording in the East Shore study area. Despite this, most of the MWQ chert is distinctive and does serve as a guide to people's movement. In the following discussion it should be remembered that the quarry is situated 15 to 20 km northeast of the lake and about 22 km northeast of the North Islands area, 23 km north-northeast of the East Shore area and 53 km north of the South Shore area.

Forty seven sites in the East Shore area (41.2%) had artefacts made of MWQ chert. The association index of 1.93 indicates a strong correlation. The South Shore area was the only other study area where artefacts of this material were recorded, and only on two sites (a.i. of 0.10 showing a very low correlation). Interestingly, one of these two sites is situated on the western margin of the lake. This indicates that people were crossing the lake from east to west at this narrow point; a pattern that will be repeated when other lithologies are considered.

The very small number of sites in the South Shore area with MWQ chert artefacts and relatively large number in the East Shore area fits the expected pattern of decreased discard with increased distance from source. This trend was also apparent within the East Shore study area, where sites with chert artefacts were more common at the northern end, near Jubilee Well, than in the southern end, near Freshwater Swamp. The pattern suggests movement of stone and people southwards along the lake margin.

No artefacts made of MWQ chert were found on any sites in the North Islands, South Islands or West Shore areas. The absence of this raw material from sites in the North Islands area is particularly informative, for these islands are relatively close to "Mt Weld Quarry". Again, the South Islands area is no further from the quarry than the South Shore area, so an absence of MWQ chert from both island study areas strongly suggests that there was very little or no movement of people from the eastern lake margin to the islands.

Coarse-grained Silcrete

Another major stone source on the eastern side of the lake was the quarries of coarse-grained silcrete in the breakaways more than 15 km from the lake shore. This raw material was found on 22 sites (91.2%) in the South Shore study area and the prevalence is indicated by a high association index (1.72). This is evidence of definite movement across the lake at this narrow point.

A relatively high association index (1.72) was also recorded in the South Islands area, where four-fifths of the sites contained artefacts made of this lithology. This probably is a function of the movement of people and stone through the South Shore area and northwest along the lake margin and into the South Islands area. The lower association index indicates a smaller proportion of sites with artefacts of this lithology on the islands, which is consistent with a decline as distance from the source increased. The alternative explanation, that people crossed directly from the eastern shore to the South Islands area can not be discounted but other lines of evidence suggest not (see below).

The East Shore area is closer to the coarse-grained silcrete quarries than the South Islands area, and as close as the South Shore area, but it has fewer sites with this material. While coarse-grained silcrete artefacts were present on almost half of the sites (52 or 45.6%), the association index (0.98) illustrates that this is no more than would be expected it sites with this lithology were even distributed between the five study areas. This is surprising given the relative proximity of the quarries, and because they are in the breakaways near where reliable rockholes and very large 'base camps' are situated. If people travelled from the breakaway sites to the lake shore then they would have most likely carried many artefacts of coarse-grained silcrete with them. It seems, then, that movement between the breakaways and the eastern shore was common but not especially frequent.

Chilled-margin Dolerite

Three very small quarries for this high quality stone were recorded in the West Shore and the North Islands areas. However, there are likely to be other sources on the western shore of the lake, where outcrops of mafic and ultramafic rocks are common. In the two study areas with quarries of this material, many artefact scatters included artefacts made of this lithology, as would be expected. In the West Shore area, chilled-margin dolerite was present on 18 artefact scatters (40.0%), while in the North Islands area it was present on 10 sites (37.0%). The respective association indices (2.96 and 2.76) illustrate the high correlation. There was also a low but positive correlation (a.i. of 1.11) between sites with artefacts of this raw material and sites in the South Islands area. Possibly this is evidence of people travelling southwards from the West Shore area along the lake margin. But it could indicate there is an unknown source of chilled-margin dolerite in the vicinity of the islands.

No artefacts of this lithology were recorded on sites in the East Shore or South Shore areas. The East Shore study area is about 20 km due east from the quarry sites in the West Shore area, so this suggests that there was rarely any direct travelling across the lake. Certainly more surveys are needed on intervening islands to be sure of this point. Nonetheless, the absence of chilled-margin dolerite artefacts on sites in the South Shore study area adds some support to the proposal that people were not moving west to east across or around the lake.

Quartz

The ubiquity of quartz in the landscape was apparent in the site assemblages. Quartz was present on 229 of the 230 artefact scatters and was the predominant material (>50% of artefacts) in 209 of the assemblages (90.1%). It was the only lithology used for artefacts on 13 artefact scatters (5.7%), while on a further 12 sites, all the artefacts but one were of quartz (5.2%).

The distribution of sites with assemblages of all or almost all quartz artefacts does not directly reflect the availability of quartz but can be related to the availability of other suitable stone. Quartz pebbles in the gibber were the primary source of stone in both the East Shore and the South Shore areas but there were 14 such sites in the former area (a.i. of 1.13) and none in the latter where other lithologies were available locally.

Crystal Quartz

One of the more interesting quarries at Lake Carey is "Con Islands 1", in the South Islands study area. This is a small quarry where clusters of always imperfect quartz crystals were broken apart, presumably to obtain the best examples of the long, white, dagger-like crystals. Several very small crystals of clear quartz were also found at this quarry but presumably if these better crystals were once present they have been removed and this part of the resource exhausted.

I suspect that the crystals were mainly sought for their purported magical powers. Magical stones were part of the Aboriginal belief system and figured prominently in shamanic healing practices (Enright 1907). If the crystals were considered powerful, then they would have been valuable and transported over the region and possibly traded further afield. However, no full crystals or crystal fragments have been found on any of the many sites in the study areas. It can be presumed that either crystals from this quarry were not valuable (but why then were they quarried?), or that they were so valuable that they were not discarded at sites. Certainly here is a minor mystery that the data do not answer.

The crystals were also reasonably suitable for knapping. Approximately a dozen artefacts of this facetted raw material were recorded at two sites on the adjacent island (sites "Con Islands #9 and #21"). Artefacts of this lithology were not recorded on sites in other study areas and together with the absence of the full crystals this suggests the crystals were not being transported about the lake. This is also evidence, albeit weak, that people were not using the islands in this study area as a series of stepping stones across the lake.

Distribution Patterns

Implements

The above analysis revealed some patterns in the distribution of sites with implements, and this provides some insight into the different subsistence activities conducted around the lake. The activities requiring grinding tools included seed processing, nut and bone cracking, and the sharpening of wooden implements.

Grinding material was recorded on numerous sites in the South Shore area and sites with these implements were reasonably common in the West Shore area. But these implements were not recorded on many sites in the East Shore area nor on the islands. This suggests that activities requiring grindstones were more usually conducted on the western and southern margins of the lake than on the eastern margin. Conversely, sites with blades were relatively common in the East Shore and the South Islands study areas, but uncommon in the West Shore and South Shore areas. This suggests that subsistence activities requiring cutting implements were more frequently performed on the eastern side of the lake. In effect, there is some evidence for two modes of subsistence at Lake Carey. This is consistent with the dichotomy between the rocky, colluvial western shore and the alluvial eastern shore. This finding will be discussed further in Chapter 7.

Movement of Stone & People

One of the principal findings of the assemblage analyses concerned the movement of stone resources to and around the lake. The apparent absence of exotic stone is strong evidence that the lake was not host to large gatherings of groups from adjacent districts, nor from remote corners of the tribal territory. Why the lake was not a centre for aggregations will be discussed in latter chapters but this finding helps identify the role of Lake Carey in the regional settlement pattern.

Tracing the movement of certain lithologies also revealed the trend for people to travel across the southern portion of the lake, where the lake is narrowest. Movement through the South Shore area would seem to have been predominantly east to west. This was not limited to people or groups moving along the lake shores, for the coarse-grained silcrete that was the best indicator of that movement came from quarries distant from the lake. So it seems that people east of the lake wanting to reach the western side were travelling south and crossing at the narrowest point. Interestingly, there is no evidence of reverse movement. Possibly this is because of a lack of distinctive stone markers, but the paucity of stone on the eastern margin should have encouraged people moving eastward to carry with them a supply of stone from the western side of the lake.

The available evidence strongly suggests that people did not travel across the lake using the islands as stepping stones. The best evidence for 'island hopping' should be found in the South Islands study area because this offers one of the shorter routes across the lake. The shortest crossing at this point would involve only 1.8 km on the lakebed and 3.9 km on islands. It would pass through the peninsular on which the crystal quarry "Con Islands 1" is located. But no crystals or crystal artefacts have been recorded on sites on the eastern shore, nor has high quality stone from the eastern shore (such as chert from "Mt Weld Quarry") been found on sites in the South Islands area.

It is not surprising that people were not crossing the lake directly but preferred to walk around it. The only means of crossing the lake was on foot. This is relatively easy when it is dry but the lakebed is slippery and boggy when it is damp. When the lake is full or partially so, walking is particularly difficult because the lakebed muds are cloying. But there was no alternative, for the water is so shallow and the mud flats so extensive that watercraft are not feasible. From my experience and that of exploration personnel familiar with the lake, walking on the lakebed is difficult to very difficult after any amount of rain, although never impossible.

Dating Aboriginal Settlement

So far I have not touched on the question of the antiquity of Aboriginal occupation at Lake Carey. There is little evidence to discuss but here I present dates obtained from an excavation of one lakeside site and consider typological evidence for dating Aboriginal occupation.

"Lake Carey East 1"

This site was one of five artefact scatters tested for sub-surface material before they were destroyed to make way for a mine (Mattner 1977c). The sites were situated on sand dunes within a radius of one kilometre of Freshwater Swamp in the East Shore study area. Excavations were conducted mechanically, using a backhoe to skim layers of sand from the trench, in a process similar to excavating spits (van Horn *et al.* 1986). This material was sieved through a 1 cm mesh. Most excavations were test-pits 10 m long and 2 m wide (the width of the backhoe bucket), but Trench 2 at "Lake Carey East 1" comprised a cutting through the dune 60 m long and 2 m wide, and reached the consolidated kopi at the base of the dune, 1.38 m below the dune crest. In all, the excavations moved more than 170 m^3 of deposit. At "Lake Carey East 1", the large Trench 2 sampled less than 1% of the deposit.

Three charcoal lens were found in the deposit at "Lake Carey East 1". The lenses were interpreted as the remains of cooking pits. Charcoal samples were collected and dated; in two cases the samples were split and dated twice to increase the reliability of the procedure. No bones were recovered, except one from the loose surface sands. No charcoal or other organic material was found in the excavations of other sites.

Table 5.20: Radiocarbon dates on charcoal from "Lake Carey East 1"

Sample	Trench	Depth (below surface)	Number	Date*
1a	1	10-22cm	Wk-4924	500 ± 50 BP
1b			Wk-4925	380 ± 60 BP
2a	2	39-49cm	Wk-4926	1060 ± 60 BP
2b			Wk-4927	1000 ± 50 BP
3	2	14-22cm	Wk-4928	1530 ± 50 BP

* conventional age date, uncalibrated.

All the samples returned relatively recent ages (Table 5.20). It must be noted that the two hearth features in Trench 2 were stratigraphically inverted, with the younger feature deeper in the deposit than the older one. Small particles of charcoal were sparsely distributed in the upper portion of the deposit, suggesting mixing of the sands. It is also probable that charcoal and other organic remains were destroyed by percolation of rain water through the porous sands.

No stratigraphy was apparent in the excavations. The only difference noted was a gradual change in colour with depth. This is a pedogenic effect and results from migration of clays down the porous profile and from the increased presence of gypsum crystals in the basal sands (Callen, pers. comm.). To test the field observation that the deposit was homogenous, samples taken from the wall of Trench 2 at three depths (10-20 cm, 50-60 cm and 90-100 cm below the surface) were separated by sieving into fractions of different grain size; namely, coarse sand (>500 micron), medium sand (500< >250 micron), fine sand (250< >125 micron) and very fine sand and silts (<125 micron), following the American geological particle size terminology (Berkman 1989). This analysis showed that the samples from three different depths were almost identical in the proportions of each size fraction. In effect, the dune was homogenous in respect of particle size.

A lack of stratigraphy was also inferred from the distribution of backed blades and backed pieces in the deposit. These types of implement are a temporal marker because they were manufactured only in the mid- to late Holocene period, as already mentioned. In Trench 2, 14 backed pieces were recorded. Most (10 examples or 71.4%) were from towards the bottom of the deposit (between spit 19 and spit 28), yet the others were found close to the surface and one was recorded on the surface (spit 0). Clearly, there was considerable mixing of the deposit.

The homogeneity of the dune, and the concomitant lack of stratigraphy, can be attributed to re-working of the deposit by bioturbation, wind action and erosion. Bioturbation was apparent in the profile of Trench 2, where several burrows and numerous tree roots were crosscut. The largest burrow, probably that of a goanna, was 90 cm below the surface, near the base of the trench at this point. The effect of wind action and erosion was apparent from the mobile sand on the surface but was more graphically demonstrated from a test-pit on a nearby site ("Lake Carey 4") where plant material and leaves were found in the profile 30 cm below the surface (Mattner & Walters 1996: Plate 5).

As the foregoing description has made clear, there are many problems in obtaining dates for Aboriginal occupation at the lake system. The high rate of turbation of the dune deposits is exacerbated by generally unfavourable soil conditions, including problems of porosity, occasional waterlogging and salinity. Stratified sites will not, therefore, exist on the dunes beside the lake nor on any other of the landforms.

Typological Dating

Backed pieces are one of the few temporal markers in the Aboriginal toolkit. But there has been no reliable dates for the commencement or cessation of their production in this region, or for that matter, most of Western Australia (cf. Bowdler & O'Connor 1991; Dortch 1977; Glover & Lampert 1969; Gould 1968). As described earlier in the chapter, backed pieces were found on a number of surface sites and were also recovered in the excavation at "Lake Carey East 1". These implements provide a minimum date of about 2000 BP, but possibly as late as 1000 BP for initial occupation of those sites on which they are present. They might indicate an earlier age, perhaps as early as 4000 BP or even 5000 BP, but this can not be firmly established for unstratified open sites.

Dating on the basis of grindstone morphology, as suggested by Smith (1989b) can not be applied here because no millstones have been recorded at the lake or in the district.

Stable Settlement

The scant archaeological evidence suggests that Aboriginal occupation at Lake Carey was reasonably recent. Possibly initial settlement dates to the mid- to late Holocene period but it might have been earlier. Late Pleistocene occupation has been recently established in the Carnarvon Ranges, about 400 km to the north (O'Connor *et al.* 1998), while early Holocene occupation of the arid zone in Western Australia has been documented at Walga Rock (Bordes *et al.* 1983) and Puntutjarpa (Gould 1968).

Since the early Holocene the regional climate and general geomorphology of the lake system have been largely unchanged and apparently less volatile than in other parts of the continent, as detailed in Chapter 2. On the basis of the stability of the environmental system and the evidence of recent occupation, I consider that there was a single landuse system operating for the full period of Aboriginal settlement. In other words, the archaeological remains are likely to have derived from an essentially constant pattern of subsistence and settlement. The significant demographic changes in the last millennia or two that have been identified in other parts of the arid zone, including increased or more intensive use of rockshelter sites (O'Connor *et al.* 1998; Smith 1988; Veth 1993; 1989a), have not been documented for this region. If those changes were associated with the adoption of new seed grinding technology, as Smith (1989b) argues, then there is no reason to assume change in the settlement patterns in southeast Western Australia, where grass seeds were not a staple nor a significant part of Aboriginal subsistence.

In this chapter the archaeological evidence has been described and analysed to reveal the archaeological signature of Lake Carey and patterns in site distribution. Only artefact scatter sites were present in the sample areas on the eastern and southern shores, while quarry sites were mostly restricted to the hills on the western shore. This reflects the geomorphological dichotomy between the two sides of the lake. Interestingly, the average size of artefact scatters varied between portions of the lake margin. Very small sites were most numerous on the eastern shore and on the islands, while on the western and southern shores most artefact scatters were slightly larger.

In all five study areas, artefact scatters were mostly situated on sand dunes. Over half of all sites were on this landform and all four size classes of artefact scatters were well represented. This result highlights the importance for heritage management of protecting areas around the lake with sand dunes. Artefact scatters were also weakly correlated with kopi dunes and areas of colluvial plain, indicating that a prime requirement for camp sites was an elevated, well-drained situation. Low-lying areas and flat plains had few sites. Consequently, the few examples are anomalous and may warrant study and preservation.

To test the hypothesis that colonies of waterbirds were a major resource at the lake, the proportions of sites in the five study areas were compared with the length of shorelines for the lake and adjacent claypans. No correlations were apparent.

For reasons relating to sampling, the assemblage analysis focussed on the presence of implements and key lithologies. Despite the differences in site size and geomorphology across the lake, backed pieces and wood-working tools were more or less even distributed between the study areas. This was in contrast to blades and grinding material. Several of the grindstones probably served as rasps for sharpening wooden tools. The general scarcity of grinding implements indicates that plant processing or seed grinding was a very minor activity around the lake.

Although knappable stone is in short supply at Lake Carey, very few artefacts made of exotic rock were carried to and discarded there. This strongly suggests the lake was not a centre for social aggregations. The predominant source of stone for artefacts was pebbles in the gibber on the plains. This suggests a very casual and opportunistic attitude to tool-making and stone procurement. Alternatively, it might indicate that the subsistence activities conducted at the lake required few stone tools. Some good quality stone from quarries in the district was transported around the lake. This line of evidence suggests that people did not cross the lake using the islands, but instead travelled around the lake, crossing it at the narrow southern point. It also appears that people did not typically visit the lake from the base camps situated in the breakaways more than 15 km to the east.

In the next chapter I assemble evidence on the resources available at Lake Carey and endeavour to isolate those resources most likely to have attracted Aboriginal settlement and produced the observed patterning of archaeological material.

CHAPTER 6

RESOURCES & SITES

To determine why people might have chosen to visit and camp at Lake Carey, this chapter collates data on the availability of resources including water, foods, medicinal plants and material for equipment, tools, decoration and ritual. In the absence of information specific to salt lakes, I rely on ethnographic and ethnobotanical accounts from other regions. The possibility that Lake Carey, during lake-full times, supported aggregations of people is assessed in terms of food availability, and particular attention is paid to the potential of flocks of waterbirds or plant foods to support such gatherings.

In the previous chapter the distribution of archaeological material was analysed in terms of the landscape units. This approach is generally not warranted in studying the distribution of resources. The landscape units are small and exist in a patchwork which means resources in any one unit were readily available to people camped in any other unit. Instead, the distribution of resources is generally analysed in terms of the five study areas which sample widespread portions of the lake system.

Water

Aboriginal occupation of the lake margin or islands was not feasible without water to drink. There are no reliable springs, 'soaks' or large rockholes so the availability of fresh water is directly determined by rainfall.

Claypans are the principal water source on the margins of the lake and on the islands. They are generally situated in interdunal swales behind the shoreline dunes or on the edge of alluvial plains. Often they exist in isolation but sometimes there are chains of claypans along in-filled drainage lines. Typically, claypans are more common on the eastern margin of the lake than on the western margin. They are only temporary water sources but some claypans are reliable because once full, they hold water for months (pers. obs.). Prominent claypans are typically identified as ethnographic sites by local Aborigines. As mentioned in Chapter 1, Mrs Sullivan recalls camping beside one, Sunrise Dam, when walking around the lake with her parents.

Claypans that repeatedly hold freshwater are usually easily distinguished from other claypans, erosion scalds or saltpans by the ti-tree shrubs (*Melaleuca* spp.) around the high water mark. Generally, their water is brown with suspended clay, resembling nothing so much as ice coffee. It is potable as is, or a flocculent could be used to clear it. A suitable material is at hand. Mason (1909:18) noted that Aborigines 'use Kopi (powdered Gypsum, Calcium Sulphate in crystalline form) to clarify very muddy clay-pan water'.

There are also minor water sources. After rain sufficiently heavy to cause creeks to flow, some potable water will be left in the creekbeds; both as surface pools and as 'soaks' in the sands and gravels. Because creeks are uncommon beside the lake, having dispersed on the bordering plains, these sources of water are uncommon in the study areas. However, minor drainage lines are found in the West Shore study area.

Rockholes were very important water sources for traditional desert peoples because they provided a store of water that could be conserved. Numerous rockholes (gnamma holes) are documented in the escarpment 15 to 20 km east of Lake Carey, and in the granite hills a similar distance to the west. Rockholes are rare beside salt lakes because there is little suitable rock outcrop. One exception at Lake Carey is in the far southwest, within the South Shore study area, where a small portion of lateritic plateau abuts the saline flats and sand dunes on the lake edge. Two rockholes, each with a capacity of several litres, are situated on this laterite plateau within the site "Bindah Breakaway 1".

A feature of freshwater is that it will form a layer on denser saltwater (in a process called meromixis) provided there is no disturbance of the water. This can happen on a pool of standing water under special circumstances, but more importantly, this layering of freshwater over saltwater happens in the soil profile, particularly in lake muds and in sand dunes. This means that temporary 'soaks' may be available at the base of dunes after rains (pers. obs.), in the same way that freshwater can sometimes be found behind coastal dunes.

Emergency water supplies can be obtained from several species of plants and these were also used as 'travelling water' to assist in covering those areas that were without water at the time they were traversed. The best known example in this region is the water obtained for the young lateral roots of kurrajong trees (*Brachychiton gregorii*), which grows on non-saline soils away from the lake edge. Another source is the leaves of *Calandria polyandra*, and possibly also *C. ptychosperma* (Jones 1979; Latz 1995). These small plants are found on sand dunes beside the lake, and more commonly, on the alluvial plains. A little water could also be obtained from the frogs which burrow deep into the mud of claypans as these dry out. The frogs were dug out, squeezed to obtain the water and then cooked and eaten.

The importance of drinking water can hardly be ignored as a factor in Aboriginal settlement of the lake. Without water sources at or near the lake, it probably was not feasible for people to travel to or stay at the lake; that is, the lake and its resources were inaccessible. This is certainly the case for the islands where the only water sources are very ephemeral claypans or pools. But while water availability might have constrained when people visited Lake Carey, it need not have determined where they chose to camp.

Water & Sites

Although it is generally considered to be so, there need not be a correlation between the size and duration of a water source and the existence of sites (cf. Gould 1968; 1991; Veth 1989a; Williams 1998). No archaeological material was observed beside the reliable Sunrise Dam claypan, and surprisingly few artefacts were recorded beside the long-lasting Landing Ground Claypan. There were several good reasons why people would chose to camp at a distance from water supplies. These include the need to be near firewood, to allow game to come to water, to seek shelter from the wind in winter or the sun in summer and to avoid the mosquitoes and 'midges' that exist near pools of water (pers. obs.). So rather than measure distances between sites and possible water sources, I chose a qualitative approach to assessing the relationship between water availability and site distribution.

The various types of water sources are non-randomly distributed and there are major differences in their occurrence across the lake system, and between the five study areas. These differences can be easily explained by the variability in landforms, geology and topography, but they are not amenable to analysis in terms of the seven landscape units. The short distances that separate the landscape units mean that people could have camped in one unit and have had ready access to water in an adjacent unit. So instead, the presence of sites within the five study areas was evaluated. The results are set out in Table 6.1, from which it is apparent that there is no obvious correlation between the presence of water sources and number or size of sites.

Table 6.1: Artefact scatter size and frequency of water sources for 5 study areas

	maximum site size	median size	density sites / km²	Water Sources claypans	creeklines	rockholes
North Islands	10 to 500	50	1.43	rare	none	none
South Islands	11 to 3000	33	1.50	rare	none	none
East Shore	7 to 15,000*	50	3.75	many	several	none
South Shore	40 to 5000	200	0.49	many	few	two
West Shore	20 to 5000	100	3.06	few	several	none

* excludes an estimate for sub-surface artefacts at "Lake Carey East 1"

Claypans are abundant in the East Shore and the South Shore areas but these areas have the greatest and least site density (3.75 and 0.49 sites/km²) respectively. Nor is the size and reliability of claypans correlated with sites. Large reliable claypans are present in the East Shore, West Shore and South Shore areas but there was no uniformity in site density or median size. The only study area with several defined watercourses (West Shore) had neither the highest site density nor contained the largest site. Similarly, rockholes were present in only one study area (South Shore) but this area had the lowest site density.

If an abundance of drinking water was necessary for occupation of the lake environment, then there should be some correlation between the availability of water and the intensity of occupation. One measure of that intensity is site size. But when this is considered, only one association is apparent. The North Islands and South Islands study areas have few water sources and the median assemblage sizes for these two areas are low (50 and 33 respectively). They also have the lowest maximum site sizes. For the other study areas, the median site size shows little correspondence with the frequency of water sources.

If the maximum assemblage size is considered the picture is no clearer. The largest artefact scatters in the South Shore and West Shore study areas contained an estimated 5000 artefacts, yet the West Shore area has few claypans but several small creeklines, while conversely, the South Shore area has numerous claypans but few drainage lines. So the similarity in maximum assemblage size is difficult to attribute to the presence of particular water sources.

These observations confirm that settlement patterns about the lake were not simply related to the presence or size of water sources. This is at odds with the major models of arid land settlement proposed by various researchers as discussed in Chapter 3.

Animal Resources

In Chapter 3, I asserted that game animals were a staple of the traditional diet in this region, especially in good seasons. In this section the availability of game animals is considered. This information was obtained from three faunal studies conducted at three areas within the North Islands, East Shore and West Shore study areas (Brearley *et al.* 1997; Ninox Wildlife Consulting

1995; 1998). These studies provide a reasonably complete picture of the vertebrate fauna that are common to the lake area, because they were conducted at different seasons and across the full range of landscape units.

A major finding of these studies is that there are only minor differences between the island biota and the 'mainland' biota (Brearley *et al.* 1997:37). There is no relict or endemic populations on the islands and there is constant movement of animals between the islands and the lake shores; mainly large mammals but also small mammals and lizards.

Only a few of the vertebrate fauna are endemic to salt lakes. These are small lizards and are found on the kopi dunes or the samphire covered saline mudflats. Some species are more common in salt lake environments than elsewhere in the region, including small reptiles and several bird species that flock to intermittent saline wetlands. These waterbirds are discussed in detail below.

Large Game Animals

Six large game animals were recorded at Lake Carey and all but one of the species is widely distributed about the lake, with three also recorded on the islands. The commonest animals are the red kangaroo (*Macropus rufus*) and the emu (*Dromaius novaehollandiae*). These are ubiquitous in the region and are regular visitors to the islands. The dingo (*Canis familiaris*) is also reasonably common in the region and probably is a vagrant in all habitats including the islands. Less common is the Australian bustard or bush turkey (*Ardeotis australis*). This bird inhabits open woodland and is probably less common on the hilly western margin than on the islands or eastern margin of the lake, where it was recorded. The grey kangaroo (*Macropus fuliginosus*) and the euro (*Macropus robustus*) were only recorded on the western margin. Probably the euro is restricted to the hills and the surrounding plains on that side of the lake but the grey kangaroo probably is more widespread that the surveys suggest (McKenzie *et al.* 1994).

All of these large game animals probably were targeted by Aboriginal hunters, mainly as a source of meat, but emu eggs (available during the winter months) would have been searched out too. All are widely distributed in the region and none are dependent on salt lake vegetation. The frequency of these species beside the lake varies considerably with the seasons and the availability of food and water.

In may be noted that the dense stands of bluebush (*Maireana* spp.) and saltbush (*Atriplex* spp.) that grow on the flats adjacent to the salt lake shores are attractive feeding grounds for kangaroos. Mobs of kangaroos can be seen grazing most mornings and evenings, while in the day they withdraw to adjacent patches of mulga woodland. Emus might also be attracted in spring, when the bluebush shrubs (*Maireana* spp.) flower, for these birds browse the minute flowers, possibly seeking the pollen.

Even if these large game animals were drawn to parts of the lake habitat at certain times, hunting them remained a problem. Hunting on the open plains poses significant difficulties as there is no cover for the hunter and game can move away easily (pers. obs.). Nor could fire be used to drive or herd animals towards hunters as it was in other regions (Hallam 1985; Latz 1995). The chenopod shrubs that are characteristic of the lake edge vegetation do not burn well.

Small Game Animals

The faunal surveys provide an indication of the variety of small marsupials and lizards that are present around Lake Carey. But this is an incomplete guide to the past diversity, because the introduction of competition (rabbits and mice) and predators (cats and foxes) have affected these species more than large indigenous species.

The surveys identified the following range: six small marsupials, four bats, three frogs, 22 lizards, four monitors (goanna) and seven snakes. Many of these small animals were an important part of the Aboriginal diet (Devitt 1988; Meehan 1989; Tindale 1972). Which species were eaten is difficult to determine, just as it is hard to establish the abundance of these species and assess their potential as food sources. It may be noted, however, that there were fewer small game species on the more homogenous eastern margin than on the western margin or the islands.

Goannas were of particular importance in the Aboriginal diet, being a consistently available source of delicious meat and fat. Both men and women hunted them. The women also dug them out of their burrows, particularly during winter when the monitors hibernate. Typically, goannas dig burrows in soft ground such as sand dunes or wanderrie dunes. In terms of the landscape units their burrows are most commonly but not invariably found in the Sand Dunes, Kopi Dunes and the Alluvial Plains units. The small game animals may be available throughout the year but it is likely that small burrowing marsupials and lizards are scarce after floods because their burrows are inundated (Ninox Wildlife Consulting 1995). These species may require several years to breed back up so small marsupials and lizards are amongst the few food resources that are not plentiful in the months after flooding.

Waterbirds

One of the enduring memories of many people when seeing a salt lake full of water is the large numbers of waterbirds, including coastal birds such as swans or pelicans which seem so out of place in the arid interior. The huge flocks of pelicans visiting Lake Eyre or the Coongie Lakes are well known but are not documented for Western Australian lakes, which lack fish or large crustacea.

Some waterbird species are adapted to the floods and droughts of the interior. They are highly mobile and instead of having a fixed breeding season, breed in response to rainfall. Most prefer freshwater, or at least water that is not too brackish, and so are common on the claypans beside the lakes. A few are salt lake specialists. (It is still not understood how the birds know when distant lakes have filled.)

At least 35 species of waterbird have been recorded at Lake Carey in the faunal surveys. Many if not all species would have been potential game for hunters, however, only a few species have potential as significant food sources because of their behaviour or breeding habits. These attributes are set out in Table 6.2 which has been compiled from general ornithology texts (Kingsford 1991; Readers Digest 1986).

Twelve of the 35 waterbirds nest in colonies, so their clutches of eggs are concentrated and a potential bonanza for predators, including people. The size of nesting colonies is not always stated in the literature but range from tens (Black Swans) to tens of thousands (Banded Stilts and Red-necked Avocets). Most species make nests on the ground near the shore. As a form of protection, many species prefer to nest on islands.

Incubation for most waterbirds is short; between 5 and 14 days. Not all birds lay at the same time in a colony, so eggs will be present for many weeks. Various species nest at different times through the year, so for egg collectors, there is a potential supply for many months, commencing about one month after the lake filled and continuing into the following summer. The Banded Stilt is capable of continuous breeding so there can be a steady supply of eggs (Burbidge & Fuller 1982).

Hatchlings were also a potential food source. In Chapter 1 it was mentioned that an elderly *Yamatji* woman, Mrs Dongoo, recalled collecting ducklings from the shores of (salt) Lake Annean, south of Meekatharra. The vulnerability of ducklings lasts about a month, with most species fledging between 24 and 35 days after hatching. Goslings are vulnerable much longer, for they fledge after 113 to 160 days. Some parents will attempt to defend their young or to lure predators away, and this habit can make the parent birds also vulnerable to hunters.

Eight species of waterbird that are common at Lake Carey might have been a food bonanza because they form small to medium-sized flocks. These are the Banded Stilt (*Cladorhynchus leucocephalus*), Red-necked Avocet (*Recurvirostra novaehollandiae*), Australian Shelduck (*Tadorna tadornoides*), Black Swan (*Cygnus alba*), Pink-eared Duck (*Malacorhynchus membranaceus*), Freckled Duck (*Stictonetta naevosa*), Red-necked Stint (*Calidris ruficollis*) and Black-tailed Native-hen (*Gallinula ventralis*).

Table 6.2: Habits of 35 waterbirds recorded at Lake Carey
(names in **bold** are potentially major food sources; <u>underlined</u> are potentially minor food sources)

Species	Common to saltlakes	Flocks	Nesting Colonies	Breeding season	Diet (found in lake)
Chestnut Teal	YES	VS (to S)		June-Jan	P
<u>Grey Teal</u>		S		any	I, P
Australasian Shoveller		VS (to S)		any	I, P
Pacific Black Duck	not	VS to S		any	I, C, P, TP
White-faced Heron	YES			any	I, C, F, Fr
Pacific Heron			S ?	any	I, C, F, Fr
Hardhead	not	M to VL		any	I, C, P
Musk Duck	not			Sept-Nov	I, C, P, F, Fr
Sharp-tailed Sandpiper		(S)		not in Aust.	I
<u>Curlew Sandpiper</u>		S to L		not in Aust.	I
Pectoral Sandpiper				not in Aust.	I, C, P
Red-necked Stint	YES	S to L		not in Aust.	I, C
Long-toed Stint	not	(S)		not in Aust.	I, C
Maned Duck	not	S to L		any	I, P, TP, In
Whiskered Tern	not	S	S ?	any	I, C, F, Fr
Banded Stilt	YES #	S to VL	L (to VL)	any	I
Black Swan	YES #	S (to L)	S to M	any (usu. winter)	P
Great Egret	not		S to M	spring & autumn	F, Fr, I, C
Eurasian Coot	not	S to M		any	P
Black-tailed Native-hen	YES #	S (to VL)		any	I, P, TP, In
Gull-billed Tern	not	(VS)	S to M	any	I, R, In, F, Fr
Black-winged Stilt	YES	(VS)		any	I, C
Silver Gull	not	S	S to L	any	I, C,P,TP,F,Fr
Pink-eared Duck	YES #	S to L		any	I, P
Yellow-billed Spoonbill	not	VS to S	S	any	I, C, F
Glossy Ibis	not	VS to S	S to M	any	I, C, Fr, In
<u>Hoary-headed Grebe</u>		VS to M		any	I
Red-necked Avocet	YES	S to M (VL)	S to M	any	I, C
Freckled Duck	YES #	VS to M		any	P, I
Australasian Grebe	not			Sept-Mar	I, C, F
Australian Shelduck	YES	S to L		any	TP
Straw-necked Ibis	not	M to VL	M to L	any	F, R, In
Wood Sandpiper	not	(VS)		not in Aust.	I, C
Common Sandpiper	not	(VS)		not in Aust.	I, C
(Common) Greenshank	not			not in Aust.	I, C, F

KEY # = breeds at salt lakes. <u>Size</u>: VL= >10k, L= 1k-10k, M= 100-1k, S= 10-100, VS= <10, (rarely occurs).
<u>Diet</u>: I = aq. invertebrates, C = crustacean, P= aq. plants, F= fish, Fr= frogs, TP= terr. plants, In= terr. insects, R= reptiles.

Of the 11 species common to saline wetlands, only two form large breeding colonies (Banded Stilts and Red-necked Avocets). Other species, such as the Black Swans, form much smaller colonies. If found, the large nesting colonies offered Aborigines considerable food resources. For example, a survey after a flood at Lake Barlee (~200 km west of Lake Carey) estimated there were 179,000 Banded Stilt nests on three of the islands (Burbidge & Fuller 1982:213). The size of a clutch is 3 to 4 eggs per nest, meaning that as many as 600,000 eggs were laid in one season on the islands. To put this into perspective, a Banded Stilt egg is roughly one fifth the volume of a store-bought hen egg and if two hen eggs are adequate for an omelette, then the 600,000 Banded Stilt eggs on three islands at Lake Barlee would amount to 60,000 omelettes. Even a small breeding colony of 1000 nests could yield 3000 eggs; enough for 300 omelettes. What is more, a colony could have been re-visited and more eggs harvested later in the season. This provided the possibility of an ongoing egg harvest for weeks or months.

But problems face hunters at a salt lake attempting to exploit the waterbirds. Nests and colonies on islands are hard to access, for although the water is never more than 1 m high at these lake-full times, the lakebed is very boggy. Also, any hunters trying to approach flocks along the shore are very exposed because there is no cover. Disturbed flocks can paddle considerable distances across the lake or embayments to avoid capture, or if they take to the air, they can land on the lake many kilometres away and be hard to find (Chapman & Lane 1997).

The influx of birds with lake-full events is not consistent nor automatic. This meant they could not always be relied upon. It appears that the productivity of the salt lakes and the breeding cycle of many waterbirds depends upon a dry period during which organic matter can breakdown, ensuring high nutrient levels when the lake next fills (Chapman & Lane 1997:57). There are fewer invertebrates and crustacea if a second flood should follow soon after the first or if water remains in a lake for consecutive seasons. This has significant consequences for waterbirds, for breeding is linked to the abundance of food. Little or no breeding will happen if a lake remains full for a second season or re-fills soon after a lake-full event.

Other Aquatic Foods

There are very few aquatic foods apart from migratory waterbirds. Several species of frog inhabit the claypans and burrow down a metre or more to survive the dry times. Aborigines dug these up, cooked and ate them, after squeezing out and drinking the water that the frogs store. The small shield shrimps and minute crustacea that are so abundant in lake waters were not eaten and there are no fish or larger crustacea (unlike the Coongie Lakes or the former Willandra Lakes).

Plant Use

Plant foods were an important part of the Aboriginal diet. But as discussed briefly in Chapter 3, the importance of plant foods can be over-emphasized. It is not known what role they played in Aboriginal subsistence in this region as only one ethnobotanical survey has been made in the vicinity of the study area. This was a short study at Leonora which yielded little information, because Parker (1980) found that after a century of dispossession the informants had little traditional knowledge of plant foods or medicines.

Elsewhere in the arid inland considerable information concerning Aboriginal plant use has been collected (Cleland & Johnston 1933; Cleland & Tindale 1954; Goddard & Kalotas 1995; Veth & Walsh 1988). Chief amongst these is the work of Latz (1995 [1982]). This extensive and detailed account of Aboriginal plant use in western Central Australia is mostly based on fieldwork and was extensively drawn upon for this section. Numerous ethnobotanical books recording Aboriginal plant use throughout Australia also have been published (Cherikoff & Isaacs nd; Cribb & Cribb 1982; Isaacs 1987; Low 1988; McCauley 1986). A limitation of the available information, and a seriously one, is that no ethnobotanical studies have looked specifically at salt lake environments. This leaves the possibility that some plants endemic to saline environments were valued and sought-after but their use has yet to be recorded.

One other caveat needs to be made. There were differences in the way that peoples used the same plants. It can not be assumed that a useful plant, if present in the study area, was harvested. There are many examples in the literature of one group eating a plant that another group did not. This was the case for old man saltbush (*Atriplex nummularia*), the seeds of which were eaten elsewhere in central Australia but not by the peoples that Latz worked with, and with the bitter seeds of desert willow (*Pittosporum phylliraeoides*), which some groups used as 'emergency' food and some thought poisonous and never ate (Low 1988; Cherikoff & Isaacs nd).

Identification of potential plant resources at Lake Carey was achieved by comparing plant lists from three botanical studies that were conducted at three locations within the North Islands, East Shore and West Shore study areas (Brearley *et al.* 1997; Mattiske Consulting 1994; 1998) with all available lists of utilised plants. While the three botanical studies only covered a portion of the lake margin and one island, they constitute a reasonably complete inventory of the extant species.

Foods, Staples & Delicacies

One fifth of the plants recorded at Lake Carey were potential sources of food (71 of the 358 species, or 19.8%). The range of potential vegetable foods provided by the plants included:

1. seeds from shrubs and trees (mostly from *Acacia* spp. but also *Atriplex nummularia, A. stipitata, Brachychiton gregorii, Casuarina cristata, Grevillea stenobotrya, Hakea lorea, Muehlenbeckia cunninghamii, Santalum accuminatum, S. lanceolatum, Sida corrugata*);
2. seeds from grasses (*Alternanthera modiflora, Dactyloctenium radulans, Eragrostis dielsii, E. eriopoda, E. falcata, E. laniflora, Erodium crinitum, E. cygnorum and Triodia basedowii*);
3. seeds from succulents (*Portulacca oleracea*);
4. greens from leaves, stems or flowers (*Brachychiton gregorii, Bulbine* sp., *Calandrinia ptychosperma, Carpobrotus* sp., *Convolulus erubescens, Disphyma clavellatum, Leichhardtia australis, Lepidium muelleri-ferdinandi, L. phlebopetalum, Portulacca oleracea*);
5. berries and fruits (*Canthium attenuatum, C. lineare, Dianella revoluta, Enchylaena tomentosa, Exocarpus aphyllus, Leichhardtia australis, Lycium australe, Santalum acuminatum, S. lanceolatum, Scaevola spinescens, Solanum ellipticum, S. lasiophyllum, S. orbiculatum*, as well as mistletoe [*Amyema* and *Lysiana* spp.]);
6. nuts or kernels (*Santalum acuminatum, S. spicatum*);
7. galls (several *Acacia* species, *Eucalyptus camaldulensis, Grevillea juncifolia*);
8. roots (*Brachychiton gregorii, Convolvulus erubescens, Daucus glochidiatus, Erodium crinitum, E. cygnorum, Portulacca oleracea*);
9. gum or kino (*Acacia kempeana, A. victoriae, Alectryon oleifolius, Eremophila maculata, Grevillea juncifolia, Hakea lorea/suberea, Pittosporum phylliraeoides*)
10. nectar from flowers (*Eremophila forrestii, E. maculata, E. latrobei, Grevillea juncifolia, Hakea lorea/suberea, Leichhardtia australis*); and
11. leaves added to cooking for steaming or flavour (*Carpobrotus* sp., *Eremophila longifolia, Zygophyllum aurantiacum, Z. compressum*).

Some plants were important sources of non-vegetable foods, and in particular, of insects and their products. These plant-related foods and associated plant species were as follows:

1. larvae or grubs (*Acacia aneura, A. kempeana, A. quadrimarginea, A. tetragonaphylla, A. victoriae, Brachychiton gregorii, Eucalyptus camaldulensis, Grevillea juncifolia, G. nematophylla, Ptilotus obovatus, Salsola kali, Senna artemisioides, S. nemophila, Zygophyllum aurantiacum, Z. compressum*);
2. honey from native bees or honey ants (*Acacia aneura, Eucalyptus camaldulensis, Grevillea junciflora, Hakea lorea/suberea*);
3. sweet exudates from lerps (*Acacia aneura, A. kempeana, Eucalyptus camaldulensis, E. oleosa*); and
4. caterpillars (*Eremophila longifolia*).

Plants were sometimes also important because of the game animals that they attracted. The possibility that kangaroos, euros and possibly emus were drawn to the chenopod shrublands on the saline flats adjacent to the salt lake has been mentioned. Goannas are also attracted in some seasons to the caterpillars found on some shrubs (Tindale 1972:249)

Many of the potential plant-based food species were considered staples or delicacies in other regions, with some species such as mulga being sources of both. Twenty two of the 71 edible species (31.0%) provided staples and/or delicacies, excluding the several varieties of mistletoe which are generally considered only children's food. The staples included the seeds of shrubs, grasses and trees, plus fruits of certain bushes. Larvae found in the roots of some plants were also staples, as were caterpillars that occur on one shrub (see Table 6.3). The delicacies typically were sweet and included fruits and nectar from flowers, honey associated with particular shrubs or trees, as well as the savoury leaves of one succulent species (see Table 6.4).

Table 6.3: Plant species providing foods considered to be staples

Species	Edible Portion	Landform	Occurrence	Seasonality
Acacia aneura	seeds	many (non-saline)	abundant	late spring, after rains
Acacia kempeana	larvae	colluvial plains	sparse	all year
Acacia linophylla	seeds	alluvial plains	sparse	late spring
Acacia tetragonophylla	larvae	many (non-saline)	sparse	all year
Acacia victoriae	seeds	sand dunes	uncommon	early to late summer
Dysphania kalpari	seeds	sand dunes	common	after rains
Eragrotis eriopoda	seeds	sand dunes & plains	sparse	summer, after rains
Eremophila longifolia	caterpillars	all. & coll. plains	uncommon	variable
Portulacca oleracea	seeds	saline/alluvial flats	uncommon	summer, after rains
Santalum acuminatum	fruits	many (non-saline)	sparse	spring
Santalum lanceolatum	fruits	many (non-saline)	sparse	after rains
Solanum ellipticum	fruits	sand dunes	sparse	after rains
Zygophyllum aurantiacum	fruits	very many	common	after rains

Of the 22 plant species that might have been important because they provided a food that was either a staple or a delicacy, only one is endemic to the salt lake environment. *Carpobrotus* sp., also known as inland pigface or *karkalla*, is a succulent that was considered a delicacy (Low 1988). It resembles other species of the genus, being small and ground-dwelling with triangular fleshy leaves. It has a limited distribution on saline flats and around saltpans. The juicy leaves were eaten raw, or included as a savoury when cooking meat. The small fruits were also eaten when available.

This small plant has a limited distribution and probably was not of sufficient importance to cause people to travel to salt lakes.

Several other important plant foods are found beside the lake but are neither prolific there nor restricted to the lake environment. *Portulacca oleracea* (purslane or pigweed), for example, was an important staple throughout desert regions. It grows on salty soils beside claypans after rains but within the study areas it has a limited distribution on the western margin of the lake. Possibly the soils beside the lake are generally too saline.

Solanum ellipticum (desert raisin) is often found on the sand dunes beside saltpans and claypans. This was a staple food for desert groups, as were several other *Solanum* species, because of its nutrition value and because the fruits dry on the shrub and so are available for harvest for several months. But while found on the sand dunes beside the lake, it prefers non-saline soils and is therefore also found on the wanderrie dunes on the alluvial plains and elsewhere in the region.

Table 6.4: Plant species providing foods that were considered delicacies

Species	Edible Portion	Landform	Occurrence	Seasonality
Acacia aneura	lerps honey ants	many (non-saline)	abundant	all year winter
Acacia kempeana	lerps	colluvial plains	sparse	winter
Acacia victoriae	kino (gum)	sand dunes	sparse	all year
Canthium attenuatum	berries	sand plains	rare	late summer – winter
Carpobrotus sp.	fleshy leaves	saline flats	uncommon	summer & autumn
Eremophila forrestii	nectar	many	sparse	spring ?
Eremophila latrobei	nectar	many	sparse	spring ?
Eucalyptus camaldulensis	lerps honey	watercourses	rare	variable summer
Eucalyptus oleosa	lerps	sand dunes	rare	variable
Grevillea juncifolia	nectar honey	sandplains & dunes	uncommon	after rains summer
Hakea lorea / suberea	nectar honey	uncommon	rare	after rains summer
Leichhardtia australis	fruits nectar	many	uncommon	1 month after rains after rains
Children's delicacies	(not counted)			
Amyema spp.	fruits	mulga woodland	sparse	all year
Lysiana spp.	fruits	mulga woodland	sparse	all year

Other important food plants that are available in the study areas prefer non-saline soils and are typically associated with the alluvial plains. Many *Acacia* species are common there, including *A. aneura*, *A. kempeana*, *A. linophylla* and *A. tetragonophylla*. This is also the case for those tree species that yield fruits, such as *Santalum acuminatum* and *S. lanceolatum*. Similarly, those trees and shrubs which have delicacies, such as lerps, nectar from flowers, honey from bees and honey ants, or fruits, are generally widely spread across landforms but are most often found within the mulga woodlands. They are not limited to nor particularly common in the lake system.

Beside the staples and delicacies, there were numerous plant species that were minor food sources as well as several that offered emergency foods. Most are relatively widespread, and only a very few of these plant species are restricted to saline environments. Those species with restricted occurrence include *Acacia oswaldii*, a shrub with edible seeds (Latz 1995), *Disphyma clavellatum*, a forb with edible leaves that were eaten raw or cooked (Low 1988), and *Atriplex nummularia* and *A. stipitata*, the seeds of which are edible and were eaten by some groups (Cherikoff & Isaacs nd).

It seems that very few of the endemic halophytic plants were utilized, although it is far from certain because there have been no ethnobotanical studies specific to salt lakes. None of the many species of bluebush (*Maireana*) were a recognized source of food, nor most of the saltbush species (*Atriplex*) or the samphires and sub-shrubs growing on the edge of the lake or saltpans. This is not surprising, given the physiographic adaptations these species have made to cope with the saline conditions including secreting on leaves or storing salt within the plant.

It is worth considering two important omissions from the list of available plant foods before turning to other matters. Two of the major staples for desert peoples were tubers or yams (such as *Ipomea*) and native millet (*Panicum decompositum*) (Latz 1995; Tindale 1977; Veth & Walsh 1988). Neither of these were recorded in the botanical surveys at Lake Carey. There are very few plants with root or stem tubers in this region (Pate & Dixon 1982:232), while native millet is restricted to regions experiencing summer rainfall.

Medicinal Plants

No complete picture can be formed of the potential pharmacopoeia provided by plants beside Lake Carey because there have been no specific ethnobotanical studies of salt lake species. From published material, much of it covering plants from eastern Australia, a list of plants was compiled for which some medicinal use was documented (Cribb & Cribb 1981; Lassak & McCarthy 1983). This was augmented by one study that focussed on Western Australian plants (Reid 1977).

Of the 358 plant species recorded at Lake Carey, medicinal uses have been noted for 37 specific species and also for one genus (*Acacia*). Multiple uses have been documented for more than half (19 of the 37) of these plants. The range of complaints for which these species were used by various groups includes the following:

1. stomach complaints (*Convolvulus erubescens, Pimelea microcephala, Santalum lanceolatum, Scaevola spinescens*);
2. urinary complaints (*Portulacca oleracea, Scaevola spinescens*);
3. diarrhoea (*Acacia tetragonophylla, Convolvulus erubescens, Euphorbia australis, Euphorbia drummondii*);
4. constipation (*Acacia kempeana, Eremophila bignoniiflora*);
5. skin complaints (*Acacia kempeana, Dysphania kalpari, Eremophila gilesii, Eremophila latrobei, Eremophila longifolia, Euphorbia australis, Euphorbia drummondii, Pittosporum phylliraeoides, Prostanthera striatiflora, Santalum lanceolatum, Santalum spicatum, Scaevola spinescens*);
6. wounds and sores (*Acacia tetragonophylla, Exocarpos aphyllus, Santalum lanceolatum*);
7. antiseptic (*Acacia tetragonophylla*);
8. eye complaints (*Centipeda thespidioides, Cymbopogon bombycinus, Eremophila longifolia*);
9. colds (*Acacia tetragonophylla, Centipeda thespidioides, Cymbopogon procerus, Eremophila longifolia, Eriostemon brucei, Eucalyptus camaldulensis, Euphorbia australis, Exocarpos aphyllus, Melaleuca* sp., *Pittosporum phylliraeoides, Santalum spicatum, Scaevola spinescens, Stemodia florulenta*);
10. fever (*Amyema* spp., *Eucalyptus camaldulensis*);
11. chest complaints (*Euphorbia drummondii, Exocarpos aphyllus, Melaleuca uncinata, Pimelea microcephala, Prostanthera striatiflora, Santalum lanceolatum*);
12. headaches (*Eremophila longifolia, Pimelea microcephala*);

13. sprains and muscle aches (*Centipeda thespidioides*, *Dysphania kalpari*, *Eremophila maculata*, *Pittosporum phylliraeoides*, *Santalum spicatum*, *Stemodia florulenta*);
14. bruising (*Solanum lasiophyllum*, *Swainsona* sp.);
15. pain relief (*Pimelea microcephala*, *Senna artemisioides*);
16. rheumatism (*Euphorbia drummondii*, *Santalum lanceolatum*);
17. warts and/or corns (*Acacia tetragonophylla*, *Euphorbia australis*);
18. promote lactation and post-natal health (*Euphorbia australis*, *Pittosporum phylliraeoides*, *Eremophila longifolia*, *Senna artemisioides*, *Senna helmsii*);
19. contraceptive (*Leichhardtia australis*);
20. snakebite (*Euphorbia drummondii*);
21. narcotic (*Solanum ellipticum*);
22. general tonic (*Eremophila longifolia*, *Portulacca oleracea*, *Santalum acuminatum*, *Santalum lanceolatum*); and
23. unspecified use (*Grevillea juncifolia*, *Grevillea stenobotrya*).

None of the 37 species with documented pharmaceutical uses are exclusive or endemic to the lake system. Almost all the species are found over a range of landscape units, with most growing on alluvial or colluvial plains. A few species are commonly found on sand dunes, and are largely limited in distribution to the dunes on the lake margin or the wanderrie dunes on the alluvial plains. These species include *Grevillea juncifolia*, *G. stenobotrya* and *Solanum ellipticum*. Curiously, there is little knowledge of Aboriginal use of these species, which may mean there is a significant gap in our knowledge of medicinal plants endemic to salt lakes.

Three of the most important drugs in Aboriginal societies are absent from the study areas and probably always were so. Native tobacco was highly prized and widely chewed. This was principally species of *Nicotiana*, although in southeast Western Australia another plant (*Isotoma petraea*) also containing nor-nicotine was used as well (Cribb & Cribb 1981:170-172). Men were prepared to travel long distances to obtain supplies of high quality *Nicotiana* (Tindale 1972), which might have been an incentive to travel to other areas and not visit the lake.

Pituri (*Duboisia hopwoodii*) is another well known Aboriginal narcotic. It grows on sand hills in arid conditions and is found in the wider region, especially to the northwest of Lake Carey and north of Leonora. I found no record of Aboriginal groups in this region using it as a narcotic or trading it. This might have been because of low levels of the active ingredient in the local species or for cultural reasons or simply a deficiency of the few ethnohistorical accounts. *Pituri* almost certainly was used in the region, as it was elsewhere in inland Western Australia, for stupefying birds and other game by adding leaves, twigs and fruits to waterholes.

It has been shown that some sources of traditional medicines were available in the study areas and that recreational drugs were absent. It is difficult to draw any firm conclusions on the role medicinal plants played in Aboriginal settlement decisions.

Cultural Plants

Apart from sources of food or medicine, plants also provided many of the items used on a daily basis in traditional society. This included material for tools and equipment, for ceremonies and personal decoration, and for shelter and firewood.

A total of 23 plant species with specific cultural uses were identified in the vegetation inventory for Lake Carey. None of these were endemic species. Only two species on the list had restricted distributions that meant they were common at the lake. *Grevillea stenobotrya* is typically found on sand dunes, both beside the lake and on the plains further afield. Ash from this plant was used as a pigment to blacken artefacts and the skin of participants for ceremonies. It was also a preferred additive for mixing with *pituri* or with native tobacco. Apparently individuals showed strong preferences in their choice of species for this purpose (Tindale 1972:254), but it is unclear if this would have been sufficient reason to visit the lake.

Fibre from the bark of one shrub, *Abutilon octocarpum,* could be used for twine to make coarse nets, useful for trapping birds and larger game, including kangaroos (Cribb & Cribb 1982:181). Interestingly, at Lake Carey this shrub was only observed on sand dunes and kopi dunes on the islands. Most likely this is a consequence of overgrazing.

Mighty Mulga

As any experienced camper knows, the availability of firewood is a major factor in choosing a camp site. For Aborigines it was easier to camp near sources of timber and walk to water or other resources than to carry quantities of timber to camp sites near other resources. The principal source of firewood and material for shelters in this region was the mulga tree (*Acacia aneura*), which was also a source of foods (seed, larvae, lerps, galls and honey ants) and wood for implements (spears, boomerangs, digging sticks). So one of the most ubiquitous plants in the district was also one of the most important and some discussion of the role of mulga and the distribution of sites is necessary.

Mulga was the principal choice for timber for building *wiltja*; small shelters used as a shade in summer. Gould (1980) has described the form of *wiltja* and extant examples still survive in the Laverton and Lake Carey districts (although not for much longer). Typically, *wiltja* were built on an oval floor-plan with a length of less than 2 m, a width of between 1 m and 2 m and a height of less than 1.5 m. A few mulga boughs were arranged so as to converge and knit together at the top, then covered with leafy branches and sometimes grasses. An opening was left at one end and the fire was situated there. *Wiltja* were often maintained and reused for many visits and generally are found in groups.

Consequently, when selecting a place to camp in summer people would have considered the availability of timber and sensibly selected places close to sources of mulga. This makes it possible to consider the distribution of sites in relation to the presence of mulga (Table 6.5).

Table 6.5: Proportions of sites and presence of mulga woodland for 7 landscape units

landscape unit	frequency of sites no.	%	density sites / km²	a.i. % Sites / %Area	presence of mulga
Kopi Dunes	31	12.5	2.40	1.29	none
Sand Dunes	130	52.4	8.60	4.64	common
Saline Flats	3	1.2	0.11	0.06	none
Chenopod Flats	22	8.9	0.82	0.45	rare
Alluvial Plains	29	11.7	0.74	0.40	abundant
Hills & Slopes	21	8.5	1.99	1.08	sparse
Colluvial Plains	12	4.8	4.67	2.53	common

An association between sites and the distribution of mulga is apparent in the case of the Sand Dunes and Colluvial Plains units, with association indices of 4.64 and 2.53 respectively. Both these landscape units have plenty of mulga and had the highest density of sites. Negative correlations are also apparent. Two landscape units without mulga, Saline Flats and Chenopod Flats, had low site densities and low correlation indices. For these two landscape units the absence of mulga (and other trees and Acacia shrubs) reflects the saline and alkaline soil conditions. These soils are also less desirable than well-drained sands for camping.

Arguing against a correlation between the presence of sites and mulga is the evidence from the Kopi Dunes and the Alluvial Plains units. The correlation index for the Kopi Dunes was slightly higher than would be expected from a even or random distribution. But mulga doesn't grow on these dunes. In the Alluvial Plains unit, mulga trees are abundant and ubiquitous, yet the correlation index for this unit is low. Most likely this was because there are very few water sources or rocky outcrops to attract or focus occupation on the Alluvial Plains.

Despite these exceptions, I feel that there was an association between the availability of mulga trees and the distribution of sites. The reasons for this association are likely to be directly related to the use of the timber for shelters and fires. But it probably was indirectly related to the soil conditions as well, for mulga grows on well-drained sandy soils which would also have been the preferred places for camping.

Useful Plants and Sites

The analysis of the available plant species makes it apparent that plant resources were not an important reason for Aboriginal visits to the lake. Almost all of the useful plants were available elsewhere in the region and all but a few of the endemic species were apparently not used. However, it must be remembered that there have been no ethnobotanical studies of salt lake vegetation so there can be no certainty about the role of endemic plants.

Although plants might not have been an important resource, many of the plant products were undoubtedly used when people visited the area. To determine if there were general correlations between the presence of useful plant species and the number of sites across the lake system, the number of potentially useful plants in the three areas covered by the vegetation surveys were investigated (see Table 6.6).

Table 6.6: Presence of useful plant species in three areas

	northern island	eastern margin	western margin
All Food Plant Species	44	25	50
Important Food Species	16	9	16
Medicinal Plant Species	18	15	25
Plants with Cultural Uses	15	8	15
	North Islands	East Shore	West Shore
Density of Sites per km²	1.43	3.75	3.06

The number of plants that were potential food sources is more or less the same on the western lake margin as on the northern island, and almost double the number of potential food plants on the less diverse eastern margin. This is the same pattern for important food species; that is, staples and delicacies. There were 16 important food species on the northern islands and on the western margin but only 9 such species on the eastern margin. Similarly, plant species with cultural uses were less numerous on the eastern side of the lake than on the northern island or the western margin. A slightly different pattern pertained to plant species with potential medicinal use. More of these species were recorded on the western margin (25 species), while the number of species on the eastern margin and the northern island were similar.

In summary, the greatest number of potentially useful species were present on the western margin of the lake, with slightly fewer on the northern island. The fewest useful species were recorded on the more homogenous eastern margin.

The presence of species can be compared with the frequency of sites in comparable areas; that is, the West Shore, North Islands and East Shore study areas (see Table 6.6). The East Shore area had the highest site density but the fewest useful plant species, while the West Shore had slightly lower site density but considerably more species identified as sources of staples, delicacies, medicines or material for cultural uses. This indicates that there is no obvious correlation between the presence of useful plant species and the density of sites. It emphasizes that plants were not a major reason for Aboriginal visits to the lake. These findings are in contrast to the assumptions underpinning most models of arid land settlement, as discussed in Chapter 3.

Miscellaneous Resources

Beside the essential resources of water and food, and the less essential resources of medicines, shelter and tools, the lake environment offered few other attractions. But there are three miscellaneous products of the lake system and it is relevant to assess their possible interest for the Aboriginal occupants.

Salt

NaCl salt is certainly available at Lake Carey and handfuls could have been collected with little effort. Thin crusts of salt crystals form on the last pools of water and can be found deposited on the very edge of the lake, in embayments and less often, in saltpans. Salt crusts also form as water evaporates from any pits dug in the saline flats, on the mudflats at the lake shore or in the lakebed.

Although readily available, it is highly doubtful that there was a demand for salt. In this region and the arid interior generally, many water sources contain some salt which derives from the soils. This increases as water evaporates and can contaminate the water source. In any case, Aborigines were able to drink water far more salty that Europeans can manage (McNiven 1998:68) and so were likely to have had sufficient salt in their diet.

Crystals

Magical stones were part of the Aboriginal belief system and figured prominently in shamanic healing practices (Enright 1907). While unusual or odd stones were used, crystals were particularly important.

The salt lake sediments are, potentially, a major source of sizeable gypsum crystals. These shiny and soft crystals, often translucent but sometimes the colour of the mud, can be larger than a hand. More commonly, they are thumb-sized or form aggregates of small crystals. Gypsum crystals are found in the muds of the lakebed or embayments, with the larger crystals typically found a metre or more below the surface.

There is a very low potential for other types of crystals, apart from these gypsum crystals, because there is little outcrop on the lake margin. An exception was the crystal quartz that was quarried at "Con Islands 1", as discussed in the previous chapter.

Feathers

Birds were on the menu for people camping at Lake Carey, and might have been the principal attraction. As a result, many colourful plumages were available if people wanted feathers for any purpose. These included black feathers from swans, iridescent feathers from various ducks and teals and the nuptial white feathers of the egrets.

From ethnographies and ethnohistorical accounts we know that feathers were widely used for personal adornment and for decoration of some ceremonial items. Specifically, the feathers of teals were a coveted decoration for some groups. It is not possible, however, to ascertain if feathers were a valued item for people at Lake Carey.

Summary

A feature of the salt lake system are the aeolian dunes fringing the lake shore. Associated with them, in the interdunal swales and on the edge of the alluvial plains behind the dunes, are claypans. While many of these are ephemeral water sources, a few larger claypans are reliably long-lasting. They would have provided people with water for weeks or months after heavy rains. Other reliable water sources are scarce. A qualitative assessment of the availability of water and site distribution failed to identify any associations between site size or site density and the presence of water sources in the study areas. This indicates that Aboriginal occupation was not tethered to major water sources, such as claypans, but was linked to other resources; for example, to firewood or timber for *wiltja*. It is also likely that the low correspondence between sites and water sources meant that occupation of the lake system happened when water was abundant; namely, after heavy rains or floods.

Many potential food sources have been identified at the lake. A handful of large game animals are present, including macropods, emus and bush turkeys. Their numbers will vary with the seasons and the pattern of rainfall but it is probable that some species (e.g. euros and bush turkeys) are less common beside the lake than elsewhere in the region. And although kangaroos have a preference to feed on the chenopod shrubs growing beside the lake, these migratory animals are likely to leave the lake district after substantial rain, just when the lake system was most accessible to Aborigines.

Small game, which was an important component of the traditional diet in the arid zone, is also present across the lake system but is unlikely to be especially abundant. Only a few lizard species are endemic. The small marsupials, snakes and lizards are susceptible to decimation by flooding when their burrows are inundated, so these animals might not have been a major or dependable food resource when people were most likely to visit the lake.

In marked contrast, waterbirds arrive in great numbers after floods transform the lake, saltpans and claypans into productive wetlands. Many species remain at these wetlands for many months and some use these lake-full events to breed. The large flocks or solitary pairs of waterbirds would have been a target for hunters, although birds might have been hard to catch in the exposed conditions of the lake shore. A potential bonanza was available if people were able to find the breeding colonies of particular species, such as Banded Stilt and Red-necked Avocet, which form colonies of many thousands. Besides eggs, hatchlings could be collected and possibly adult birds as well. This was a resource that was available for several months until all the hatchlings had fledged. Because many of the waterbirds apparently prefer to nest on the shores of islands it is likely that this was the resources responsible for attracting Aboriginal occupation of the islands.

Foods were also available from a variety of plant species, especially in the productive months after heavy rains or floods. Of the plant species producing foods that were possible staples or delicacies, only one was endemic to salt lakes. Inland pigface (*Carpobrutus* sp. or *karkalla*) is a succulent that grows on saline soils and which was considered a delicacy in some parts of arid Australia (Low 1988). Typically, the other sources of staples or delicacies are common throughout the district and probably are less abundant ion saline soils beside the lake. Similarly, some plant species known to have medicinal or cultural uses are available around the lake but are likely to be more common in other landforms. They are unlikely to have been a motive for visiting Lake Carey. None of the endemic plant species have been identified as medicinal plants or drugs but this may reflect the lack of ethnobotanical fieldwork at salt lakes.

From this consideration of the potential resources available at Lake Carey, only one candidate stands out as a primary reason for Aboriginal occupation. The flocks of waterbirds that arrive after floods occur in very large numbers on both the lake and the adjacent wetlands. The waterbirds are present for several months at least and provide several high-protein foods (from eggs to adult birds). These aggregations are only available about salt lakes, unlike almost all other food resources. Finally, these resources are most abundant when the lake and its environs were most accessible to Aborigines because of the abundance of ephemeral water sources. Naturally, other resources that were available would have been exploited to some degree, including the range of plant foods.