Water views: Water-based survey methods on Cowan Creek, New South Wales

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Abstract

A survey of shell midden sites within the Cowan Creek area, which lies to the north of Sydney, was conducted over a period of five months. The survey design was based upon a site location printout obtained from the New South Wales National Parks and Wildlife Service Aboriginal Heritage Information Management System. Due to the ruggedness of the terrain within the area, the sites were first identified from the water, and GPS was used to verify the coordinates. The location of the sites was then confirmed on foot. During the survey potential habitation sites were also examined, and a total of thirty-eight new sites containing middens, were identified and recorded for inclusion on the site register with National Parks. Recorded site density, as a result of the survey, has increased along Coal and Candle Creek from 0.5 sites /linear km, to 8.5 sites/linear km. Surface examinations of the midden deposits in this area suggest that *Trichomya hirsuta* and *Crassostrea commercialis* were strongly favoured by Aboriginal people in the past. The results of the survey indicate that the water-based survey method adopted for the purposes of this project was highly efficient in the location of sites containing middens in Cowan Creek, within a short period of time. The results also indicate that a great deal of this information is being rapidly degraded within the area, with the majority of sites displaying damage due to both natural and anthropogenic influence, despite the protection afforded by inclusion of all of these sites within a National Park.

Introduction

Shell midden analysis has been crucial to the understanding of many aspects of prehistoric life within Australia. The study of occupation sites of this type may be advantageous to a researcher for a variety of reasons. Shell, being the primary component of middens, is highly durable, which in combination with the frequent large size exhibited by many deposits, results in a highly visible source of archaeological information. The size and depth of a midden deposit may also contain a wealth of valuable archaeological material, providing chronological evidence of cultural adaptation and resource utilisation. The environment within a midden itself is generally conducive to the long-term preservation of such evidence, including faunal remains, stone tools, shell scrapers and charcoal. The structure of the midden, and the taphonomic processes involved in its deposition, also provide a rather unique representation of the environmental and cultural conditions that existed during the period of occupation. This combination of features has provided a valuable medium for study in the past, with midden analysis receiving attention from a variety of disciplines, attempting to answer questions relating to Aboriginal occupation.

In the past excavations have been performed on shell middens in order to obtain information about diet, technological adaptation, demography and social structure of prehistoric cultures. While the results of such analyses have certainly acted to broaden the knowledge and understanding within the archaeological community, in order to access this information there inevitably results in some degree of disturbance/damage to the integrity of the site or sites in question. While it may be argued that the archaeological significance of a site is based upon the information it contains, and that the only way to access this information is to excavate, it has been suggested that in many cases this has acted to reduce, rather than increase the archaeological significance of the site itself (Bowdler 1984). The basic dilemma, it would seem, is whether a site is more valuable if it remains intact, or does its value only become truly appreciated once the information it contains is examined and assessed through excavation?

In some instances the answer is simple. For example, where an impending threat exists that will lead to the total destruction and inevitable loss of the site/sites, it may be argued quite reasonably that excavation is the only course of action in order to salvage archaeological information. The most common threat to Aboriginal sites comes from the increasing pressures of industrial development and population growth. Within many coastal regions of Australia the location of Aboriginal midden sites unfortunately demonstrate a propensity to coincide with land desirable for real estate, which has resulted in the destruction and loss of many sites. Within some areas however, middens appear to have been granted a small reprieve due to their fortuitous location within the bounds of a National Park, or other area deemed unsuitable for development due to the topographic or geological nature of the terrain. Within these locations the archaeological integrity and significance of sites may remain virtually intact and undisturbed.

The New South Wales National Parks and Wildlife Service (NPWS) are the legal custodians of Aboriginal sites in New South Wales. Their most recent approach to site conservation includes a reluctance to allow any form of excavation for research purposes, on sites within some national park areas around Sydney (K. Przywolnik, NPWS pers. com.). Although this may protect the sites from the impacts of researchers, various agents of disturbance can frequently still impact upon the integrity, and thereby the significance of sites located within the national park boundaries. The NPWS are also responsible for maintaining a site register, which lists all reported sites and their location, and has often provided a useful source of information to researchers who are interested in a particular area. Attenbrow (1991) noted during her 1989/1990 survey of Aboriginal sites located within the Port Jackson area, that the information recorded on the register frequently comes

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from different sources, often resulting in variation in terms of the quality and level of information recorded for each site. The large number of sites recorded on the register would also make monitoring and assessment of the individual sites in terms of their condition, deterioration and level of preservation, virtually impossible. It was also noted during the 1989/1990 survey, that previous site recording within the Port Jackson area also displayed an imbalance in terms of the types of site that had been recorded, and the environmental zones that had received attention. This resulted in areas of the catchment that, according to the register, had either not been surveyed or contained very few sites. The consequences of such disjointed surveying and recording techniques may therefore result in a misleading and biased representation of occupation and site usage within an area.

Traditional midden analyses have been conducted using a site by site strategy, however it has been argued that the archaeological significance of a site may lie in its role within the contextual framework of the grouping of sites, or site complexes that exist in the area (Vinnicombe 1980). The implications of this are important in terms of previous and future research, and for the design and implementation of appropriate land management strategies, suitable for the conservation of archaeological and cultural heritage. Although it is impossible to protect every known Aboriginal site within a particular region, it may be more practical and beneficial (as Vinnicombe recommended in 1984:117) to preserve a small group of sites, which reflect a variety of activities within an area. The first step towards achieving this aim is to devise a suitable method to enable an assessment of the distribution, condition, and content of all sites located within a particular area.

In view of the rapidity at which information relating to many aspects of site usage has, and may continue to be lost, together with the fact that in many instances a thorough analysis through excavation may no longer be feasible, a new rapid-assessment technique is needed. In this way it may be possible to create a catalogue of information that attempts to include a representative sample of sites situated within a region, which would provide a useful aid for the identification of areas in need of protection. An appropriate technique should incorporate a re-assessment of the condition of sites previously recorded within an area, and also an intensive spot survey within other areas that apparently are devoid of sites yet display good potential, in order to fill in any 'gaps' that exist in the record. A suitable strategy should also aim towards obtaining the maximum information with minimum disturbance to the sites themselves in order to maintain their integrity. The survey method devised for the project conducted in the Cowan Creek area attempts to satisfy all of these criteria.

The study area

Cowan Creek lies at the lower end of the Hawkesbury River, and forms part of an extensive drowned river valley system located 32 km north of Sydney (see Fig. 1). It is surrounded by Ku-ring-gai Chase National Park and as such as been largely unaffected by development. The entrance to Cowan Water lies approximately 3 km from the ocean inlet at Broken Bay, and extends some 15 km in a southwestern direction. Various smaller creeks, inlets and bays exist in the Cowan Water area including Cowan Creek, Smiths Creek, Coal and Candle Creek, Jerusalem Bay, Refuge Bay and America Bay. Many natural drainage channels and small creeks also exist along its reaches and contribute the freshwater component to the environment, which is especially evident during times of heavy rainfall. Tidal influence extends to the farthest ranges of Cowan Water, with some of the smaller creeks displaying stands of mangroves and mudflats at their upper reaches. Small pockets of seagrass beds also exist within many of the bays and inlets in the area.

Due to the scenic quality of the area, it is a popular and frequently utilised stretch of water favoured by recreational visitors, especially boating and fishing enthusiasts. Despite this, due to the inaccessible nature of the terrain, combined with its characteristic poor soils associated with the sandstone environment, the area has experienced minimal impact, either during initial colonial settlement or as a result of the subsequent expanse and spread of European urbanisation. The only exception to this, and occurring prior to 1894 when Ku-ring-gai Chase was declared as a reserve for recreational use, involved the logging of some stretches of forest along Cowan Creek and Bobbin Head (Fairly 1972).

Hawkesbury sandstone predominates in the area, which weathers to produce the numerous caverns that are synonymous with the landscape within the region. Despite the associated poor sandy soils, vegetation varies from dense forest within gullies and better-watered sheltered areas to heath, scrub and woodland communities restricted to exposed regions displaying shallow poorly drained soils. Throughout most of the study area, which has not experienced bushfires since 1994, it was noted during the survey period that the groundcover was extremely thick with leaf litter, Casuarina needles and small shrubs.

Survey design and methodology

The design of an archaeological survey method that would satisfy all of the criteria set out in the project was an important factor. The survey was initially based upon a printout obtained from the NPWS sites register, also known as the Aboriginal Heritage Information Management System (AHIMS). This register contained information about the Aboriginal sites that have been recorded in the Ku-ring-gai Chase National Park since 1980, and indicated that 65 registered Aboriginal sites containing middens, were located within the boundaries of the study area. It did not provide an indication of the condition, or the rate of deterioration to the sites since they were initially recorded.

Traditionally survey strategies have been based upon a stratified surveying technique (Byrne 1984; Vinnicombe 1980). However where the terrain is rugged and inhospitable it is difficult to adhere to such predetermined strategies. Taking this into account, and for the purpose of this type of project, a different strategy was devised which was expected to yield the optimum results in terms of site location and assessment. Initially the project was based upon the location and examination of known sites, and their assessment in terms of a simple review of their condition and surface content. A sufficient strategy was therefore simply to work through the site printout and locate the sites using the specified map coordinates (given as eastings and northings), and brief description of the location and accessibility of each site.

The survey was also unusual in that the focus of the project was initially on the examination of midden sites

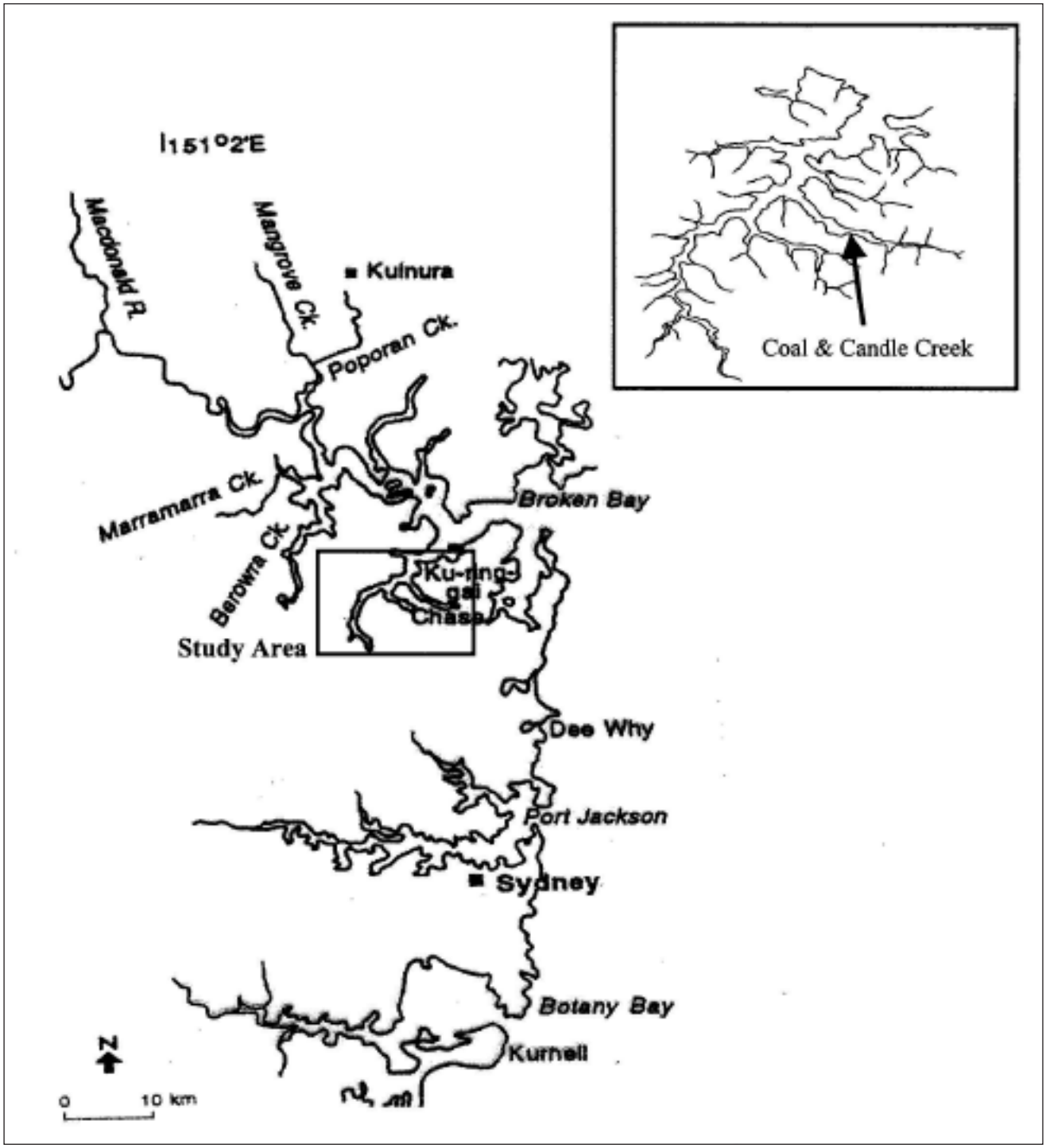

Figure 1 Location of study area and associated tributaries of the Hawkesbury River: Windsor to Broken Bay. (Source: adapted from original in Johnson 1997.)

only, which by their very definition tend to be situated within close proximity to the water, and are frequently conspicuous. As a consequence it was an advantage to conduct the survey by boat using the site coordinates, a map, and a handheld GPS. Subsequent to GPS verification that a site was within close proximity, the actual location of the site was confirmed on foot. As with many survey strategies however, what appears to be a simple procedure on paper proves to be something quite different when put into practice in the field.

The problems encountered during the survey were twofold. Firstly the nature of the terrain, which was frequently steep and covered in a dense understorey of

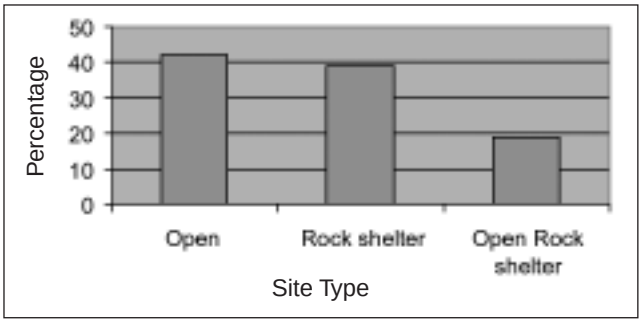

Figure 2 Site type/abundance of new sites recorded in Cowan Creek.

shrubs and leaf litter, proved to be a formidable physical impediment to site location in some areas. Secondly, many of the coordinates given for the sites on the printout tended to be inaccurate. This may be a consequence of the fact that many of the sites had been recorded during the 1980s, when the GPS system was subject to selective availability, or reflect a lack in continuity of recording methods as sites were recorded by a number of different people, and for a variety of projects. This greatly delayed the location of many sites. In some instances it was impossible, despite intensive searching of the bushland to locate some sites that were listed on the register.

Conducting the survey by boat was beneficial within this area due to the increased visibility it afforded in this type of terrain. It allowed areas to be examined for the presence of sites, which would otherwise have been almost impossible in a land-based survey. During the initial stages of surveying it became apparent that the site density in some areas differed significantly from the information suggested by the register. It became clear that where one site was listed frequently there would be others close by. As a result the technique was expanded in order to include intensive surveying for sites from the water, combined with spot checks of areas located within the vicinity of registered

Site no.	Site name	Site type	Contents
1.	Cockle Creek	RS	A, S, T, P, Ch, Bs
2.	Smiths Ck, S1	RS	A, S, T, P, Ch
3.	Cotton Tree Bay/ Cowan Ck 3	M	A, S, T,
4.	Charcoal Rock Shelter	ORS	S,T,C, Ch, Art
5.	Coal & Candle Ck, S1	OH	A, S. T,C, Ch, Bs, Us
6.	Coal & Candle Ck, S2	OH	T,C,S,A, Fl
7.	Fig Tree Pt	OH	T, S, A, C, P,
8.	Xanthorroea R.S	ORS	T, S, A, C, Ch, Us, Wa
9.	Red Fish Cave, C & C Ck	RS	T, S, C, O, Ch, Art
10.	Coal & Candle Ck, Waterfall	RS	T, S, Ch
11.	Coal & Candle Ck, S3	ORS	T, S, P, Tt, Fl, Us,Ch, Art
12.	Coal & Candle Ck, S4	RS	T, A, S, Bs, Ch
13.	Coal & Candle Ck, S5	ORS	A, T, S, P, Ch
14.	Coal & Candle Ck, S6	RS	S, C, T,A, Bs, Ch
15.	Coal & Candle Ck, S7	RS	A, S, T, C, Us, Ch
16.	Mangrove Midden	OM	A, P, S, T, Ch
17.	Coal & Candle Ck, S8	ORS	A, S, P, T, C, Fl, Ws
18.	Halletts Beach S1	RS/M	A, S, T, C, B, St, Ch
19.	Coal & Candle Ck, OS1	OM	A,S,T,C
20.	Coal & Candle Ck, OS2	OM	A,S,T,C
21.	Coal & Candle Ck, OS3	OM	A,S,T,C
22.	Sandy Bay 1	OM	A,S,T,C
23.	Sandy Bay 2	OM	S,T,C, Ch
24.	Coal & Candle Ck, OS4	OM	S,T
25.	Coal & Candle Ck, OS5	OM	A,T,S,C, Ch
26.	Coal & Candle Ck, OS6	OM	T,S,C, Ch
27.	Coal & Candle Ck, OS7	OM	T,S,C,A,Ch
28.	Coal & Candle Ck, OS8	RS	T,S,C,Ch
29.	Coal & Candle Ck, OS9	OM	T,S,A,P,Ch, Us
30.	Coal & Candle Ck, RS1	ORS	T,S,A,C,P,Ch, Art
31.	Coal & Candle Ck, RS2	ORS	T,S,Ch, Art
32.	Coal & Candle Ck, RS3	RS	T,S,C, Ch
33.	Coal & Candle Ck, OS10	OM	T,S,P,A,C, Ch
34.	Coal & Candle Ck, OS11	OM	T,S,C,A, Ch
35.	Coal & Candle Ck, RS4	RS	T,S,C, Ch,Us
36.	Coal & Candle Ck, RS5	ORS	T,S,A,C, St, Fl
37.	Coal & Candle Ck, RS6	ORS	T,C,S, Ch
38.	Midden Point	OM	T,A,C,S

Key to symbols

RS – rock shelter	OH – overhang	ORS – open rock shelter
OM – open midden	Art – drawings	A – *Anadara trapezia*
P – *Pyrazus ebeninus*	T – *Trichomya hirsuta*	C – *Chama fibula*
S – *Saccostrea commercialis*	Ch – charcoal	O – ochre
Bs – burnt shell	St – stone artefact	Fl – stone flake/s
Us – utilised shell	Ws – worked stone	

Table 1 Sites recorded during the survey in the Cowan Creek area, New South Wales.

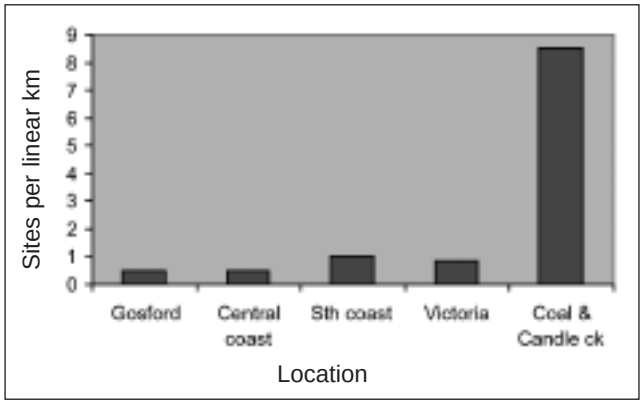

Figure 3 Comparison of site density with other areas along the Australian coast.
Note: this information compiled from Coutts et al. (cited in Vinnicombe 1980); Stockton 1972, 1977; Sullivan 1976; Vinnicombe 1980.

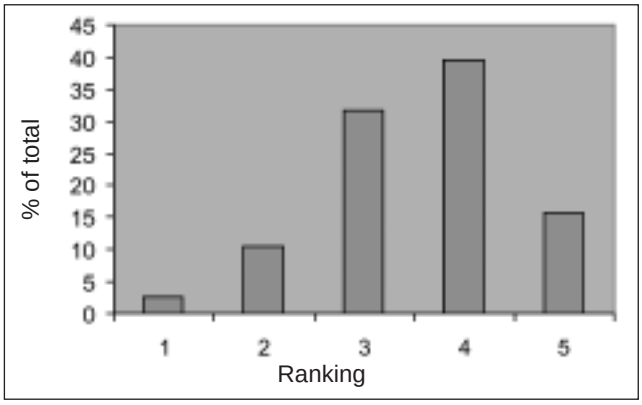

Figure 4 Site condition recorded during the survey in the Cowan Creek area.

Key to ranking system:

1 >80% intact: majority of midden undisturbed and displaying good preservation
2 60-80% intact: good preservation with large areas intact
3 40-60% intact: some areas eroded/degraded, but with pockets of intact shells visible in places
4 20-40% intact: majority of surface highly fragmented/eroded, some small patches intact
5 0-20% intact: little/no intact shells evident, generally midden composed of grey powdery substrate with isolated larger shell fragments visible

sites. In this way the register provided an indicator of both the location in which sites were known to occur, and also areas in which sites were likely to be found. One area that particularly stood out in terms of an apparent dearth of sites already identified was Coal and Candle Creek, with only two sites listed on the register. Ultimately this area, which provided an environment that was favourable for Aboriginal occupation in terms of resource availability and habitable rockshelters, proved to be a focus for site surveying (see Fig. 1 for location).

Once located, the condition of each site was assessed according to its level of preservation, species composition and integrity. The level of preservation was estimated according to the percentage of intact shells evident on the surface. A determination of species composition was made according to the number of intact and/or identifiable fragments present within a subjectively selected 30 cm square. Site integrity and condition was assessed according to the proportion of the site as a whole that displayed disturbance or degeneration, and where possible included the nature of the cause, such as trampling, digging or erosion. For the purposes of this survey, midden locations were classified as either open, within rock shelters, or open rock shelters. This third category was necessary in order to discriminate between middens identified within rock shelters and those situated under rock overhangs of less than 1 metre (measured from the rear of the shelter).

Results

The survey, due to the constraints of time, was limited to one day per week over a period of five months, with the surveying team comprising three people (one person driving the boat and two people surveying). During this time 60 out of the registered 65 sites were located and examined, and 38 new sites were identified and recorded (Table 1). The survey included an assessment of potential habitation sites, primarily sandstone rock shelters which were numerous and commonly associated with this type of environment due to natural weathering processes. The identification of these sites was based on an inspection of the shelter floor for any visible signs of occupation, including faunal remains, artefacts, manuports, or the presence of art on the rock walls. The majority of the newly identified sites were located along the eastern side of Coal and Candle Creek (western side not surveyed), and included rockshelters with art and shell middens, open middens and rockshelters containing artefacts. The most abundant occupation site type that was identified during the survey was open midden sites (42%), followed by rock shelters containing midden deposit (see Fig. 2). This may be a consequence of Aboriginal site selection and usage within the area, or simply a reflection of preferential visibility. Site density was calculated along Coal & Candle Creek, and yielded a density of 8.5 sites per linear km, which is very high compared to the results obtained from other studies along the Australian coast (Fig. 3). This may be due to a higher level of site preservation in this area compared to other regions that have experienced a greater level of impact from urban development. Most of the sites were located within 20 m of high tide, with the exception of one large rock overhang displaying numerous charcoal drawings, which was situated approximately 100 m above the water level. Although accurate measurements of depth were not practicable for the purposes of this survey, estimates were made and indicated that the majority of middens (70%) displayed a deposit depth >30 cm. The majority of new sites displaying good preservation and integrity were located within rockshelters or shallow rock overhangs, with open midden sites generally evidencing a greater level of disturbance and erosion.

Many of the sites that were located and examined showed some degree of disturbance. The types of disturbance varied from site to site, but included the impact of animals (including humans) digging holes into the deposit, trampling of the surface, gullying due to natural drainage through the deposit, bioturbation caused by the

growth of plants, and the erosional impacts of wave action. Each of the sites was assessed for damage and subsequently assigned a ranking between 1 to 5 according to their level of preservation and integrity based upon an examination of the surface. A rank of 1 given to a site indicates the highest level of integrity, and 5 the lowest (see Fig. 4). The majority of sites recorded during this survey appeared to be in a poor condition, with most assigned a ranking of three or more. Despite the apparent poor condition displayed by many sites within this area, their potential in terms of further archaeological work, and from a cultural heritage value, is not refuted. This is due to the fact that although the general condition of a site may be poor, frequently 'pockets' of relatively intact or undisturbed midden material remain within many of the rockshelter sites that were examined, offering an opportunity for more detailed analysis.

Species composition and midden contents

The co-dominant shellfish species based on the surface counts of the middens in the study area, were the Sydney rock oyster (*Saccostrea commercialis*) and the Hairy mussel (*Trichomya hirsuta*). Other species that were identified but occurred in lesser amounts within the deposits were the whelk (*Pyrazus ebeninus*), Sydney cockle (*Anadara trapezia*), and Spiny oyster (*Chama fibula)*. Each of these species is commonly represented within midden deposits around Sydney and are strongly associated with an estuarine environment. This may indicate that similar conditions have persisted within the area throughout the last occupational period. Individual broken specimens of the giant turban shell *Turbo torquatus*, were also identified at two sites. This is not an estuarine species, and must have been transported from its rocky shore habitat situated around Broken Bay. Its presence may be suggestive of fish-hook production occurring at these sites, with other midden studies indicating it was a species commonly chosen for this purpose (Attenbrow 2002:119).

Although the majority of the archaeological material identified was shell, some stone artefacts were also noted, including numerous chert flakes, a basalt pebble tool, and a shaped and utilised *Xanthorroea* flower stalk (possibly part of a fishing spear), together with several *Anadara* shells displaying use-wear. This suggests that tool manufacture and maintenance was occurring at many of the sites, and may be indicative of 'base camp' as opposed to 'dinner-time' (Meehan 1982) site usage in some areas. Most of the art observed during the survey was in the form of charcoal drawings, some of which were hard to distinguish with any degree of certainty due to erosion. One exception to this was a large red ochre fish that was painted on the wall of a small rockshelter (with the piece of ochre rock used for the drawing still in situ). Axe grinding grooves were also noted, and although not abundant in the area tended to occur close to the shoreline, within close proximity to some of the sites. This low number may be a reflection of the limited distribution of sandstone exhibiting a grain size conducive to grinding within the study area.

Discussion

The Cowan Creek area contains a rich and varied collection of Aboriginal sites, displaying a great deal of information relating to the resource utilisation and subsistence strategies adopted by the Aboriginal people who have inhabited the area The density of sites observed, together with the apparent depth of many midden deposits recorded during the survey along Coal and Candle Creek, will greatly enhance the level of information on the site register, with the results of this survey indicating that this was a location strongly favoured for occupation in the past. This may be due to the combination of abundant and accessible resources, together with the prevalence of suitable inhabitable rock shelters within the area. Whether or not this was a region that was occupied intensively over a short period of time, or sporadically over a longer time period is open to conjecture, and is difficult to determine without excavation. The material accumulated, together with the size and depth displayed by many of the deposits, may be interpreted as an indication that occupation patterns in this area varied. The evidence is supportive of both short-term visits, during which perhaps only a single meal of shellfish was consumed, to more long-term campsites that displayed evidence of a variety of activities taking place during periods of occupation.

The information available from ethnohistorical accounts supports the archaeological evidence for Aboriginal occupation in this region. During Governor Phillips exploration of Broken Bay and its surrounding waterways in March 1788, both written accounts and painted scenes of the area, indicate a large Aboriginal presence during this time. By June 1789 however, Phillips accounts also attest to the decimation wrought upon the local Aboriginal people in this region due to the impact of smallpox, and resulting in few sightings of 'live natives' during his second excursion (Champion 1990). Although this may provide an indication of the last time that the area was occupied by a relatively large number of Aborigines, it has been suggested that people were still living in a traditional manner in the vicinity up until the early 1900s (Jacobs 2003:59; Read 2000:24-25). The archaeological material still visible upon the surface of the middens today could therefore be occupational debris deposited anywhere between late eighteenth to early twentieth century. Although some of the material was also indicative of European visitation, and included glass and plastic bottles, and other forms of litter, the shellfish remains evident throughout many of the deposits are consistent with Aboriginal usage of sites within this area extending to the uppermost layers.

The middens indicate that the favoured shellfish species for collection include rock oyster and the hairy mussel, which must it seems, have been abundant in the past based on the quantities present in the deposits. Although rock oysters are still prolific, and are obvious in their domination of the rocks along the high water line, the hairy mussel appears to be more cryptic. Isolated individuals were located growing interspersed between the densely packed oyster shells, but diving indicated that they were also present at the sub-littoral level, where they formed clumps on the soft sediment. With this in mind, and if the 'time-distance' factor often associated with gathering strategies is invoked (Bailey, 1975), together with the often large quantities that are evident within many of the deposits, it seems likely that the 'clumps' would have been favoured for collection by Aboriginal people camping in the area. A suitable collection strategy therefore may have been to dive into the water, either from canoes or the shoreline (which is extremely steep and rocky in many places), in order to gather this mussel. Alternatively at low tide and during periods of low visibility a similar strategy may have been

adopted to that utilised by the Anbarra women in their collection of oysters attached to mangrove roots in the Northern Territory. This involves the women wading into the water and using their feet to 'feel' around in the sediment in order to locate clusters of shellfish prior to diving down to retrieve them (see Meehan 1982:100).

In the past there has been a great deal of debate concerning the observation of large amounts of mussel remains within archaeological deposits (Bowdler 1976; Sullivan 1987; Mackay and White 1987). Although the focus has generally been on the common mussel (*Mytilus edulis)*, and the associated social implications of its presence and the introduction and adoption of hook and line fishing, the question remains as to why Trichomya has not received similar attention? Although *Mytilus* was not observed within any of the middens in this particular area, it is reasonable, due to the similar environments occupied by these two species, to evoke a similar argument to that proposed by Bowdler and Sullivan, in that the increases of mussel remains observed within these midden deposits may be indicative of the introduction of fishing with hooks and lines. The abundance of *Trichomya* observed within the deposits may indicate a change in collection strategies as a consequence of the introduction, and increasing popularity of hook and line fishing. The presence of large pieces of the Turban shell (*Turbo torquatus*), found on the surface of two deposits (one at Coal and Candle Creek, the other at Smiths Creek) may be supportive of this hypothesis, and attest to the fact that the manufacture of shellfish hooks was taking place in this area. Ethnohistorical accounts also provide supportive evidence of fish-hook production occurring in the area, with William Bradley clearly documenting an Aboriginal woman demonstrating how the hooks were fashioned out of 'pearl' shell, during his visit to Broken Bay in the late 1700s (Bradley 1786-92: cited in Attenbrow 2002:118). Alternatively, and in association with the 'fishing hypothesis', *Trichomya* may also have been collected and used as bait, a suggestion that was initially proposed by Sullivan (1987), in reference to the late occurrence and abundance of *Mytilus* within other deposits. Although the small number of Turban shell pieces observed is not suggestive of large-scale hook manufacture taking place, other evidence, including the shaped Xanthorrhoea flower stem (possibly part of a fishing spear) and the ochre fish drawing, does imply that fish were an important resource for the Aboriginal people occupying the area. In order to clarify the role played by fish and shellfish for the people that occupied this area, it is important that a more detailed examination of the midden material be conducted in the future, however this may only be achieved through excavation. Perhaps, in order to minimise the impact of such an investigation, excavations could be limited to the removal of column samples, which will enable a determination of the presence/abundance of fish remains, and shellfish-hooks to be made.

Although only a quarter of the rockshelters examined during the survey showed evidence of art, mostly charcoal drawings, this was consistent with other studies in the region (McDonald 1992; Vinnicombe 1980). The images depicted were often fragmented and eroded, which made them difficult to interpret. However, andropomorphic figures, marine animals and weapons were images decipherable at some shelters. The most easily identifiable image was that of a large fish, measuring 33 cm in length and drawn in red ochre on the rock wall of a small rockshelter situated along Coal and Candle Ck. Although the image was clear it was not possible to identify to the species level, and the purpose behind the drawing is open to conjecture. This, and the other faunal images that are depicted, may have totemic implications, or more simply were created in order to demonstrate the suitability of the shelter and its proximity to particular resources, as a guide for future occupation.

Conclusion

This survey has produced a dramatic increase in the number of sites along Coal and Candle Creek from the previously recorded 0.5 to 8.5 sites per linear kilometre of the creek. Other research on site density along the east coast of Australia would suggest that this level of density is unusually high. For example, slightly to the north of this study area in the Gosford-Wyong region, Pat Vinnicombe surveyed for sites along a 2 km transect of coastline, and determined a site density of 0.5 sites/linear km (1980). This was also in keeping with Stockton's work on the Central Coast (1972, 1977) which indicated a site density in this area of 0.51 sites/linear km. Sullivan (1976) calculated 1.0 sites/linear km associated with sandstone environments during work in the South coast, and 0.85 sites/linear km on the Victorian coast (Coutts et al cited in Vinnicombe 1980). There are many plausible explanations to account for this apparent variation. Firstly, the high site density observed in this area may simply be due to a pattern of intense Aboriginal occupation and utilisation of the region over a period of time. It is perhaps more plausible to suggest that the lower densities observed in other areas is a reflection of the loss of sites due to the impacts of urbanisation and development. This study area, which, due to its inhospitable and rugged nature, appears to have experienced very little such impact, and could therefore provide a more accurate depiction of the site density that existed in other areas prior to the expanse of European settlement. Site visibility and location in this area may have been enhanced due to the nature of the terrain, which is open forested with rocky outcrops extending down to the water line, combined with the preponderance of sites within close proximity to the water. The survey technique adopted here could also be beneficial for other researchers to adopt, enabling the coverage and examination of large areas that would otherwise be inaccessible, and result in the maximum site identification suited to this type of environment. The high density of sites identified in this study may be attributed to one or more of these factors, however it is undeniable that the absence of development and cultivation within the immediate area is a significant factor.

The methods adopted for this survey achieved the initial aims of the project, in that a large number of sites were located and examined within the study area, over a relatively short period of time. The results of the survey indicate that this area contains a wealth of information reflecting a variety of Aboriginal social and economic activity. The results also suggest that the majority of both registered and newly recorded sites within the Cowan Creek area appear to display a disturbing level of degradation. This is despite the protection afforded by their inclusion within the bounds of a National Park. Although open midden sites by their very location are more vulnerable, and therefore generally display the greatest level of degeneration caused

by both natural and anthropogenic means, there are also many sites within rockshelters that appear to be suffering damage due to the impacts of fossickers and 'day-trippers'. Although it may be impossible (given the magnitude of the area) for management strategies to be implemented for all of the Aboriginal sites, it is important that the significance of the sites within Cowan Creek and other areas around Sydney, be thoroughly assessed and recorded, before this valuable source of information becomes irretrievably lost.

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