Often-used indicators of cultural and demographic change include changes over time in numbers of sites and stone artefacts. They have often been interpreted as indicators of population increase in continent-wide and regional prehistories in Australia. At a regional or local scale, variations in numbers of sites and artefacts over space and time have been used as the basis for proposing changes in land and resource-use patterns which include the redistribution of populations. In addition, changes in artefact numbers in individual sites have been used as evidence for the extent to which the use of specific locations varied over time — often referred to as changes in ‘the intensity of site use’. Unprecedented large-scale increases in numbers of sites and artefacts were said by some researchers to have occurred about 4000 BP and to have been associated with the introduction of the ‘Small Tool Tradition’. Furthermore, these quantitative changes have been part of the archaeological evidence used since 1980 in theories for late Holocene intensification and/or increased sociopolitical complexity in south-eastern Australia — a theme which became a major focus in Australian archaeological research.

In this context, the study of quantitative changes in the archaeological record of the Upper Mangrove Creek catchment has much to contribute. Of particular interest in the catchment data is the lack of correlation in the timing and direction of dramatic late Holocene changes in numbers of sites and artefacts. Most conspicuous are the differences in timing in the dramatic increases in sites and artefacts which occurred in the second and third millennia BP respectively, and a decrease in artefact accumulation rates in the last 1000 years, which contrasts strongly with the continuing increase in site numbers. Such trends and patterning throw doubt on claims that chronological changes in numbers of sites and artefacts reflect population changes. This study of the catchment data also clearly demonstrates that dramatic changes in numbers of sites and artefacts do not necessarily coincide in time with the introduction of the ‘Small Tool Tradition’, or other changes in the stone artefact assemblages, such as the appearance of backed artefacts, the increasing use of bipolar technology for core reduction, and variations in the abundance of certain raw materials. Other behavioural explanations may account for these dramatic changes in sites and artefacts and the ways in
which they can be interpreted and explained depend on the assumptions that are made. For example, they could be the result of the reorganisation of habitation patterns and subsistence strategies, which included the adoption of different mobility patterns and other risk minimization strategies in the face of environmental change. If so, it is likely that such processes involved the restructuring of social relationships as well as technological systems.

Research aims and context — past and present

The aim of this study is to investigate ways in which chronological and spatial changes in numbers of archaeological sites and stone artefacts can be interpreted and explained in terms of demography and human behaviour, using the Upper Mangrove Creek catchment as a case study. The original research aim of my doctoral thesis, however, was to investigate pre-colonial land-use and subsistence strategies in the coastal regions of south-eastern New South Wales, that is, the land between the Great Dividing Range and its associated ranges and the ocean shoreline. This strip of land can be divided into two geographical/environmental zones: the coastal plain associated with the shoreline or maritime zone, and the coastal hinterland. The central NSW coastal hinterland, except for areas such as the Cumberland Plain and Hunter Valley lowlands (respectively, to the south and north of the Upper Mangrove Creek catchment), is predominantly forested hills, ranges and dissected sandstone plateaux, which is often very rugged country. The Upper Mangrove Creek catchment lies within the coastal hinterland (Fig. 1.1).

Field-based coastal studies in south-eastern NSW of the 1960s and 1970s focused principally on the excavation of shell middens in close proximity to the shoreline (e.g., Megaw 1968a, 1968b, 1974; Lampert 1966, 1971a, 1971b; Bowdler 1970, 1971, 1976). The coastal bias in this excavation work in conjunction with the interpretation of local historical sources led researchers to the viewpoint that the hinterland (usually referred to as ‘inland’) was used to a much lesser extent than the ocean and estuarine shoreline zones (Lawrence 1968, 1971; Poiner 1971, 1976; Lampert and Hughes 1974). Poiner and Lawrence proposed that most of the population was concentrated along the coastal shoreline and subsisted predominantly on marine resources. They claimed the hinterland regions were used only in times of hardship; that is, in winter and/or stormy weather when fish and shellfish were difficult to obtain. Lampert (1971a: 63–4) concluded that the upper deposits at Burrill Lake and Currarong represented the activities of people with wide-ranging economic interests (land, estuary and seashore), but with a strong orientation towards seashore resources. Later regional studies for the NSW far south coast and central coast by Attenbrow (1976) and Ross (1976) respectively led to models for site distribution and subsistence patterns in which the coastal hinterlands were occupied to a greater degree than proposed by some of the earlier researchers. These two literature reviews showed that inhabitants of the coastal hinterlands of these regions belonged to different clans who spoke different dialects (or, for the Sydney region, Ross claimed a different language — see also Ross 1988) from the people who lived along the adjacent ocean coastline. The Upper Mangrove Creek catchment was most likely part of the country of a hinterland group — a clan of the Darginung (Capell 1970: Map 1; Attenbrow 1981: 16–22).

In 1979, initial results from the Mangrove Creek Dam salvage project indicated that the catchment was an ideal locality in which to undertake a field investigation into Aboriginal use of the coastal hinterland. There were numerous sites with various types of archaeological evidence (e.g., archaeological deposits, pigment and engraved images, grinding grooves and scarred trees); there were stratified sites with chronological depth to the archaeological record going back ca 11,000 years; and the length of habitation recorded at individual sites with
archaeological deposits varied (Furey 1978; Attenbrow 1980; Vinnicombe 1980 IX C: 6–11). It was also known that within the observed time depth, temporal changes occurred in various aspects of the archaeological record — in the stone artefact types and assemblages, in the technology, and in the raw materials from which stone artefacts were produced. It was thus with some knowledge of the catchment’s archaeological record from the salvage excavations and within the above research context that I began my research project in the Upper Mangrove Creek catchment.

However, I considered the data obtained from the salvage project, which was restricted principally to the storage area (i.e., the valley bottom), were a biased sample and unlikely to be representative of the evidence for Aboriginal use of the total catchment. Additional fieldwork was therefore undertaken in that part of the catchment which lies above the storage area. An intensive survey of the upper part of the catchment in a manner similar to...
that undertaken for the storage area was not practicable in terms of the finances available and time constraints, so I designed a survey program to sample the catchment.

During the course of the research project it became clear to me that the nature of the archaeological evidence available from the catchment would be far more detailed than anything that was yet recorded for the coastal/maritime zone in the NSW central or south coasts. Thus comparisons between the two zones (coast and hinterland) could not be made at the same level. Such comparative work will have to wait until a study comparable to that undertaken in the Upper Mangrove Creek catchment is carried out in the coastal zone.

It also became apparent during analyses of the data that certain quantitative changes in the catchment’s archaeological record were relevant to and had consequential implications for then current research issues relating to the interpretation and explanation of the mid- to late Holocene archaeological record in Australia (Attenbrow 1982b). These issues involved a perceived continuing increase in the numbers of sites and artefacts through time in many regions in eastern Australia, and the belief that dramatic increases in sites and artefacts were the product of dramatic population increases (e.g., Lampert and Hughes 1974; Hughes and Lampert 1982; Ross 1981, 1984; Beaton 1983, 1985). These changes also were argued to be associated with the introduction of the Small Tool Tradition, and were a principal line of evidence for advocates of intensification and/or increased sociopolitical complexity in the late Holocene (Lourandos 1983a, 1985a; Ross 1984; Williams 1985, 1987, 1988).

I considered that the chronological changes in the number of habitations established, the number of habitations used and the numbers of artefacts accumulated which I had documented in the Upper Mangrove Creek catchment were relevant to the then current models and hypotheses which incorporated population increase. Of particular relevance was the late Holocene decrease in the artefact accumulation rates which occurred in the first millennium BP in the catchment as a whole and in some individual sites. These decreases occurred during the same period as the numbers of sites inhabited and the numbers of sites established continued to increase. Changes in numbers of artefacts and sites could thus not both be indicators of population change. Also of significance was the fact that the documented quantitative changes did not necessarily all occur at the same time — dramatic increases in artefact numbers occurred in the third millennium BP, whereas they occurred in site numbers in the second and first millennia BP. In addition, the timing of these quantitative changes did not correlate with the timing of qualitative changes in the stone artefact assemblages.

Early in 1985, I altered the focus of my research. Rather than focusing on the interpretation of site/artefact distribution patterns across the catchment in a regional context, I began investigating temporal changes in quantitative aspects of the catchment’s archaeological record and the factors that may have produced such changes. Broader issues which I began to investigate at this time included how quantitative changes, particularly those pertaining to numbers of sites and artefacts, had been identified in the past in other regions of eastern Australia, as well as problems involved in interpreting and explaining the changes. These investigations highlighted the limited nature of both the data that were then available and our understanding of the ways in which changes in population numbers and different aspects of human behaviour are manifested in the archaeological record.

This monograph is based on my doctoral thesis submitted in 1987, however, some changes have been made. In addition to restructuring the presentation of some information and discussions, certain sections of the thesis as well as some tables and figures are excluded as they are not directly relevant to the monograph’s main theme. Thesis Chapter 2, in which I reviewed previous site and/or artefact distribution studies, is excluded. This chapter illustrated the type of studies that were based on spatial patterning of sites and artefacts across the land, the type of investigations that had included or had been based on site and artefact distribution studies in...
Australia, and the way in which my study was similar to and/or differed from other Australian
distribution studies. A review of sampling theory and the use of sampling in archaeological
surveys in Australia is also excluded (in thesis Chapter 4), as well as discussions on spatial
distribution patterns within the Upper Mangrove Creek catchment (in thesis Chapter 5).

Additional information has been included in the monograph to acknowledge the
numerous studies that have taken place since 1987. In addition, a further four radiocarbon
dates for sites in the catchment are included in the analyses (Chapter 6), and more recent dates
from studies carried out in regions adjacent to the catchment are referred to (Chapter 7). These
additional studies and radiocarbon dates support the findings of the thesis. The last four thesis
chapters (8 to 11) have been reordered so that the chapter about climatic and environmental
changes, which has been revised to incorporate the findings of current palaeo-ecological
studies, is now Chapter 9. Thesis Chapters 9, 10 and 11 have been rewritten as Chapters 8 and
10. The final chapter (10) now presents behavioural interpretations of the catchment habitation
and artefact indices in terms of changes over time in subsistence and mobility patterns and
risk minimisation strategies — themes that were introduced but not explored in the thesis.

Research methods — an outline

The following lines of investigation were undertaken as part of the research project and have
been presented in subsequent chapters in the following order.

- A review of interpretations and explanations proposed by other researchers during the
  1970s and 1980s for quantitative changes in the archaeological record (Chapter 2).
- Archaeological site survey and excavation in the Upper Mangrove Creek catchment. The
  aim of the fieldwork program was to retrieve evidence of the length, nature, extent and
  intensity of Aboriginal use of the catchment. The fieldwork was designed to obtain an
  unbiased (and hopefully representative) set of quantified data relating to spatial and
temporal changes in the archaeological record. The survey was carried out under a
probability sampling scheme — a stratified random sample. All excavatable sites with
archaeological deposits and a purposefully selected sample of potential archaeological
deposits in rockshelters in the random sampling units were excavated (Chapters 3 and 4).
- An examination of factors likely to have affected the archaeological record and the data
  sets which form the basis of the analyses. This examination was undertaken to establish
whether the documented spatial and temporal changes were likely to have been biased
by natural (e.g., geomorphological), methodological and/or analytical processes. It was
included so that I would be aware of, and perhaps could control for, at least some of the
biases which may have skewed the results and subsequent conclusions (Chapter 5).
- Analyses of field data from the Upper Mangrove Creek catchment. The analyses were
designed to obtain information on the spatial distribution of archaeological sites and
potential habitation sites in the catchment, as well as the timing of initial habitation and
temporal changes in the contents of each excavated habitation site. To quantify temporal
changes in the numbers of sites inhabited and the numbers of artefacts accumulated,
I calculated three indices: the rate of habitation establishment, the number of habitations
used and the rate of artefact accumulation. The latter was calculated not only for each of
the habitations, but also for the catchment as a whole and for each topographic zone.
When applied to the combined data for the whole catchment, this index is called the
local rate of artefact accumulation (Chapter 6).
• Examination of the data from several regions in eastern Australia on which explanations for quantitative changes have been and/or can be based. The reason for this examination was twofold: firstly, to examine the data on which researchers of the 1970s and 1980s had based their conclusions and, secondly, to establish whether the temporal trends documented for the Upper Mangrove Creek catchment were anomalous (Chapter 7).

• A re-examination of population-change and behavioural explanations of the 1970s and 1980s against the archaeological evidence on which they were based. This comparison indicates that simplistic relationships between numbers of sites/artefacts and numbers of people, or between artefact numbers and introduction of the ‘Small Tool Tradition’ or Bondiaian assemblages, are unlikely to describe the full complexity of a region’s prehistory (Chapter 8).

• A review of the evidence for climatic and environmental change during the Holocene and late Pleistocene in eastern Australia. Climatic and environmental change may have influenced human behaviour and thus may have been an indirect factor in producing the observed changes in the archaeological record. These discussions concentrate on the period during which the Upper Mangrove Creek catchment is known, from the archaeological evidence, to have been inhabited; that is, the last 11,000 years (Chapter 9).

• Interpretation of the Upper Mangrove Creek habitation and artefact indices based on prior models and theories relating to habitation, subsistence and mobility patterns and risk minimisation strategies (Chapter 10).

Research area

Mangrove Creek is a southerly flowing creek draining into the Hawkesbury River on the NSW central coast. The research area is the catchment of Mangrove Creek Dam, which was constructed between 1978 and 1982 to supply water for the Gosford–Wyong area. The catchment, which is 101 sq km in area, is about 80km north of Sydney Harbour (Fig. 1.1). It is north-west of Wyong, approximately 33km from the ocean shoreline and 28km north of the Hawkesbury River. Geologically, the area is part of the Hornsby Plateau of the Sydney Basin. It is heavily dissected sandstone country with a maximum elevation of about 200m. The valley floor at the dam wall has an elevation of about 25m above sea-level. Valleys are steep-sided with clifflines and small outcrops of sandstone on the ridgesides and along most of the creeks. Cliffs range up to 8m high.

The catchment was part of McPherson State Forest, except for small cleared areas of freehold along the wider parts of the valley bottoms and on the northern and eastern ridgetops adjacent to George Downes Drive. It was thus principally undeveloped land covered with eucalypt forest and woodland with rainforest species growing along the banks of less open and steep-sided gullies (Figs 1.2 to 1.4). Except for the area inundated by the dam waters, the area remains the same today.

Mangrove Creek is estuarine in its lower reaches, but within the dam catchment it is all fresh water. Estuarine conditions extend almost 10km (as the crow flies) up Mangrove Creek, i.e., about 18km from the southern end of the catchment. Tributaries in the upper parts of the catchment have been known to dry up in extremely hot weather, but even in these rare times water is available from small springs scattered throughout the catchment (pers. comm., Robert Thompson, Kulnura 1980). (For a fuller description of the catchment environment and general region see NSW Department of Public Works 1977; Benson 1978; Vinnicombe 1980; Attenbrow 1981, 1982a).
Figure 1.2  Forested land in valley bottom, looking north along Wattle Creek. Easter 1980. Photographer Val Attenbrow.

Figure 1.3  Lower slopes of forested ridgside with Black Hands Shelter in large boulder in middle distance. Easter 1978. Photographer Val Attenbrow.

Figure 1.4  Periphery ridgetop on eastern side of catchment with Sunny Shelter. August 1982. Photographer Val Attenbrow.
Previous fieldwork in the Upper Mangrove Creek catchment

The first archaeological work in the Upper Mangrove Creek catchment was undertaken in the 1960s by N. W. G. Macintosh, who recorded the art and excavated the deposit in a rockshelter known as Dingo and Horned Anthropomorph. The drawings in one part of this rockshelter are spectacular and in some respects unique (as the site’s name implies). The most interesting find in the deposit was some dark red ochre, which was said to match the colour of the drawings and which came from levels dated to 581±120 BP (GX-0070) (Macintosh 1965: 85, 96–7).

The catchment, however, became the focus of major archaeological work in the late 1970s when a dam was being built across the upper reaches of Mangrove Creek. An initial survey (Collier 1976) confirmed to the NSW NPWS the presence of Aboriginal sites in the storage area. A salvage program, to record archaeological evidence of the Aboriginal use of the area to be inundated — an area of 12 sq km — was subsequently implemented under the management of the NPWS on behalf of the NSW Department of Public Works. The salvage program included an intensive site survey of the storage (inundation) area directed by Kate Sullivan, then of the NPWS, and Louise Furey, consulting archaeologist (Furey 1978; Sullivan 1983: 7–9); detailed recording of pigment and engraved images by Ben Gunn (1979) and Leo Rivett (1980); an inspection of selected shelters with pigment images by Alan Watchman (1982); and test excavation and excavation of sites with deposits by Pat Vinnicombe and myself (Vinnicombe 1980: Chap. IX; Attenbrow 1981, 1982a, 1982b, 1982c). Geomorphological studies were undertaken by Phillip Hughes and Marjorie Sullivan (Hughes and Sullivan 1979; Hughes 1982), analyses of faunal remains by Ken Aplin and Klim Gollan (Aplin 1981; Aplin and Gollan 1982), and analyses of stone artefacts from Loggers and Deep Creek by Nicola Stern (1981, 1982). Subsequent site survey of a small area above the storage area and salvage excavation of an open archaeological deposit were undertaken by Theresa Bonhomme (1984, 1985) for additional works associated with the dam. Recently, information about all recorded open archaeological deposits in the catchment has been collated in a single report (Attenbrow 1997 [1998]).

I first became involved in the salvage excavation program in January 1978 as assistant archaeologist to Patricia Vinnicombe, who was then undertaking the North Hawkesbury Archaeological Project for NSW NPWS (Vinnicombe 1980). After the initial 1978 fieldwork seasons, it was realised that the salvage work would exceed that originally envisaged. This realisation and her existing commitment to the North Hawkesbury Archaeological Project, led Pat Vinnicombe to relinquish her position as project archaeologist for the excavation component of the salvage program and I undertook that role from mid-1978.

The salvage program, which was completed in 1982, revealed a wealth of archaeological data. Thirty-four sites were recorded: nine rockshelters with art and archaeological deposits, 17 rockshelters with archaeological deposits, two rockshelters with art, four axe grinding grooves, one open campsite and one scarred tree. For the salvage program, major excavations (between 2 sq m and 13 sq m) were carried out at four sites (Loggers, Black Hands, Mussel and Wattle Creek). Smaller areas (between 0.25 sq m and 1 sq m) were test excavated in 21 locations, 10 of which were initially recorded as potential habitation shelters; only four of the rockshelters proved to have sterile deposits.

The salvage excavations showed that use of Loggers Shelter began about 11,000 years ago. At the other sites with radiocarbon age determinations in the storage area, the age of initial habitation varies from about 8500 years to 1365 years ago. The type and amount of archaeological material in the sites also varies. Stone artefacts were present in all sites, but the number retrieved varied widely, the smallest number being five (from a test pit 0.25 sq m in area and 60cm deep). The largest number of artefacts was recovered from Loggers, where the
The highest density of artefacts (number/kilo or number/cu m of deposit), however, came from Mussel, where an area of 1 sq m with a depth of 140cm produced 14,191 artefacts (Attenbrow 1981: Tables 6.6 and 6.8). Further excavation at Mussel after submission of the 1981 salvage report showed that the cultural deposit has a total depth of 180cm and provided an earlier radiocarbon age of 8730±70 BP (SUA-2410).

The research potential of the catchment was realised not long after the salvage program began and I registered as a part-time postgraduate student at the University of Sydney in 1979. This was well before the salvage program was finished and, for the next four years, both the salvage program and the research project were carried out simultaneously within similar research frameworks. The study area for my postgraduate work, however, consisted of the total catchment — that is, the land above the storage area as well as the storage area. To differentiate between the two studies in this monograph, I refer to them as the ‘salvage program’ and the ‘research project’. The study area for the research project is referred to as ‘the Upper Mangrove Creek catchment’ or ‘the catchment’, and the area inundated by the Mangrove Creek Dam as the ‘storage area’.

For the salvage excavation reports (Attenbrow 1981, 1982b), data from the storage area only were presented and conclusions relating to use of the area were drawn on the basis of those data. In my doctoral thesis (Attenbrow 1987) and this monograph, I concentrate and base conclusions on the results of a sampling program of the total catchment, which includes land within as well as above the storage area. Some sites in the storage area also occur in the catchment sampling units and thus the ‘storage area’ and ‘catchment’ data sets are not mutually exclusive.