



Late Holocene hunting economies in coastal southeastern Australia: Insights from the archaeological fauna of Curracurrang 1 Rockshelter, Royal National Park

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ABSTRACT

Curracurrang 1 (1CU5) is a rockshelter site located in the Royal National Park (RNP) on the coast south of Sydney. Excavated from 1962 to 1966, the site's rich Holocene cultural deposit has become important for understanding regional Late Holocene developments in Australian lithic and shell technologies. Our comprehensive analysis of 1CU5's faunal remains is presented here, accompanied by new AMS radiocarbon dates and a reinterpretation of the site's occupation sequence. Much of the midden deposit spans from about 2500 BP to approximately 1850 AD, rather than only the last ~1500 years as originally believed based on less comprehensive dating. A wide range of terrestrial and marine fauna were exploited at 1CU5, with the relative importance of the latter group increasing within the last ~1500 years. Greater fish consumption during the later period may relate to use of novel hook and line fishing technology using hooks made from shellfish, but concurrent increases in seals, seabirds and marine invertebrates suggest a broader increased reliance on marine resources. By comparison, the earlier period, which coincides with the manufacture of backed microliths, displays relatively greater reliance on terrestrial marsupials. Taxonomic representation suggests occupation of the shelter from winter through spring, and potentially into summer. Analysis of the 1CU5 fauna marks an important contribution to the understanding of Late Holocene economies at the interface of the greater Sydney and NSW South Coast cultural and biogeographic regions.

Keywords: Curracurrang, coastal, Australia, hunting, Holocene, aboriginal, marine, fishing

RESUME

Curracurrang 1 (1CU5) est un site d'abri sous roche situé sur la côte au sud de Sydney, dans le Royal National Park (RNP). Fouillé entre 1962 et 1966, les riches dépôts culturels Holocène du site sont devenus d'importants référents pour comprendre les développements régionaux de la fin de l'Holocène en rapport avec les technologies lithiques et coquillières australiennes. Notre analyse complète des restes fauniques de 1CU5 est présentée ici, accompagnée de nouvelles datations radiocarbones par AMS et d'une réinterprétation de la séquence d'occupation du site. Une grande partie du dépôt d'amas coquillier s'étend d'environ 2 500 BP à environ 1 850 après JC, plutôt que de dater seulement des 1 500 dernières années, comme supposé précédemment sur la base de datations moins complètes. Un large éventail de faune terrestre et marine a été exploité à 1CU5, l'importance relative de ce dernier groupe ayant augmenté au cours des ~1 500 dernières années. L'augmentation de la consommation de poisson au cours de la période la plus récente peut être liée à l'utilisation de nouvelles technologies de pêche à la ligne et à l'hameçon utilisant des hameçons fabriqués à partir de coquillages. Cependant, l'augmentation simultanée de restes de phoques, d'oiseaux de mer et d'invertébrés marins suggère une dépendance accrue à l'égard des ressources marines en général. En comparaison, la période antérieure, qui coïncide avec la fabrication de microlithes à dos, montre une dépendance relativement plus grande à l'égard des marsupiaux terrestres. La représentation taxonomique suggère une occupation de l'abri de l'hiver au printemps, et potentiellement jusqu'en été. L'analyse de la faune du site 1CU5 représente une contribution importante à la compréhension des économies de l'Holocène tardif à l'interface des régions culturelles et biogéographiques du grand Sydney et de la côte sud de la Nouvelle-Galles du Sud (NSW).

Mots-clés: Curracurrang, Côtier, Australie, Chasse, Holocène, Aborigène, Marina, Pêche

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INTRODUCTION

The economies of Aboriginal people living in the coastal and near-coastal regions of southeastern Australia have been of interest to international scholarship since the first European settlement in the late eighteenth century AD. Several members of the early Sydney colony, and its expanding settlements, made reasonably detailed descriptions of the animal species that were targeted for food by the local Aboriginal people and the technological means by which they were obtained (Attenbrow, 2011; Organ, 1990). Generally speaking, for coastal peoples these describe a subsistence strategy heavily oriented around the exploitation of marine resources, particularly fish, shellfish and crustacea (Attenbrow, 2011) with a distinct lack of focus on large terrestrial mammals and only occasional use of birds and reptiles. By contrast, groups occupying the hinterlands, appear to have concentrated on terrestrial mammals, birds, and freshwater fish (Attenbrow, 2010a). Since then, understandings of Australian southeastern coastal economies have been augmented by growing documentation of the oral histories and knowledges of traditional owners of the coastal Sydney area (Wesson, 2005).

Knowledge of these economies has also been extended into antiquity through the excavation of numerous archaeological sites in the areas in southern Sydney, the Kurnell Peninsula, and the Royal National Park to the south, taking place since as early as the late nineteenth century (Attenbrow, 2010b, 2011, 2012; Harper, 1899). Comparisons of archaeological faunal materials from these sites with the range of taxa reported as traditional foods by observers of traditional Aboriginal societies in and around the Sydney colony from 1788 AD onwards, largely confirm the importance of marine fish and molluscs in the local diet, but have also noted the archaeological presence of many species not recorded in European colonial observations (such as terrestrial marsupials, seals and seabirds), and conversely, the archaeological absence or extreme rarity of many taxa of historical import (such as fruit bats and crustacea) (Attenbrow, 2010a, 2010b, 2011, 2012).

The value of archaeological fauna in understanding economic strategies and human diets in this region is therefore significant, in that it informs beyond the limitations of a handful of historical records. However, the scope for either historical records or existing archaeological reports to inform on the diet of coastal people in the greater NSW southeast coast region has been in some respects quite limited. Attenbrow (2010b, p. 73) notes that it has not been possible to interpret chronological trends in the composition of dietary fauna in the greater Sydney region, either in taxonomic range or in relative representation frequencies, because all described assemblages from this area are too small and incomplete. Although bone is often better preserved on the NSW South Coast than the Sydney region, much of it is also limited chronologically to the last millennium.

Attenbrow (2010b, p. 71) notes further that understanding the diet of Aboriginal groups in the coastal fringe of the greater Sydney region and its surrounds has been hampered by the fact that most of its largest excavated faunal assemblages have not been systematically analysed. One of these sites, Curracurrang 1, also known as 1CU5, was excavated almost 60 years ago, but its very large faunal assemblage has since remained uncharacterised beyond a very brief list of taxa identified at the time of excavation (Megaw, 1965, 1968). Here, we present the first systematic zooarchaeological analysis of 1CU5's faunal remains, concentrating on the vertebrate material, which offers a unique insight into the animal procurement strategies of Dharawal and regional Aboriginal people over the last three millennia. We discuss the findings in relation to current discourse concerning models of Late Holocene economies in Australia.

Site setting, excavations and original interpretation of occupational sequence

1CU5 is part of an occupational rockshelter and cave site complex on the coast of the Royal National Park (RNP), located immediately to the south of the greater Sydney region (Figure 1). The RNP is a part of the traditional country of the Dharawal people, which reaches from coastal Sydney in the north, to the Shoalhaven River in the south, and west as far as the Appin or Camden areas. 1CU5 was identified by Megaw as the site within this complex with the largest midden deposit, and after initial excavations, as the site with the greatest occupational antiquity. It has therefore made one of the greatest contributions to understanding of pre-Contact economies in the RNP, but research which to date has focused on the site's lithic, bone and shell technologies (Attenbrow, 2012).

The rockshelter is approximately 150 m from the water's edge. Its immediate surroundings are coastal heath and scrub, which slope to a small inlet fringed by rocky shore at the base of steep cliffs (Figure 2). However, the RNP otherwise contains very diverse habitats within a few kilometres of 1CU5, including littoral rainforest, wet and dry sclerophyll forests, maritime grassland, freshwater heath swamp/sedgeland, lagoons, beaches, coastal swamp, estuary and mangrove forests (DECCW, 2011). The coastal swamp, estuarine and mangrove environments are mostly limited to the northern edge of the RNP where the Hacking River empties into the sea (Port Hacking), and where several archaeological sites are known (Attenbrow, 2010a, 2012). It seems unlikely that local people utilising these environs would have transported large amounts of resources from these habitats to the Curracurrang site complex, which sits over 7 km away. There is however a small brackish lagoon within 1.5 km of 1CU5 at Wattamolla which houses some estuarine fish species such as flathead (Platycephalidae).

The excavation of 1CU5 took place over three summer field seasons between 1962 and 1966, directed by Vincent Megaw of the University of Sydney's Department of Archaeology. Between these three seasons the recording

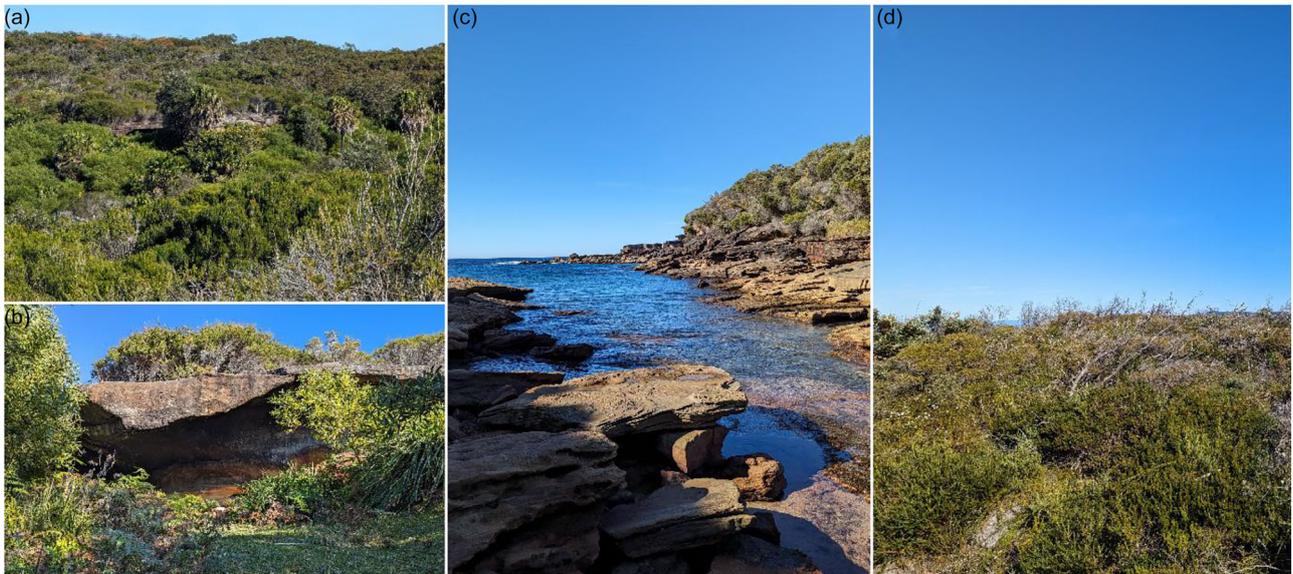
FIGURE 1. +Curracurrang rockshelter. (a) Location of Sydney region in southeastern Australia; (b) location of Curracurrang within the Sydney region.



notation for excavation units used by the excavators changed, rendering the context and relationships of the resulting archaeological materials very difficult to interpret. It is therefore necessary to briefly describe the excavation methods, and the occupational sequence and depositional units observed at 1CU5 as understood from the original field notes. All archaeological materials and archival materials are now housed at the Australian Museum, Sydney.

The first season of work excavated seven test pits in a west-east transect extending from the deepest part of the rockshelter enclosed by the overhang to the bottom of the slope; these pits were designated CU/5 to CU/35 (Figure 3). The excavated strata were based on Megaw’s interpretation of culturally significant depositional units and, with very few exceptions, all excavated material from a single “unit” within a given test square was lumped together in storage. The identified units were, from surface to base, named

FIGURE 2. 1CU5 Rockshelter and adjacent RNP environments, in 2023. (a) View of 1CU5 from the north; (b) main part of rockshelter overhang amidst scrub; (c) rocky shore at Curracurrang Cove inlet; (d) coastal heath on cliffs around Curracurrang.



“Midden”, “Bondaian” and “Lowest”. Disturbances to some of the deposit within the overhang (Squares CU/5 and CU/10), caused by the activities of earlier campers and amateur artefact-collectors necessitated a “disturbed” sub-category from the upper part of the “Midden” units for these test squares.

Having identified the site’s basic cultural phases, subsequent field seasons excavated most of the rest of the deposit within the rockshelter overhang, and much of the midden immediately beyond the dripline on the slope of the hill. These second and third field seasons no longer bulk excavated entire depositional units but used arbitrary spit-depths. As such, in these seasons excavation unit (XU) numbers were assigned in ascending order based on the sequential position of the square within the planned grid (Figure 3), and the spit. For instance, XU 1 corresponds to Spit 1 of Square 1, whilst XU 24 corresponds to Spit 2 of Square 9, and XU 32 to Spit 3 of Square 2. As all squares were not excavated to the same depth, and as the square sequence skips numbers, this system proved impossible to accurately interpret without reference to an unpublished spit key contained with Megaw’s original field notes. A list of XU names and their corresponding Spit, Square and sedimentary contexts can be found in Table S1.

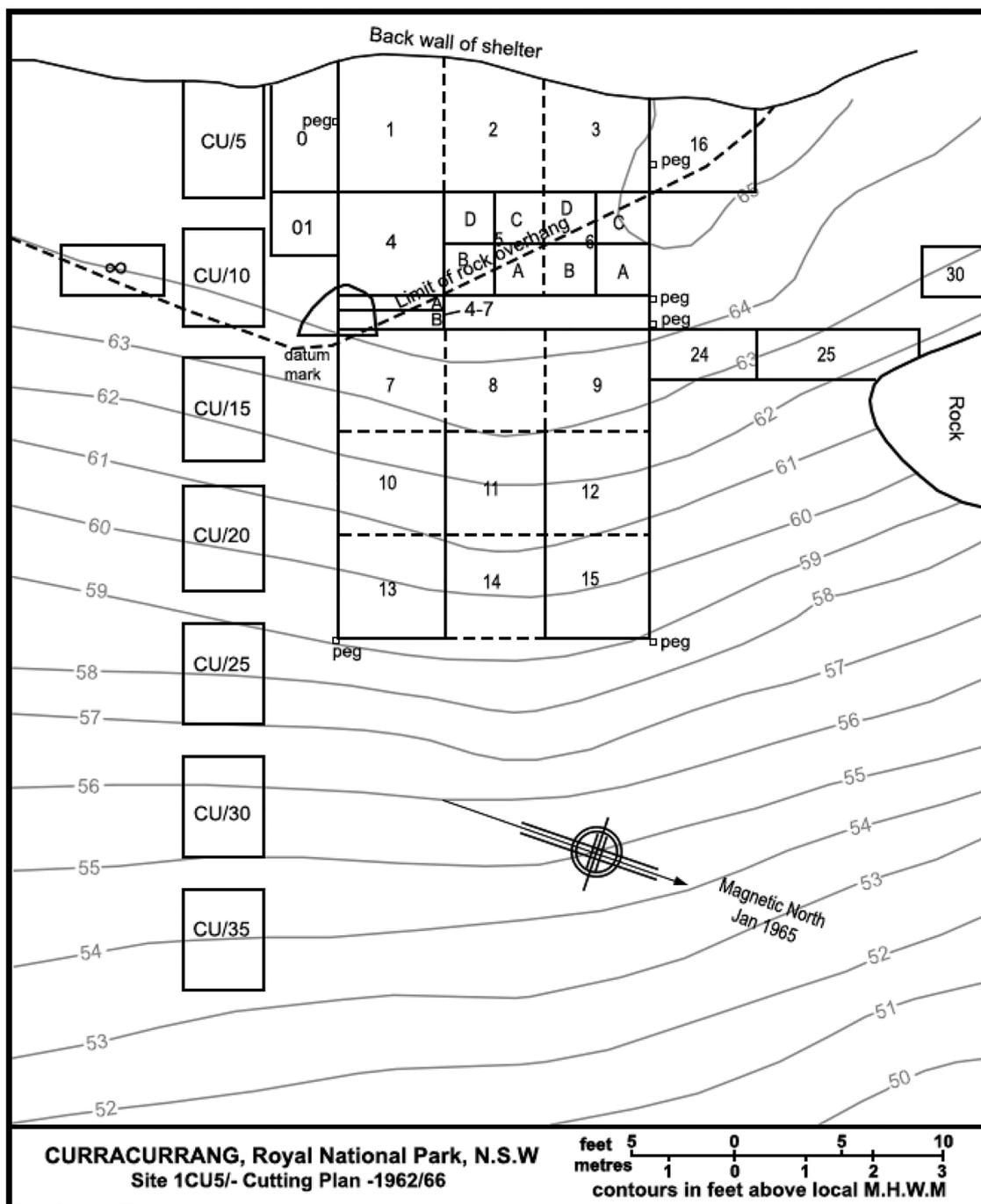
With radiocarbon dates from the first season’s test pits, Megaw (1965) identified an occupational sequence for 1CU5, which was closely adhered to in subsequent publications after more dates were produced from the later excavations (Megaw & Branagan, 1969; Megaw, 1968). Here we discuss Megaw’s original dates alongside their present calibrated ranges produced in OxCal with the SHCal20 calibration curve (Hogg et al., 2020). The earliest occupation unit of 1CU5 contained a “large primary flake

and pebble-tool” assemblage with associated charcoal dating to the early Middle Holocene (8591–7869 calBP; 7450 ± 180 BP; GaK-482) through to the early Late Holocene (3556–1586 calBP; 2500 ± 400 BP, GaK-895). The sedimentary context associated with this unit was a yellow clay and eroded sand from the underlying (sandstone) bedrock (Megaw 1965). Observing similarities with the earliest lithic industries retrieved from McCarthy’s (1964) excavations elsewhere in eastern Australia, Megaw termed his “bottom” industry “Capertian” (Megaw, 1968).

Directly above the “Capertian” layer was a unit of black sandy soil, which produced hundreds of backed artefacts – Bondi points and geometric microliths – in addition to ground-edged axes, burins and fabricators (Megaw, 1968, pp. 326–327). Again, referring to McCarthy, Megaw termed this unit “Bondaian”. Despite abundant lithics, and this unit comprising the most extensive area of occupation at the site, it was noted that very little to no faunal or other organic remains were retrieved from the Bondaian unit. It is possible that this indicates use of the site for lithic manufacture rather than food processing during the Bondaian period, but as with the Capertian, it was explained as a simple differential preservation issue attributable to increasing acidity from the surface to the base of the deposit (Megaw 1965, p. 203).

Above the Bondaian was a thick midden unit, which in most squares constitutes the greatest portion (by depth) of the deposit. Megaw (1968, p. 326) notes that the midden built up in two discernible stages, and unpublished section drawings from the field notes divide the midden material into an upper “loose banded midden” and lower “coarse midden” layer. Some sections show a third “fine shelly midden” or “crinkly shell” layer directly between the coarse

FIGURE 3. 1CU5 site plan, redrawn from Branagan and Megaw (1969).



midden and black sediment units. This is generally very thin and seems to closely follow the margins of underlying black sediment, even vertically. It is not clear whether it constitutes a separate (depositional) layer or is only the lowest part of the coarse midden unit which has been broken and compressed by the weight of overlying sediment/trampling. At present we favour the latter explanation.

Megaw (1968, p. 326) observed that midden material had seemingly built up within a large pit, dug by the site's

occupants in antiquity into the older sediments that predominantly lay within the rockshelter overhang, specifically closest to the back wall in the deepest part of the overhang (i.e., the most sheltered area). Megaw's unpublished section drawings from the excavation show that this pit contains most of the younger "loose" midden material, and lies within the excavated Squares CU/5, CU/10, 0, 01, 1, 4, 5 and 6 (Figure 2). It appears to have been dug into the "Bondaian" black sand/soil and the "coarse" midden, which we now understand to be

contemporary (see radiocarbon chronology below), and which only remains in these squares in spits well below the surface; whereas further down the slope (e.g., Squares 10–15) it was found at or just below surface level. Megaw (1968, p. 326) suggested the pit was dug to remove occupational debris and rockfall accumulations or to create a windbreak. Both options are viable if the hearths in this area of the shelter were used both for cooking and for warmth at night, leading to buildup of faunal waste in the living space which had to be cleared out. Very similar pit-digging into “Bondaian” sediment layers was also noted at other rockshelters in the Curracurrang site complex, such as 2CU5 (Glover, 1974).

A significant technological shift was discerned by the excavators between the Bondaian and midden units. Ground-edge axes continued to be produced but the manufacture of microliths ceased entirely (Megaw, 1968, p. 326). They were replaced by simple scrapers and greater proportions of eloueras (a larger, thicker type of backed artefact generally considered to function as adzes) and fabricators than observed in the Bondaian unit. In addition, the vast majority of 1CU5’s worked bone implements (predominantly points and barbs for fishing spears) came from the midden layer, as did its shell fish-hook industry. The latter, in particular, appears to have come from the upper midden of the test square CU/15 (Attenbrow, 2010a, p. 28).

Megaw noted that the midden “comprises mainly marine shell – with limpets (Patellidae) and nerites (Neritidae) predominating” (1968, p. 326), and his unpublished section drawings also indicate that the lower “coarse” midden featured large abalone shells (Haliotidae). Unfortunately, it appears that very little of the shell material from 1CU5 was kept and deposited at the Australian Museum. Aside from occasional small fragments which evaded the initial sorting processes, what little remains of the shell are those pieces believed to be part of the site’s shell fish-hook manufacturing sequence (Attenbrow, 2012), and a very small sample of some preliminarily identified molluscan taxa from the south faces of Squares 0 and 01. For this reason, no quantitative data could be presented on the shellfish aspect of the site’s economy in the present study. The remaining faunal materials are nearly entirely fish, mammal and bird bone, with a much smaller proportion of other marine invertebrates. To understand variation in subsistence at 1CU5 it is essential to first review the evidence for this site’s chronology.

Radiocarbon chronology, new dates and sequence reinterpretation

The timing of the Bondaian occupation period and the nature of its relationship to the Midden unit are complex issues and require specific consideration. Broadly speaking, Megaw (1965, 1968) interpreted the Midden excavation unit as marking a distinct period of occupation after the Bondaian. Charcoal samples from Bondaian excavation units produced dates ranging between 2360 ± 90 BP (2705–2155 calBP; GaK-896) and 840 ± 90 BP (916–565

calBP; GaK-689), although it was noted by Megaw (1968, p. 328) that the latter seemed too recent. Section drawings showing the stratigraphic position of the corresponding sample from Square 7 on the exterior slope of the site, show it to be from a high vertical position very close to both the surface of the deposit and the overlying loose midden layer. In this light the charcoal’s derivation from a more recent depositional event appears very plausible.

Indeed, it is implied by Megaw that the real end of the Bondaian phase was closer to 1500 BP, as indicated by a date of 1580 ± 30 BP from charcoal near the top of this unit in square CU/10 (1524–1357 calBP; GaK-481) and 1430 ± 90 BP from the transitional interface of Bondaian and Midden strata from the baulk 4–7a (1510–1073 calBP; GaK-894) (Megaw, 1968, p. 328). Furthermore, Megaw (1968, p. 328) regarded the worked-bone point (as opposed to microlithic) technology predominant in 1CU5’s midden layers as in chronological accordance with the same phenomenon as at other southeastern coastal Australian sites – Durras North (a Walbunga Yuin site) dating to 1470 ± 80 BP (1518–1178 calBP; GaK-873) and Glen Aire dating to 1580 ± 45 BP (1532–1317 calBP; NZ-728).

Broadly speaking, sites within the southern Sydney region have a clear chronological disjuncture between deposits which contain backed artefacts, and those which lack them – instead containing bone points, eloueras, and shell fish-hooks (for a list of relevant sites in the region, see Attenbrow, 2012, pp. 57–64). The abandonment of backed artefact manufacture and increased production of the latter three technologies regionally seems to have occurred c.1500–1000 BP. Dated sites within or adjacent to the RNP at which this pattern is evident include Wattamolla at $<840 \pm 160$ BP (896–1439 calBP; ANU-177) (Megaw & Roberts, 1974, p. 4); Curracurrang Shelter 7 at 1050 ± 100 BP (773–1225 calBP; ANU-179) (Tracey 1974, p. 25); Captain Cook’s Landing Place (now known as the Meeting Place) at $<1330 \pm 100$ BP (593–987 calBP; ANU-0721) (Megaw, 1974, p. 36) and Gynea Bay at 1220 ± 55 BP (689–991 calBP; NSW-6) (Megaw & Wright, 1966).

Megaw presented three radiocarbon dates from the midden, all of which indicated “modern” occupation c.1700–1750 AD — in other words within a century of European contact and initial colonisation in the Sydney region (Megaw, 1968, p. 328). Alongside a European glass bead these were taken as an indication that occupation and deposition of material in the Midden unit had continued until the commencement of European settlement at Sydney in 1788 AD. The “modern” dates’ samples were from the uppermost part of the midden, but not from the very surface (instead at 9 or 16 inches depth). The upper midden was disturbed in places during the twentieth century by amateur artefact collectors and campers, who probably mixed the most recent surface hearth materials with somewhat older material from below. However, it is important to note that Dharawal people also continued to use sites in the Kurnell-RNP region post-Contact.

The established radiocarbon chronology for 1CU5 therefore suggests that “Bondaian” occupation associated

Table 1. New radiocarbon dates for 1CU5. Calibrated ranges producing using SHCAL (Hogg et al., 2020).

Sample ID	Square	Spit	Unit	Sample	¹⁴ C age (years BP)±	Calibrated 95.4% probability range (years BP)
SANU-64832	9	2	Loose banded midden	Dingo (mandible)	807 ± 20	726–667
SANU-64838	9	2	Loose banded midden	Dingo (mandible, duplicate)	805 ± 20	726–667
SANU-64833	2	3	Coarse midden	Dingo (mandible)	2257 ± 22	2331–2136
SANU-72537	3	5	Coarse midden	Dingo (tibia)	2049 ± 26	2011–1890
SANU-72538	3	7	Coarse midden	Bone (marine fish)	2567 ± 22	2744–2492
SANU-64835	3	12	Coarse midden	Dingo (metapodial)	2088 ± 21	2087–1929
SANU-64831	16	2	Coarse midden	Dingo (mandible)	2105 ± 22	2142–1996
SANU-64837	16	2	Coarse midden	Dingo (femur)	2095 ± 24	2090–1930

with the first backed artefact and ground-edged axe production began around, or soon after, 2500 BP. After ~1500 BP, microliths manufacture ceased and a new period of occupation creating shell midden deposit associated with elouera, bone and (eventually) shell fish-hook industries began. This can then be roughly separated into an early phase and a late phase, the latter reaching into the European Contact era. The established chronology contends that Bondaian and collective Midden strata represent different occupational phases with little to no chronological overlap, and that fauna was only absent from the Bondaian phase due to chemically-based preservation issues.

We have obtained new radiocarbon dates on animal bone from various parts of 1CU5's midden strata, particularly the coarse midden, which indicate that a substantial revision of this chronological and stratigraphic sequence is in order. The new dates indicate that much of the midden deposit is contemporary with Megaw's dates for Bondaian occupation and lithic manufacturing found in the adjoining and underlying "black" sediment which is devoid of fauna. Dingo bones sampled from the highest and lowest layers of the "coarse midden" within the rockshelter overhang returned AMS dates with calibrated ranges between 1900 BP and 2330 BP (Table 1). Some of these dates, particularly those from Square 3, are stratigraphically inverted. This is because the dated dingo bone from Spit 12 (SANU-64835) is probably intrusive and belongs to an incomplete and fragmentary dingo skeleton identified from the lowest spit of the adjacent square (Square 16), which is likely to represent a burial (Koungoulos et al., 2023).

Conversely, a dingo mandible sampled from the "loose banded" upper midden layer from an outside Square (7) produced a calibrated range of approximately 730–670 years BP (SANU-64831, SANU-64832). As this individual is represented only by a lone hemimandible, and all nearby surrounding sediment is excavated, it is unlikely to represent a burial, but rather meal discard like most of the

site's fauna. The contextual significance of the different sets of dingo remains from 1CU5 been covered in detail elsewhere by Koungoulos et al. (2023).

Taken together, the new dates for 1CU5 suggest a rapid buildup of the coarse midden deposit between ~2500 and 2000 BP, corresponding with the manufacture of backed artefacts and edge-ground axes. This was followed by formation of the loose banded upper midden from at least the early 1st millennium BP until European contact. It is possible that secondary pit-digging/discard-clearing activity within the rockshelter in antiquity removed the original interface between the most recent coarse midden and oldest loose midden, but it is equally possible that isolating material specifically from the bottom of the latter unit for dating at the time of excavation could have provided a more precise indication of its origin. Thus, at this time Megaw's (1968) original interpretation should be modified to specify that the *upper* midden unit, which is far richer in faunal remains than the lower, began forming after ~1500 BP.

Our interpretation is substantially different from Megaw's understanding of the site, but there is no contradiction between his existing and our new radiocarbon dates. Our samples come from the lower "coarse" midden, whereas Megaw's samples for the "midden" were almost exclusively from the uppermost "loose" midden layer, except for GaK-894 (1430 ± 90 BP). This is listed as coming from a considerable depth and representing the transition between the midden and Bondaian units. The unpublished sections for 4–7a, however, show that the border between the two units here was predominantly *vertical* (i.e., the lateral edge of the midden "pit" rather than its bottom) and uneven and that the midden portion had been disturbed by animal burrowing at various depths. In light of this and our new dates, GaK-894 probably originally derived from occupation at the end of the Bondaian/coarse midden depositional periods. In comments provided to Gakushuin radiocarbon dating laboratory with

his samples, Megaw suggested it had mixed with older material due to trampling (Kigoshi, 1967, p. 59).

We note that preliminary assessment of the fauna suggested mixing between the materials from the loose midden and coarse midden has very likely occurred in certain squares located outside the overhang of the shelter roof as discard from the former has moved down the face of the exterior slope over time. CU/15 is recorded as “coarse midden” but produced two radiocarbon dates from the eighteenth century AD (Megaw, 1968, p. 328). Squares 7, 10 and 13 lie directly downslope of the deepest part of the overhang and are recorded as having small to moderate layers of loose midden overlying their coarse midden layers. As related above, Square 7 produced a seventeenth century AD radiocarbon date from Spit 2 of this midden on its eastern face, and a <1000 year old date from the black soil underlying the loose midden in Spit 4.

The calibrated range of 726–667 years BP taken from a dingo mandible in the 2nd spit of Square 9 (SANU-64838), recorded as coarse midden, is potential further evidence of reworking of younger material into older midden deposit. However, it is equally possible that this isolated element represents an intrusive deposition (burial) which has since been thoroughly disaggregated by downslope movement and disturbance and does not directly relate to the antiquity of the coarse midden. Nevertheless, currently it is best to cautiously consider the collective fauna from Squares CU/15, 7, 10 and 13 and very possibly the adjoining external squares (8, 11, 12, 14 and 15) as comprising at least in part a palimpsest of reworked loose and older coarse midden materials.

The main implication of the above findings is that the midden deposit from 1CU5 does not entirely postdate the manufacture of Bondi points/backed artefacts but began forming contemporarily to it. The lack of faunal remains in the “Bondaian black soil” and the lack of backed artefacts in the coarse midden may primarily reflect spatial organisation of cooking/eating/discard and stone working activity areas during the use of 1CU5 as an occupational site during this time. Contrary to Megaw’s (1965, 1968) expectations, evidence is at hand for dietary protein procurement during the Bondaian period, in addition to the period after the abandonment of backed technologies in which eloueras proliferated and shell fish-hooks began to be used. The resolution of excavation and dating does not allow us to pinpoint the transition between these periods, but for analytical purposes, the surviving faunal remains from 1CU5 can be divided between two distinct stages of occupation, corresponding to the upper and lower stages of midden buildup. Very little to no bone is preserved in the basal unit and that which does survive is unidentifiable, and in many cases probably constitutes intrusive crushed materials from the overlying and younger coarse or fine shelly/crinkly midden units. Our analysis of the 1CU5 fauna follows this revised understanding of the site’s occupational chronology.

Megaw’s (1968) radiocarbon dates suggest the timeframe for the initiation of the earlier period’s unit may, as outlined

earlier, be closer to or in excess of 3000 BP. Based on the miniscule amounts of bone in the lowest levels of the coarse midden and in line with observations of the disappearance of bone of this antiquity in other sites from the greater region owing to soil acidity (Attenbrow, 2012), it seems safe to conclude that very little fauna deposited prior to ~2500 BP is preserved. For instance, in the unit (Spit 7 of Square 3), which produced our oldest date of 2567 ± 22 or 2744–2492 calBP (SANU7-2538), there was only 0.8 g of fish bone, and no other bone. Below this level in the same square, only two further pieces of bone were retrieved, one of which is almost certainly more a recent intrusive dingo burial (SANU-64835).

As such, the potential for understanding the economic practices and human diets at 1CU5 is limited to the later half (approximately) of the Bondaian technological phase and subsequent periods. The degree to which the distribution of fauna may correspond to relative intensities of microlith production *within* the Bondaian phase is not possible to ascertain as no data on abundances of the latter associated with dated XUs are available in the published literature. It would seem that most of the reported microliths (Megaw, 1965, 1968) come from the initial test-trench CU/-squares, for which Megaw’s unpublished section drawings show that greater depths and volumes of the “Bondaian black soil” were excavated compared to the more northerly squares excavated in later seasons, where the midden as deeper and black sediment layers thinner (this of course being because the midden was formed by discard of food wastes into a pit dug deeply into the black sediment).

MATERIALS AND METHODS

Our identifications and analyses focused on the site’s mammalian and avian vertebrates. Mammalian and avian remains from every excavated square and spit of 1CU5 were weighed, examined and identified at the Australian Museum, with the use of its modern comparative mammal and bird collections for identification to the highest taxonomic level possible according to preservation and completeness. We discuss the taxa recovered from 1CU5, grouped at the class, order and family levels, with remarks on the significance of their ecology and historic importance in the diets of regional Aboriginal groups. We also consider the identification of 1CU5 taxa with regards to comparative archaeological faunal sequences from the RNP, the Kurnell Peninsula, and coastal and hinterland sites in the greater Sydney area, referring to the taxonomic lists compiled by Attenbrow (2010b, 2012).

The site’s osseous material is predominantly made up of fish bone, which is well-preserved and suited to identification, as most craniofacial elements and several pectoral elements are abundantly represented alongside the vertebrae. Because of the very large quantity we have not attempted a systematic identification and quantitative taxonomic analysis of the 1CU5 ichthyofauna. We present here only some comments on the trends in fish bone

weights which inform on patterns in the site's use and animal economy during the last ~2500 years of occupation and provide preliminary indications of the taxonomic range.

Reptilian and invertebrate remains were infrequently recovered from 1CU5. We have provided general comments on the taxa represented but, in most cases, did not attempt to identify them beyond the family or order levels. Occurrences of exotic mammalian and avian fauna also deposited at 1CU5 after European contact were identified to species. However, since these are intrusive and probably relate to transient use of the rockshelter overhang area by non-Indigenous squatters or campers in the late nineteenth and early twentieth centuries AD, they are excluded from our considerations of the diet of the site's Aboriginal inhabitants up to c.1850 AD.

Finally, human remains at 1CU5 were reported by Megaw (1965, 1968) as burials in both the upper and lower midden. These are not discussed here, but their presence should be considered potentially relevant to the dingo burials present in the midden. Throughout much of southeastern Australia there is a strong association between dingo and human burials, in that dingo burials tend to be found where humans are buried and the two are often in close spatial association (Koungoulos et al., 2023).

Because of the very large number of excavated squares and units, the variable spit-depth criteria used over the three excavation seasons, and the limited chronological/stratigraphic resolution available, we present faunal abundance data (NISP/MNI) for the two major identifiable occupational periods: an early stage corresponding to the lower units of coarse midden, crinkly midden, and black sediment units (c.2500 BP–c.1500 BP) and a later stage corresponding to the upper units of loose midden (c.1500 BP–1850 AD). As noted above, no fauna remains are available for the earliest occupational phases from c.8000 BP to c.2500 BP. We describe the trends in faunal representation between the two periods and discuss their significance to understanding animal procurement and diet in the Late Holocene of coastal southeastern Australia.

RESULTS

Taxonomic range of fauna represented

Class Arthropoda

Order Decapoda

Decapod claw and leg fragments are widely but uncommonly represented in the midden, particularly the upper unit. No attempt has been made to identify these further but at least three morphological varieties or types of claws could be distinguished. All would appear referable to the true crabs (infraorder Brachyura) from the immediate rocky intertidal area, such as those in the genera *Leptograpsus* (Grapsidae) and *Guinusia* (Plagusidae). None are obviously referable to the two largest and commercially important species, these being the mud crab *Scylla serrata* and blue swimmer crab *Portunus pelagicus*;

both are more typically found in the estuarine settings that are several kilometres from 1CU5.

Decapod remains are known from Sydney, Kurnell and RNP sites, but in extremely small numbers. Owing to the fragility of their exoskeletons aside from the hardest elements of the claw, they are probably under-represented relative to their actual dietary importance (Attenbrow, 2010a, p. 69). Interestingly, historical sources recorded the use of specific traps to capture spiny lobsters (Palinuridae) but do not note the consumption of crabs (Attenbrow, 2010a, p. 69). The Dharawal language however has names for both lobsters and crabs indicating familiarity with these taxa, and these crustaceans continue to be harvested and eaten in the community today.

Class Actinopterygii

Order Perciformes

1CU5's fish assemblage appears to be dominated by Australasian snapper *Chrysophrys* (formerly *Pagrus*) *auratus*, an important food fish but one also used for decorative and ceremonial purposes. The thick, solid frontal bones of this species' neurocranium occur in nearly all spits containing fish bone. These vary enormously in size, indicating substantial variation in catch body sizes and (presumably) ages. At least one other member of the bream family (Sparidae), the yellowfin bream *Acanthopagrus australis*, is also represented. The next most common seem to be the wrasses (Labridae); at least two taxa, including the eastern blue groper *Achoerodus viridis* and the smaller purple wrasse *Pseudolabrus fucicola*. Two members of the Carangidae family, probably the trevally *Pseudocaranx dentex* and yellowtail kingfish *Seriola lalandi*, are present in smaller numbers in addition to the bluefish/tailor *Pomatomus saltatrix* (Pomatomidae); at least one leatherjacket (Monacanthidae) species; and at least one unidentified eel-tailed catfish (Plotosidae). A single large otolith of mulloway *Argyrosomus japonicus* (Scianidae) was identified. All these taxa were previously reported from other nearby sites on the RNP eastern coastline, including Curracurrang 2 (Attenbrow, 2012, p. 48).

The small number of species reported here is likely to be a substantial underestimation of the total taxonomic range caught and eaten by the inhabitants of Curracurrang. A detailed understanding of the site's fishing economy requires further specific identification and quantitative analysis, as many of the families and genera identified thus far are represented in the Sydney area by multiple species, some of which occupy different habitats and require different strategies to capture. This acknowledged, it is probably safe to assume that the bulk of individuals represented, and thus majority of fish consumed at 1CU5, are the snapper *Chrysophrys auratus*. The combination of this and another common sparid (yellowfin bream) together with the labrids, collectively dominate abundance counts from other Sydney region coastal sites, with up to 90% of NISP represented by snapper alone (Attenbrow, 2010a).

Reviews of historical fishing techniques in the Royal National Park and the greater Sydney region indicate that two methods were used to procure fish: multi-pronged or

harpooned spears were used by men, and hooked fishing lines used by women (Attenbrow, 2010b, 2011). Both methods are certain to have been used by 1CU5's inhabitants, as fishing spear-points and shell fish-hooks were abundantly present in the midden (Megaw, 1965, 1968). Full analysis of the site's ichthyofauna could ascertain the impacts on fishing yield and dietary composition triggered by the latter technology's adoption within the southern New South Wales coastal regions within the last 1000–500 years (Attenbrow, 2010a; Gerritsen, 2001; Walters, 1988). Nets and traps were not historically observed in use in the Sydney region, though they were in other parts of the NSW coast. However, archaeological finds of juvenile and/or very small species potentially suggest their use in Sydney in the past (Attenbrow, 2010a, p. 18). We did not observe notable numbers of juvenile or very small species in 1CU5's assemblage but this might be subject to change with closer analysis.

Class Aves

Order Galloanseriformes

Family Phasianidae

An ulna and radius of a phasianid bird which in shape and size closely resembles the introduced domestic chicken (*Gallus gallus*) were identified from the upper midden. Two sterna from a single context (Square 0, Spit 4) were also identifiable as deriving from modern broiler chickens, which reach a large size before developmentally mature. This strain of meat chicken was only developed in the early-mid twentieth century (Bennett et al., 2018), indicating that the bones were discarded and managed to intrude the deposit to some depth in only a matter of decades before the 1960s excavations.

Order Passeriformes

Family Corvidae

One tarsometatarsus was identified as the Australian raven *Corvus coronoides*, which is widely distributed across southern and eastern Australia. Corvid remains have not been reported from Sydney, Kurnell or RNP sites although “crows” were mentioned as food items by colonial observers (Attenbrow, 2010b, p. 75).

Order Pelecaniformes

Family Ardeidae

One radius and a coracoid were identified as belonging to this waterbird family, which consists of the egrets, bitterns and herons, with several genera found in coastal and freshwater habitats of eastern New South Wales. The radius is a close match in size and morphology to the Australian little bittern *Ixobrychus dubius*, whilst the coracoid is a close match for this taxon in morphology but seems unusually small even for this species which is probably the smallest in its family. This species can be found along mangrove, lagoon or estuary edges but is more common in the reed and shrub systems of freshwater wetlands. Its presence at 1CU5 probably indicates some exploitation of the numerous small lakes and swamps between the RNP's coast and the western escarpments, or at the coastal and estuarine lagoons/river mouths located 1–7 km north of the rockshelter. Members of this family have not been reported

from Sydney, Kurnell or RNP sites nor are they specified as historical food items (Attenbrow, 2010b, p. 72, 2012, p. 50).

Order Procellariiformes

Family Diomedidae

Several very large wing and leg elements, predominantly from the upper midden unit, were identified as the wandering albatross, *Diomedea exulans*. One ulna bears cut-marks just below the distal head (Figure 4). This species is the largest known seabird by wingspan; it spends most of its time in the air or on the water, returning to land only to breed. However, they breed exclusively on subantarctic islands, so it is likely that these individuals were somehow ambushed whilst in the water, hit with projectiles from the air (less likely) or possibly simply obtained as washed-up carcasses (DECCW, 2011, p. 226). No members of the albatross family have been reported from coastal Sydney, Kurnell or the RNP sites nor are they listed as historical food sources (Attenbrow, 2010b, p. 72, 2011, 2012, p. 50).

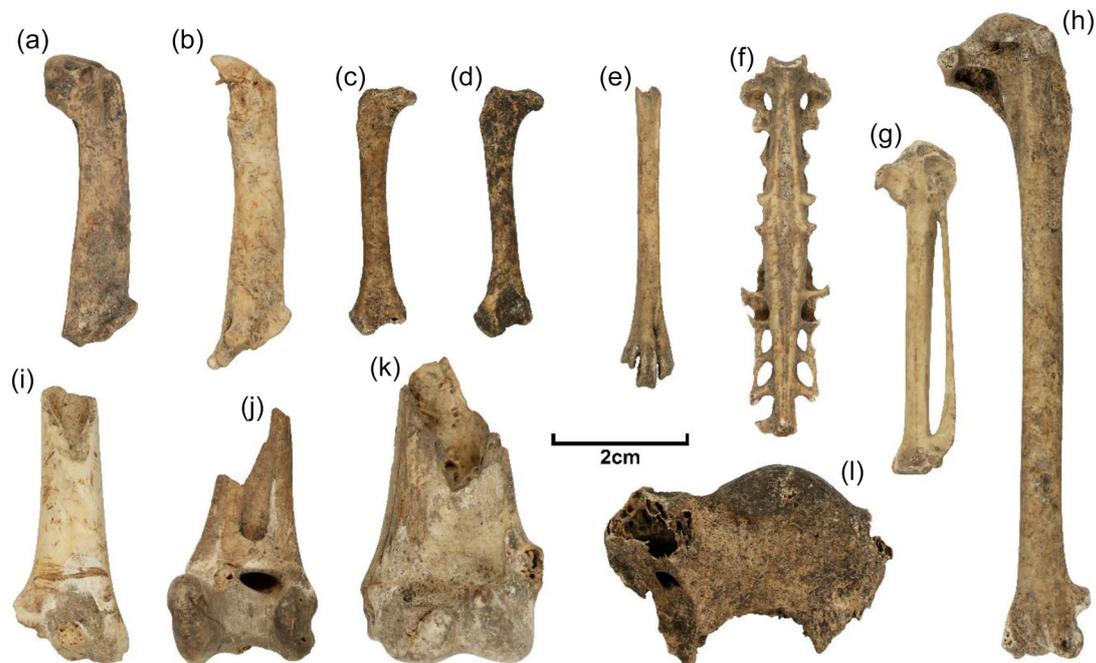
Family Procellariidae

The avifauna of 1CU5 is dominated by the short-tailed shearwater *Ardenna tenuirostris*, commonly known as “muttonbird”, which is renowned as an important coastal Aboriginal food throughout much of eastern Australia and Tasmania. Skeletal element representation for this species is very broad with all wing and leg bones observed in addition to the sternum, coracoid, scapula, synsacrum and occasional vertebrae (Figure 4). A related species also known as muttonbird, the sooty shearwater *Ardenna grisea*, is also present but in much smaller numbers, as was one example of *Ardenna bulleri*. A small handful of other similar sized Procellariidae specimens, which could not be confidently identified but probably include *Ardenna wavicus* or the related genus *Puffinus gavia*, both abundant in the RNP waters (DECCW 2011, p. 228), were also noted. Finally, there are a very few occurrences of the smaller petrels (prions), most referable in size and morphology to *Halobaena caerulea* and/or *Pachyptila* sp., which are present but rare in the RNP (DECCW 2011, pp. 227–228).

Muttonbirds and closely related members of the shearwater family (Procellariidae) are known from coastal Sydney, Kurnell and RNP sites, though they are not specifically mentioned as among the avian food species historically (Attenbrow, 2010b, p. 72, 2011, 2012, p. 50). Muttonbird bones are known from well-excavated NSW far South Coast and eastern Victorian sites (Coutts, 1984; Lampert, 1966, 1971). Analysis of fishing-spear bone points from Durras North, where almost 500 were excavated, also found that the majority were manufactured from the leg bones of short-tailed shearwater (Freeman et al., 2021). Muttonbirding, the practice of capturing shearwaters from within their subterranean nesting burrows, is best known archaeologically from Tasmania, where it continues to be practiced today (Dunnett, 1992; Skira 1993; West & Sim, 1994). Muttonbirding is not known to have been a historical practice in the greater Sydney region.

As *A. tenuirostris* arrive southeastern Australia from September and breed through summer, their archaeological remains have been cited as evidence of spring to summer

FIGURE 4. Marine birds from 1CU5. (a–b) Little penguin humeri; (c–h) shearwater (muttonbird) femorae, tarsometatarsus, synsacrum, carpometacarpus and humerus; (i–l) wandering albatross distal ulna, distal tibiotarsus, distal and proximal humeri.



occupation (Attenbrow, 2010a, p. 80). To avoid terrestrial predators, shearwaters nest almost exclusively on offshore islands, the nearest of which is some 45 km to the south on the Five Islands, Port Kembla. The adjacent headland there, Red Point, was formerly home to the Australian mainland's only known muttonbird nesting area (Anon, 1952). This was probably an extension of the breeding colony of the adjoining islands, which were likely the main nesting area and could be retreated to in the event of predator visitation. Taking this into account with the lack of any substantial juvenile component evident in the 1CU5 shearwaters, it is probable that the muttonbirds represented in 1CU5 were obtained by means other than exploiting rookeries. Occasionally *A. tenuirostris* washes up on RNP beaches in massive numbers, with as many as 87 recorded in a single recent event (DECCW, 2011, p. 228). Plausibly this could have served as a means for people to obtain them, as well as the other marine birds described here.

Order Sphenisciformes

Family Spheniscidae

Wing elements from the little penguin, *Eudyptula novaehollandiae* (Figure 4), are the most common bird bones found at 1CU5 after the shearwaters, though are still rare. This species is the smallest variety of penguin, and has been recorded from several coastal Sydney, Kurnell, and RNP sites despite not being specifically noted as a historical food source (Attenbrow, 2010b, p. 72, 2011, 2012, p. 50).

Class Echinoidea

The spines of at least one species of sea urchin are present but in extremely small numbers, in addition to one fragment of test and one rotula. No effort was made to

further identify any of these. Urchins are not mentioned in faunal reports from coastal Sydney, Kurnell, or the RNP nor apparently as historical food sources (Attenbrow, 2010b, p. 72, 2011, 2012, p. 50), despite two species, *Centrostephanus rodgersii* (Diadematidae) and *Heliocidaris erythrogramma* (Echinometridae) being locally common and commercially important today (Worthington & Blount, 2003). In the intertidal and shelf areas surrounding 1CU5, urchins can easily secret themselves in the abundant rocky crevices leaving their long spines jutting out. Extraction by hand may be difficult but can be aided by the use of sticks or wooden tools. Dharawal community members today continue to use urchins as fishing bait (burley).

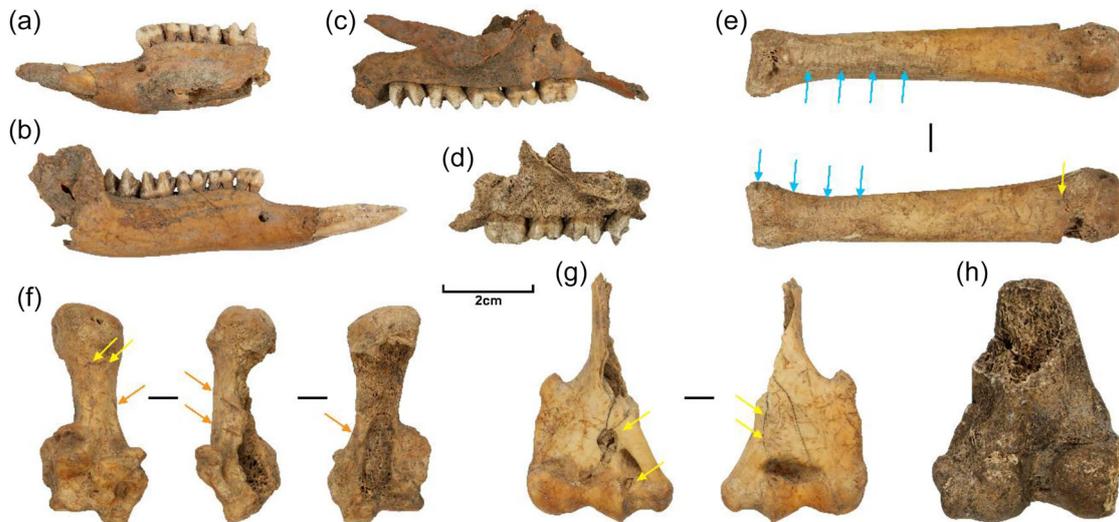
Class Mammalia

Infraclass Marsupialia

Family Dasyuridae

The dasyurids, carnivorous marsupials, are represented at 1CU5 exclusively by a fragment of maxilla from the largest extant member of this family remaining on the Australian mainland, the tiger quoll *Dasyurus maculatus*. This species prefers closed forests but is only moderately arboreal in lifestyle and was probably captured on the ground. Tiger quoll has been reported from one Kurnell Peninsula site and has a Dharawal language name, but is not known from any published RNP site (Attenbrow, 2012). Dasyurids of any kind are infrequently represented in Australian archaeological fauna (e.g., O'Connor 1999, pp. 44–46, 90) and do not seem to have been eaten with much regularity historically, in contrast to parts of New Guinea, where many species are also found (e.g., Majnep & Bulmer, 2007).

FIGURE 5. Macropod remains from 1CU5. (a–b) red-necked wallaby mandibles; (c–d) swamp wallaby maxillae; (e) swamp wallaby fourth metatarsal; (f) swamp wallaby calcaneus; (g) swamp wallaby distal humerus; (h) large macropod (probably red-necked wallaby) distal femur. Yellow arrows designate large carnivore (dingo) pits and punctures; orange arrows designate cut-marks; blue arrows indicate rodent scavenging.



Family Macropodidae

Macropod remains are reasonably abundant at 1CU5 and clearly contributed the most terrestrial meat in the occupants' diets in both phases. Two large wallaby species, the rednecked wallaby *Notamacropus rufogriseus* and swamp wallaby *Wallabia bicolor*, are well-represented craniodentally at 1CU5. A smaller species, the brushtailed rock wallaby *Petrogale penicillata*, is less common but nevertheless reasonably well-represented at 1CU5. The red-necked pademelon, *Thylogale thetis*, is the smallest and least well-represented member of the family at 1CU5. All four tend to occupy closed forest, particularly *T. thetis*, but *N. rufogriseus* is also found in scrub and heath habitats typical of the RNP coastal fringe. All have been reported from Kurnell and Sydney sites but only *W. bicolor* and *T. thetis* have been thus far identified at RNP sites (Attenbrow, 2010b, p. 72, 2012, p. 50). All of them except *W. bicolor* have been extinct in the RNP since at least the early twentieth century (DECCW, 2011, p. 53, owing to colonial introduction of novel predators, competing herbivores and pelt industries (e.g., Lunney et al., 1997).

Macropods are represented by nearly all elements of the skeleton, but limb epiphyses and manual/pedal bones seem to be more common in the upper unit, whereas craniodental elements, particularly lower incisor teeth, are far more common in the lower. Scavenging by camp dingoes may have destroyed or removed many limb bones, perhaps particularly during the early phase where most macropod evidence is in the form of lower incisors (Figure 5). Specifically, it is the ends of long bones which are rare; these are where most diagnostic features are located but also happen to be where canids seek bone nutrients and (being softer) where the process of accessing the shaft marrow begins (Koungoulos et al., 2018; Solomon, 1985).

Parts of the shafts are no doubt represented in the midden's numerous unidentified mammal fragments. It is also probable that the human occupants of the site shattered macropod long bones to access marrow themselves, and used these elements to manufacture worked bone points that were found in abundance at the site (Freeman et al., 2021; Megaw, 1965, 1968).

No macropod remains are referable to the two largest macropods found within the broader region during the Holocene: the grey kangaroo (*Macropus giganteus*) and eastern wallaroo (*Osphranter robustus*). Both taxa prefer grassland or open forest, which is not found within the RNP, so their absence is not particularly surprising. Remains of either species have not been recorded from other RNP sites but were found at Kurnell and elsewhere in coastal Sydney (Attenbrow, 2010b, p. 72, 2012, p. 50).

Family Peramelidae

Peramelids (bandicoots and bilbies) are present but rare. Better-preserved cranial and mandibular specimens are mostly referable to southern brown bandicoot *Isoodon obesulus* but in one case the long-nosed bandicoot *Perameles nasuta*. Both species inhabit scrub and low-lying vegetation and remain present along much of the coastline of southeastern Australia, although *I. obesulus* has suffered drastic reductions in its range and numbers in modern times. Both species were recorded from coastal Sydney and Kurnell sites, but in the RNP sites bandicoots have only been identified at the family level (Attenbrow, 2010b, p. 72, 2012, p. 50). Neither appear to have been noted as important food sources by early observers (Attenbrow, 2010b).

Family Phalangeridae

The common brushtail possum *Trichosurus vulpecula*, an arboreal species, is very poorly represented at 1CU5 and

only as fragmentary postcranial elements in the upper midden unit. Possums were reported as a popular and important Contact-era food source in the greater Sydney region, but seemingly only in areas located well away from the coastline (Attenbrow, 2010b, p. 90). Their central importance in the manufacture of skin-cloaks in southeastern Australia is well known, but historical and ethnographic data suggests that such garments were typically worn outside of the Sydney region proper (Attenbrow, 2010a, p. 107), including further south along the coast. Brushtail possum has been reported from coastal Sydney and Kurnell sites, though not in the RNP (Attenbrow, 2010b, p. 72, 2012, p. 50), where today it seems to be unusually uncommon (DECCW, 2011, pp. 70–71).

It has been suggested by Kohen (1986) for the nearby Cumberland Plain (the flat plain on which most of Sydney sits) that overharvesting of macropods led to a transition, during the last millennium, to the state of reliance on possum-hunting observed during the Contact era. As possums were at this time extracted from tree branches and hollows by using ground-edged axes to cut footholds for climbing, the archaeological abandonment of microliths (presumed to be mounted in spears for large game) and their “replacement” by ground-edged hatchets on the Cumberland Plain during the last millennium has been offered as evidence of such an event (Kohen, 1986). Zooarchaeological corroboration of this transition from Sydney has not been forthcoming, but similar macropod-to-possum transitions have been detected in the New England region of northern NSW (e.g., McBryde, 1985).

Family Potoroidae

All remains from this family from 1CU5, including several well-preserved craniomandibular specimens, are referable to the long-nosed potoroo *Potorous tridactylus*. Most of the RNP is suitable habitat for this species which inhabits both closed and open forest, scrub and coastal heathland, but its presence has not been recorded (DECCW, 2011, p. 56) suggesting it may have become locally extinct very soon after Contact. Potoroo has been reported from coastal Sydney and Kurnell sites, but not previously from the RNP sequences (Attenbrow, 2010b, p. 72, 2012, p. 50).

Family Pseudocheiridae

The common ringtailed possum, *Pseudocheirus peregrinus*, is the only other truly arboreal marsupial identified from 1CU5. The occupants’ clear preference for this species, which dwells in closed forest and dense scrub, over the substantially larger and usually more common brushtail possum is interesting but probably due to abundance. Today it is common arboreal mammal in the RNP (DECCW, 2011, pp. 70–71). It has been reported from coastal Sydney and Kurnell sites, but not previously from the RNP (Attenbrow, 2010b, p. 72, 2012, p. 50). Ringtail possums would have been procured using the same methods as for brushtails; using axes to cut footholds for climbing high into trees to extract them from branches or hollows.

Family Vombatidae

The presence and abundance of wombat at 1CU5, in all but two cases represented by molar teeth, is surprising and significant. All specimens are referable to the common wombat *Vombatus ursinus*, which is a flexible species found in closed and open forest in addition to grassland and heath. Wombats were recorded by early colonists as a traditional food of hinterland rather than coastal groups (Attenbrow, 2010b, p. 71), perhaps owing to its historic rarity in coastal areas (Attenbrow, 2010b, p. 193). It was not identified in the fauna of any Sydney hinterland and coastal, Kurnell Peninsula, and RNP archaeological sites collated by Attenbrow (2010b, p. 72, 2012, p. 50). Wombats are very rare in the area around 1CU5 today with none known to presently reside within the RNP itself, although a small population exists >15 km away in the adjoining Heathcote National Park (DECCW, 2011, p. 71).

Ethnographic data suggests wombats were labour intensive and difficult to capture, as they are hard to find and then remove from within their deep burrows. However, nineteenth century historical observations from southeastern Australia note that the assistance of tame dingoes or dogs was enlisted in procuring them. Eyre (1845) reports that dingoes were used to chase wombats into their burrows, which then had a fire lit inside and the entrance sealed with earth, suffocating the wombat, and allowing it to be dug out later. Bulmer (in Vanderwal, 1994) records that a hole was dug over a wombat burrow into which “dogs” were sent, flushing the animal out for capture by hunters.

Infraclass Placentalia

Order Artiodactyla

Family Bovidae

Vertebrae from domestic cow (*Bos taurus*), and domestic sheep (*Ovis aries*) vertebrae and were identified from uppermost midden units. These have clearly identified butchery marks from cleavers and meat saws and were probably deposited by people using the rockshelter for picnics or camping in the nineteenth or twentieth century.

Family Suidae

Cleaver chopped vertebrae and a large scapula with the proximal edge (vertebral border) removed by sawing were identified as (presumably domestic) pig *Sus domesticus* from disturbed pockets of the upper midden. They are assumed to have entered the midden through the same scenarios as the cow and sheep bones.

Order Carnivora

Family Canidae

Remains of dingo were exceptionally plentiful at Curraurrang and these have received special attention in a previous work (Koungoulos et al., 2023). At least 27 individual dingoes are represented in the excavated material. This includes two individuals probably exceeding 6–8 years of age, at least three other adults (>1.5–2 yo), and at least seven very young juveniles between 2 and 8 weeks old. Many of these are believed to be purposeful burials based on the wide range of elements retrieved from these individuals. Several direct AMS radiocarbon dates were obtained from dingo remains (Table 1), which

indicates that dingoes accompanied the site's occupants from at least 2300 BP and continued to be present locally until at least ~800 BP but most likely until Contact.

The high representation of near-neonate juvenile dingoes indicates that occupation of Curracurrang occurred during whelping season. Dingoes, unlike domesticated dogs, normally breed only once and seasonally during the winter months (Smith, 2015). The presence of pups at 1CU5 therefore indicates that the site must have been used during winter. Some dingo remains possibly represent meal refuse, because they were found as isolated elements (e.g., the dated Square 9 specimen in Table 1) and cannot be linked to more complete skeletons identified as burials. Such instances are mainly mandible fragments, loose teeth and manual/pedal elements. It is possible that some isolated fragments of teeth and foot bones could represent intrusive domestic dogs deriving from post-Contact site use, though there are no morphological indications of this (c.f. Gollan, 1982).

Carnivore damage in the form of pits, punctures, scores and other gnawing bone surface modifications were observed on much of the terrestrial mammalian bone (refer to Figure 5). This is a strong indicator of the presence of tamed dingoes at the site and their consumption and destruction of discarded large mammal bones, as speculated previously based on high dental attrition in the adult dingoes buried at 1CU5 (Koungoulos et al., 2023). Dingo scavenging and bone crushing behaviour, by breaking up and physically relocating mammal bone away from archaeological sites, has been implicated as a major factor behind reduced mammal bone weights and abundance counts in some Australian sequences postdating ~3000 BP (David, 1984; Pocock, 1988; Solomon & David, 1990; Walters, 1984). The suggestion that this occurred at 1CU5 is supported by the fact that macropod/vombatid abundance counts are mostly based on elements that are inedible or less rewarding for muscle/organ/marrow seeking canid scavengers, namely the teeth, the pedal digits, calcanei, etc., rather than limb elements.

Dingo remains are frequently reported from Sydney hinterland and especially coastal sites, as well as in the Kurnell and RNP sites, though in no case have they been obtained in any quantity approaching that from 1CU5 (Attenbrow, 2010b, p. 72, 2012, p. 50). Dingo and domestic dog burials are predominantly known from the areas bordering, rather than on, the Cumberland Plain. In particular, the coastline of southeastern Australia from approximately Kurnell to Gippsland is one of three regions of Australia where dingo burial seems to have been commonly practiced and is well-represented archaeologically – the others being the southern Murray Darling Basin and the Kimberley/Top End region of tropical northwestern Australia (Koungoulos et al., 2023). In nearly all known examples, including the nearby Meeting Place site at Kurnell, dingoes were buried in the same manner and location as people, and this is true at Curracurrang (Koungoulos et al., 2023). However, it is important to note that there is no evidence for any specific

chronological association between particular human and dingo remains at Curracurrang, only that the site was used at various times within the span of its occupation for the burial of both people and dingoes.

Family Otariidae

The remains of an otariid pinniped species are very well-represented throughout the fauna bearing layers of the site. All identifiable specimens are referable to the Australian fur seal *Arctocephalus pusillus doriferus*. The remains represent both adults and juveniles, although the latter are less common and almost entirely restricted to the later phase. Diagnostic features present on the few cranial remnants and variation in the size of adult specimens (males are substantially larger than females; Brunner, 2004) indicate that both sexes are represented. Elements from the entirety of the body are present indicating the transport and probable in situ butchering of whole carcasses, requiring carrying them uphill from the shoreline for a minimum distance of ~150 m, and realistically much more. Unlike the terrestrial mammals, the seal bones do not appear to have been subjected to dingo scavenging or human marrow extraction processes as several complete to nearly complete limb bones were readily identified (Figure 6). Two of the more intact limb bones bear cutmarks, although the occurrence of butchery evidence in the entire 1CU5 archaeofauna is remarkably low for such a large assemblage.

Despite their bones being reported from numerous coastal Sydney, Kurnell and RNP sites, seals were not observed by early European settlers as part of the traditional diet of Sydney region Aboriginal groups (Attenbrow, 2010b, p. 66), potentially due to it being an opportunistic practice. However, seal hunting was documented along the NSW South Coast through to eastern Victoria and the Bass Strait coast of southern Victoria, regions with colder waters and generally higher abundances of seal. One early observer of Aboriginal people living at Batemans Bay, some 180 km south of 1CU5, mentions that they lived principally on marine fish and seal (Harper, 1826). Seal and other pinniped bones are reported in coastal middens and rockshelters within this broad region (Coutts, 1984; Lampert, 1966, 1971; Yap, 1992), though never in appreciable amounts, and they are commonly absent from sites with otherwise reasonably to well-preserved faunal material (e.g., Coutts, 1970; Lampert, 1971; Lampert & Steele, 1996).

European sealing largely exterminated the Australian mainland's coastal breeding colonies by the mid-late nineteenth century, which historically reached as far north as the Port Stephens area. Today the nearest such rookery is more than 250 km to the south of 1CU5 on Montague Island, about 7 km offshore (Gill, 1967; Hainsworth, 1967; Smith, 2001). There are no offshore islands, pebble beaches, large ledges or rock platforms of the sort that rookeries tend to prefer anywhere near to 1CU5, nor is there reason to suspect the small platforms visible on beaches several kilometres to the north and south would have been any larger in the last ~2500 years owing to sea-level

FIGURE 6. Variation in size and development of fur seal bones from 1CU5. (a) juvenile mandible; (b) very young juvenile pelvic innominate; (c) adult cranial fragment; (d–e) juvenile and adult scapulae; (f–g) probable female and male adult humeri; (h–i) juvenile and adult radii.



changes (Sloss et al., 2007). It is therefore very unlikely that the 1CU5 seals were obtained via harvesting of seasonal breeding colonies in fixed locations.

Seals were therefore more likely opportunistically consistently captured, probably when they came ashore to rest or recover on the small rocky platforms and shelves fringing the coastline, or in their immediately adjacent shallows. Today seals can occasionally be seen on a rock platform at Marley Head 5 km to the north of 1CU5 and individuals, including subadults, have been noted “loafing” for several hours in the shallows just off the RNP sea cliffs (DECCW, 2011). Seals visit the coasts as far north as Sydney mostly in the winter months, and their presence in a few Sydney coastal sites has been cited as probable evidence of winter occupation (Attenbrow, 2010a, p. 80). Washes of deceased seals on the beaches and rocky shores could also have been taken advantage of although probably because seals are only occasional visitors to the RNP rather

than long-term residents, their washes do not seem to be at all common in the RNP (DECCW, 2011).

Order Cetacea

Numerous fragments of an unidentified but large cetacean were retrieved from two XUs, within the lower midden unit. A large proportion of these comprises highly fragmented chunks of cancellous bone which are nondiagnostic but probably derive from the interior of the vertebral body. Supporting this are some fragments of a vertebral body (centrum) and cortical fragments of what appear to be vertebral processes. The centrum fragments are complete enough to estimate an original maximum width of 15 cm for this element. Considering that the centrum’s unfused and poorly developed endplate surface suggests a subadult individual age, this size probably rules out identification with the smallest cetacean taxa observed on the RNP coast – two species of dolphin (Delphinidae) and potentially also the dwarf and pygmy sperm whales

(Kogiidae). This leaves several genera that visit the RNP coasts (DECCW, 2011, pp. 249–250), the most notable being the southern right whale (*Eubalaena glacialis*) and humpback whale (*Megaptera novaeangliae*) both of which breed locally in the winter months (DECCW, 2011). In future a molecular (proteomic) approach could be used to identify the taxa represented in the 1CU5 cetacean material (c.f. Multari et al., 2023).

Whale was known to be consumed, though not hunted, by people of the Sydney region and those of the coastal areas to the north and south. Very large gatherings of people from the Sydney region feasting on whale beachings were recorded in the earliest days of the Sydney colony (Attenbrow, 2010b, p. 30,66). This ties in with oral histories told today by descendants of Bidy Giles, a Dharawal speaking woman, who in the late 1800s recounted her family knowledge that the engravings at nearby Jibbon Beach near Bundeena had been carved to commemorate outstanding events like successful hunts or whale strandings (Goodall, 2008, p. 97). Whales are also a part of the Dharawal creation story and considered a special ancestral being which is not actively hunted. Whales visit the greater Sydney coastline more frequently in winter and beachings occur typically between June and October (Attenbrow, 2010b, p. 80). The whale-bone presence in 1CU5 was originally noted by Megaw (1965) and is cited by Attenbrow (2010, p. 80) as further potential evidence of winter occupation of coastal sites in the greater region. Whale bone has been found in sites on the Kurnell Peninsula (Attenbrow, 2012, p. 51) and others along the NSW South Coast (Lampert, 1971).

It is possible that the whale bone found at 1CU5 is evidence of the local people bringing back portions of meat “on the bone” from whale beaching feasts for later consumption. However, all the discernible cortical centrum and vertebral process fragments, and many of the internal cortical bone chunks, exhibit unusual modifications resembling the burrow borings of ship worms (Figure 7), a bivalve mollusc family (Teredinidae) which have a highly reduced shell and long worm-like bodies. These worms were favoured foods of some Aboriginal groups in southern Sydney and the NSW South Coast (Attenbrow, 2010a, p. 70). Although these animals almost exclusively bore into and reside within submerged woods (and thus are typically found in mangroves, rivers, and estuaries), they do not actually consume the wood, but are filter feeders which simply use soft woods as an ideal burrowing substrate (Paalvast & der Velde 2013). The 1CU5 specimens could represent a highly unusual case of a *Teredo* sp. using submerged whale bones as an alternative substrate in the absence of available wood. However, apart from a recently described rock boring genus from the Philippines (Shipway et al. 2019), there are no known records of teredinid worms using bone substrates (Belaústegui et al., 2012), or indeed anything other than wood.

An alternative is offered by the resemblance of the borings to those of another widespread bivalve family, the piddocks (Pholadidae), which together with the Teredinidae

form the superfamily Pholadoidea. This family is generally more flexible in its choices of substrate and there are many fossil trace examples of their utilisation of marine mammal and reptile bones for burrows (Belaústegui et al., 2012; Boreske et al., 1972; Domning & Ray, 1986; Sato & Jenkins, 2020; Tapanila et al., 2004). Whatever their taxonomic affiliation, it seems that pieces of bivalve infested submerged whale bone were brought back to the shelter so that they could be processed, and the molluscs extracted at the occupants’ convenience. If this involved using tools to break up the large vertebra for extraction it could partly explain the highly fragmented nature of the bone (see NISP count in Table 3).

If our identification of these markings as bivalve borings is correct, this would not be the first archaeological example of such a scenario. At Bomaderry Creek, a rockshelter located on the NSW South Coast some 90 km south of 1CU5, the shell valves of *Teredo* sp. comprised the most common molluscan remains in the deposit (Lampert & Steele, 1996, p. 61); also found were pieces of rotten wood exhibiting their distinctive burrows. The authors concluded that the occupants had collected and returned to the cave with infested, waterlogged wood to extract the worms at their leisure, as we suggest was the case at 1CU5. No *Teredo* sp. shell valves or pholad shells were evident in the 1CU5 materials, although as noted earlier, the site’s shell material appears to have not been retained outside of a small sample.

Order Chiroptera

Family Pteropodidae

Bats are represented at 1CU5 only by a single distal femur from a pteropodid (flying fox or fruit bat). Of the two or three local species found locally (*Pteropus alecto* is nominally found much further north but has been recently recorded in northern Sydney) the specimen’s size would suggest it is most likely *Pteropus poliocephalus*, the common grey-headed flying fox, which is abundant in Sydney and its surrounds. Bats of any kind have not been reported amongst the fauna of nearby RNP and Kurnell sites (Attenbrow, 2012), and their absence from the archaeological record of the greater Sydney region more broadly is at odds with the impression of their high dietary importance in the observations of early colonists (Attenbrow, 2010b, pp. 73–74).

Order Lagomorpha

Family Leporidae

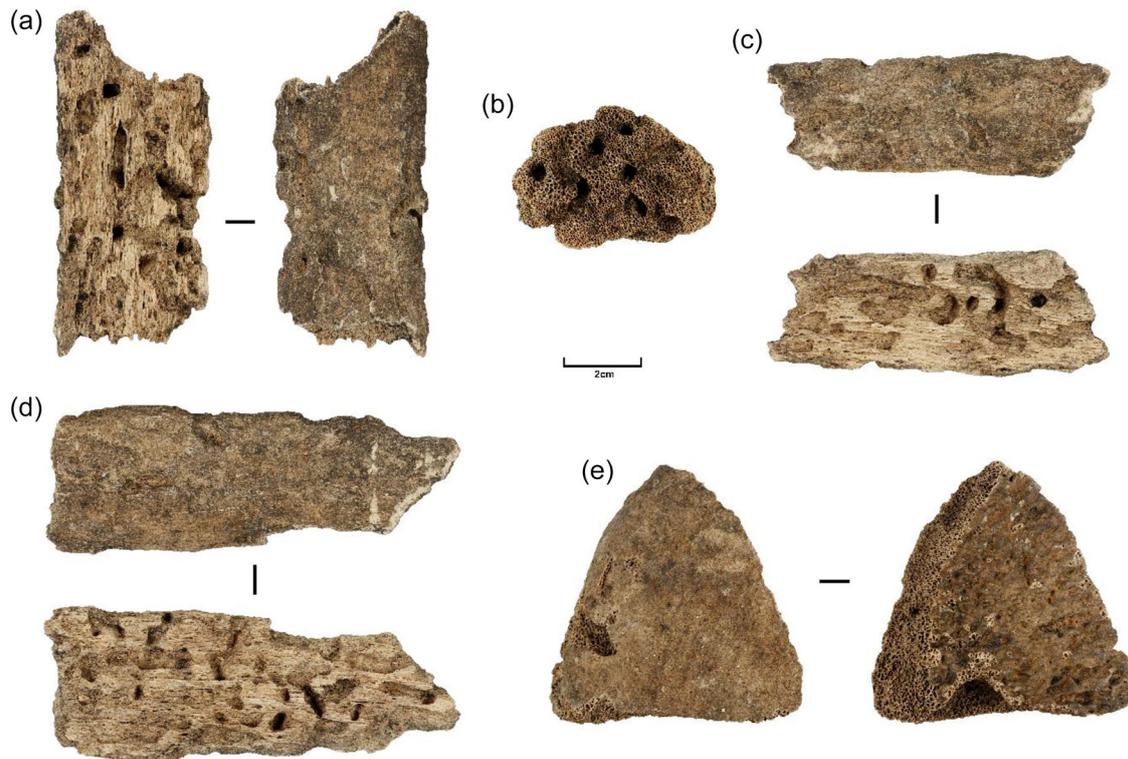
Some rabbit (*Oryctolagus cuniculus*) bones were identified from the midden and are presumably linked to the animal burrowing recorded in upper layers of some squares by Megaw, particularly in Square 1 and Square 4–7a, rather than being food items. Most have an adhering dark and very fresh-looking loamy dirt not observed on the other faunal material, indicating their recent intrusiveness. Rabbit burrowing is another likely source of disturbance in the upper midden.

Order Rodentia

Family Muridae

Craniomandibular elements of murids are reasonably common and identifiable as bush rat (*Rattus fuscipes*) rat

FIGURE 7. Whale bone fragments bearing taphonomic modifications. (a) Rib or vertebral process; (b) cancellous vertebral bone; (c–d) rib or vertebral processes; (e) vertebral centrum (endplate).



and swamp (*Rattus lutreolus*), although most murid remains from the site are limb bones which are also referable to either of these two species based on their sizes (Parker, 2019). Both species are present in the RNP today and are represented in Sydney, Kurnell and RNP sites (Attenbrow, 2010b, p. 72, 2012, p. 50). Gnawing marks from rodents were observed on some of the mammal bones (Figure 5) as well as many of the snapper neurocranial fragments. No craniomandibular or dental evidence of the much larger water rat, *Hydromys chrysogaster*, which was historically present and is represented in a Kurnell site (Attenbrow, 2010b, p. 72, 2012, p. 50), were identified.

Class Reptilia

Order Squamata

Suborder Lacertilia

Family Agamidae

One mandible of an agamid (“dragon”) lizard was identified. The specimen is relatively large, but no attempt to identify it further was made. The RNP is home to at least four agamid lizards (DECCW, 2011, p. 249). Members of this family have been found in coastal Sydney and Kurnell sites but not RNP ones (Attenbrow, 2010a, p. 74, 2012, p. 52).

Family Scincidae

Two moderately large and one very small (probably representing a non-dietary natural death and inclusion) species of skink were identified based on maxillary and mandibular specimens. No attempt to identify these further was made but at least one of the larger specimens is

referable to eastern blue-tongue lizard (*Tiliqua scincoides*). Unidentified “large skinks” have been reported from coastal Sydney and Kurnell sites but not RNP ones (Attenbrow, 2010a, p. 74, 2012, p. 52).

Family Varanidae

One decently preserved maxilla belongs to the goannas or monitor lizards (*Varanus* sp.). Both the lace monitor *Varanus varius* and heath monitor *Varanus rosenbergi* are found in the RNP. Although no systematic comparisons were attempted, the 1CU5 specimen is most likely referable to the former taxon. Goanna is one of the few genus-level reptile identifications made for an RNP site; they are also noted in coastal Sydney and Kurnell sites (Attenbrow, 2010a, p. 74, 2012, p. 52). Early observers noted that goannas and other reptiles were held in “esteem” as foods by Sydney area Aboriginal groups, but that they were hunted only when appropriate, including when bad weather prevented fishing (Attenbrow, 2011, p. 471).

Suborder Serpentes

Family Colubridae

At least one snake vertebra was referable to this family, which is poorly represented in Australia. The RNP hosts two arboreal colubrids, the mildly venomous brown tree snake *Boiga irregularis* and common tree snake *Dendrelaphis punctulatus*. No attempt was made to identify the specimen further. Colubrids have not been mentioned from Sydney, Kurnell or RNP sites (Attenbrow, 2010a, pp. 74–75, 2012, p. 52).

Family Elapidae

At least one snake vertebra was referable to this family of venomous snakes. RNP is home to numerous elapid genera which dominate the region's snake diversity (DECCW, 2011, p. 250). No attempt was made to identify the specimen further. Elapids have only been tentatively identified at one coastal Sydney archaeological site (Attenbrow, 2010a, p. 74).

Family Pythonidae

One snake vertebra was identifiable as belonging to the python family (Pythonidae). It is presumed to belong to the diamond python, *Morelia spilota*, which is the only representative of this family in the nearby region. *M. spilota* has been recorded in the RNP's littoral rainforest patches along its southern coastline (DECCW, 2011, p. 165) but has been reported archaeologically only from a coastal Sydney site (Attenbrow, 2010a, p. 75).

Order Testudines

Marine turtles are very poorly represented, with just four possible small fragments of shell identified. No effort was made to identify these further owing to their poor preservation. Marine turtles are very rarely seen in the Sydney area and RNP (DECCW, 2011), and there are no known observations of their hunting by Contact-era Aboriginal peoples locally (Attenbrow, 2011). Bones of the leatherback turtle *Dermochelys coriacea* (Dermochelyidae) have been tentatively identified from two coastal sites in northern Sydney though with little confidence, with reports noting that they could possibly actually be seal (Attenbrow, 2010b, p. 80).

Trends in taxonomic representation

A wide range of terrestrial and marine animal taxa, representing at least 42 species, were identified from the 1CU5 midden deposit. In this section, we consider the relative abundances of each and their bearing on the dietary composition of the rockshelter's ancestral occupants. Native mammalian taxa are mostly grouped by family, with macropods additionally split into "large" (red-necked and swamp wallaby) and "small" (rock wallaby and pademelon); birds are mostly grouped by order, but the smallest (prion) members of Procellariidae have been placed with "other birds" because only a few are present; invertebrates are grouped by class. Exotic fauna are given their own categories. It bears mentioning here that many of the identified taxa are either represented at 1CU5 for the first time in an RNP archaeological site, and in some cases, for the greater Sydney area more broadly. This is almost certainly a direct consequence of 1CU5's large deposit, the degree of faunal preservation, and the sheer volume of the excavations conducted, rather than any special peculiarities of the site's nearby resources or the dietary preferences of its occupants.

The most abundant class of bone at 1CU5 is overwhelmingly from the bony fishes (superclass Osteichthyes) which appear in every square at Curracurrang and essentially every bone-containing spit. Fish bone weight data are presented in separate tables for the first season test pits (Table 2) and the 2nd and 3rd season

squares (Table 3) respectively because of the major differences in the way each series were excavated. The greatest quantities of fish bone by weight are derived from the upper (loose) midden layers, which as noted above are primarily found within the deepest part of the rockshelter overhang and immediately downslope. A clear divide is observed in the difference of total fish bone retrieved from spits corresponding to loose midden (7781.4 g) and coarse midden (4522.4 g), as well as in sharp drop-offs between the weights corresponding to the loose and coarse levels from squares with the deepest-excavated deposit. Even within the rockshelter overhang, there is a clear drop-off in fish weights at the same uppermost depths from squares in the deepest part comprised predominantly of loose midden and squares at or nearer to the overhang's edges which comprise coarse midden.

These trends are clearer for the 2nd and 3rd season squares due to their less arbitrary assignment of excavated units. However, they are also clearer within the rockshelter overhang than on the slope outside of it. This is likely because, as noted earlier, the deposits within these squares seem to be composed of a mixture of material from both periods which has accumulated on the slope via post-depositional movement (including erosion). Hence, many of the "coarse midden" layers of the slope squares have seemingly unusually large amounts of fish bone when compared to the same depositional layers within the rockshelter. This is particularly true for the 2nd spit of most of the external squares (Tables 2 and 3). Megaw's excavation sections for this part of the site do not provide much differentiation between the midden deposit types observed, meaning there is uncertainty as to the degree of mixing between older and younger material here. With such palimpsests likely, some degree of confounding of the assignment of 1CU5 faunal material to periods of antiquity is likely; this is an unfortunate consequence of the excavation and recording methods used at the time. However, we are confident that loose and coarse midden units in squares within the rockshelter overhang are not mixed and that they clearly record trends in the abundances of fish and other faunal bone.

Considering the relative representation and abundances of taxa, presented in Table 4, there is a marked increase evident in the relative abundances of marine animals of all varieties (including invertebrates, but excepting the special case of unidentified cetacean) in the more recent upper midden unit. Considered with the dramatic increase in fish bone weights occurring in the same unit, this trend suggests a broad spectrum increased dietary importance of marine over terrestrial food sources within the last ~1500 years at 1CU5. This cannot be interpreted simply as the result of better bone preservation in more recently deposited material, as the absolute and relative abundances of nearly all terrestrial mammals decrease during this period relative to their representation in the lower midden unit (which is considerably older). There are no discernible patterns within the taxonomic range of marine food taxa found between each period, other than the only appearance of

Table 2. Fish bone weights from test trench squares of 1st field season excavations at 1CU5. Hyphens indicate that the excavated unit includes the transitional area between two units.

Square, excavated unit name	Depositional unit type	Fish bone weight (g)
<i>CU/5</i>		
Disturbed midden top	Loose midden	364.2
Midden	Loose midden	555.9
Bondaian	Black sediment	123.3
<i>CU/10</i>		
Disturbed midden top	Loose midden	538.8
Top-Midden	Loose midden	2.9
Bondaian	Black sediment	0.3
<i>CU/15</i>		
Midden (A)	Loose-coarse midden	18.9
Midden (B)	Coarse midden	643.3
Bondaian-Bottom	Black sediment	34.5
<i>CU/20</i>		
Top-Midden	Coarse midden	117.9
Midden-Bondaian	Coarse midden-black sediment	488.3
Bondaian	Black sediment	58.6
<i>CU/25</i>		
Midden	Coarse midden	0.6
Bondaian-Lowest	Black sediment-yellow sand	8.3
<i>CU/30</i>		
Top-Midden	Coarse midden	0.1
Bondaian	Black sediment	105.9
Bondaian-Lowest	Black sediment-yellow sand	2.7
<i>CU/35</i>		
Midden-Bondaian	Coarse midden-black sediment	38
Bondaian	Black sediment	4.1
Bondaian-Lowest	Black sediment-yellow sand	3.8

Table 3. Fish bone weights for first four spits of 1CU5 squares from 2nd and 3rd seasons. Unshaded cells indicate loose midden deposit; dark shaded cells coarse midden or black sediment; intermediate shading indicates transitional units.

Square	Fish bone weight (g)			
	<i>Spit 1</i>	<i>Spit 2</i>	<i>Spit 3</i>	<i>Spit 4</i>
0	197.1	72.7	23.9	0
0(1)	140.0	6.8	7.1	0.1
1	345.7	138.8	133.4	15.9
2	129.0	48.2	127	60.3
3	24.2	5.5	18	8
4	166.2	110	45	69.3
5	20.5	24.0	0.2	16.2
6	394.9	0.2	2.5	15.9
7	28.2	123.3	125.5	13.7
8	310.7	371.6	91.3	16.4
9	13.4	335.5	90	2.1
10	2.5	1251.1	100.3	0
11	7.5	41	0	-
12	9.3	588.4	59.4	4.7
13	16.7	681.0	17.3	0
14	8.3	13.6	-	-
15	3.3	643.8	22.6	0
16	18.3	33.8	39.0	0
24	0.1	28.1	0	0
25	108.4	353.3	79.6	209.7
30	214.0	10.2	0.4	0
∞	2.3	3.1	-	-

urchins being in the upper midden, although this statement obviously does not account for potential differences in the unidentified fish and molluscan material.

Within the terrestrial component of the 1CU5 diet, some changes in composition are apparent between periods. The importance of all terrestrial marsupials declines in the later period, except for the rodents and brushtail possums which increase, and the smaller macropods (pademelon and rock wallaby), which essentially do not change. Recalling that the large macropods and wombats provide far greater amounts of meat by weight per-individual than all the other terrestrial mammal taxa here (Weisbecker et al., 2013), the actual meat-weight contribution of terrestrial species in the 1CU5 diet must have sharply declined in the later period, apparently to be replaced amply by increased consumption of seal. Fully-grown *A. p. doriferus* males and females weigh on average 279 and 79 kg respectively, and even subadults less than two years old normally weigh in excess of 40 and 20 kg respectively (Arnould et al., 2003). Interestingly, the exploitation of the arboreal ringtail possum also seems to have been almost exclusive to the early period whilst the brushtail, though poorly represented altogether, exclusive to the later period.

Some mammalian taxa, namely the tiger quoll and fruit bat, are one-off representations. When it is considered that most of the midden was excavated, their rarity signifies that they were indeed very incidental parts of the pre-Contact occupants' diet and presumably obtained on an

Table 4. NISP and MNI counts for identified 1CU5 fauna.

Taxon	Upper Midden		Lower Midden	
	NISP	MNI	NISP	MNI
Large macropod	71	3	85	11
Small macropod	12	2	11	2
Potoroo	8	2	12	4
Wombat	7	5	19	11
Bandicoot	3	1	8	2
Brush-tail possum	5	2	0	0
Ringtail possum	2	1	10	5
Quoll	1	1	0	0
Bat	0	0	1	1
Rodent	26	17	16	9
Dingo	75	18	297	17
Seal	104	14	72	4
Cetacean	0	0	260	1
Shearwater	74	12	46	6
Albatross	7	4	2	1
Penguin	8	4	5	1
Other/unid. bird	62	25	53	28
Snake	8	3	3	3
Lizard	4	4	3	2
Turtle	2	1	2	1
Crab	84	24	14	12
Urchin	3	1	0	0
Cow	6	2	0	0
Sheep	1	1	1	1
Pig	2	1	0	0
Rabbit	16	6	1	1
Chicken	4	4	0	0

opportunistic basis. No discernible patterns are evident in the relative abundances of the terrestrial reptiles, which are minimally represented compared to the mammals and marine birds, and thus seemingly not dietarily significant. Abundances of dingo bones are predominantly driven (especially regarding NISP) by the presence of burials with numerous elements preserved, and these should not be considered dietarily significant. Although it is possible that people at the site consumed dingo sometimes, the incomplete, disturbed and disaggregated nature of all of the known burials and their cutting through by excavation squares makes it difficult to confidently assign isolated dingo elements as meal remnants, as opposed to transported pieces of disturbed burials. No meaningful change appears to have occurred in the abundance of dingo burials between the periods, but as these are in most cases likely to be intrusive depositions the chronological relevance of their surrounding matrix is dubious and should be expected to vary case-by-case based on where people decided to inhume each individual.

Nearly all the exotic post-Contact fauna are restricted to the upper midden, indicating the extent of depth of penetration of midden by very recent material is quite limited. The lowest rabbit bones may have arrived at their relatively great depth (as low as Spit 3, or some 12–18 inches) directly via the burrowing actions of that animal. Although traditional Aboriginal occupation of the Georges River area and parts of the RNP continued into the 1870s

(Goodall & Cadzow, 2009), there is little suggestion from zooarchaeology that this occurred to any noticeable extent at 1CU5. That most of the fauna reflect occupation prior to the late 19th century is supported by good representation of animals such as rock wallaby, potoroo, long-nosed bandicoot and native rodents which have suffered severe declines in numbers and range reductions after the proliferation of introduced cats (*Felis catus*) in the 1840s and the red fox (*Vulpes vulpes*) in the 1870s. Many are now extremely rare or locally extinct in the RNP (DECCW, 2011).

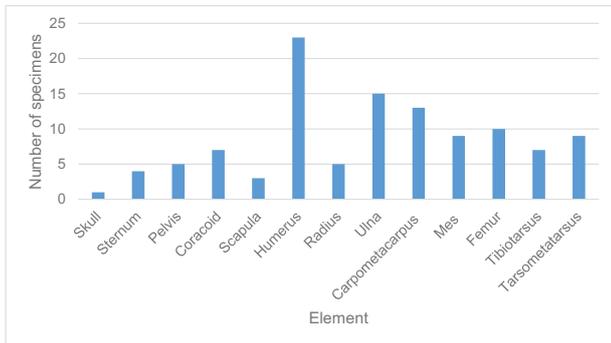
Marine bird and seal procurement

Questions regarding procurement are raised by the consistent representation of fur seals and the several types of seabirds at 1CU5 in the absence of any known historical or pre-Contact rookeries, or even suitable potential sites for them, within reasonable distance for any of these taxa. How then were these non-resident, transient visitor animals obtained with any regularity? Debates about the procurement of marine mammals and offshore nesting seabirds by ancestral people elsewhere have focused on the question of whether they were hunted or retrieved as washed-up carcasses, because the distinction is of significance in understanding the nature and structure of economic activities, gendered division of labour, hunting technologies, and patterns in residential mobility and seasonality (e.g., Dunnett, 1992; Fletemeyer, 1977; Vanderwal & Horton, 1984; West & Sim, 1994).

For seabirds, age profiles featuring high representations of subadults or young adults might feasibly indicate hunting in the form of harvesting. However, fledglings and young adults beginning their first seasonal migration from the breeding grounds are especially prone to being killed in storms, and can hence dominate the resulting assemblages of washed beach carcasses (Harrison, 1990, pp. 103–104), generating equifinality in hunted versus scavenged assemblages. An alternative assessment method focuses on the representation of elements from seabirds: in washed-up carcasses, the wing elements from the coracoid and scapula through to distal phalanges) are most likely to hold together through wave turbulence and be deposited on beaches as discrete meat-bearing units attractive to scavengers (Bovy et al., 2016). In the case of 1CU5, the best-represented seabird group, the shearwaters (Procellariidae), distribution is clearly weighted in favour of wing elements over the leg and especially the axial elements (Figure 8). Similar patterns apply to the other well-represented seabirds: the little penguins are represented exclusively by wing bones, and all but three albatross elements are also from the wing.

On the whole the data indicate more common deposition of wing elements, though not to the exclusion of leg and axial elements. As such it is likely that the shearwaters at least were frequently taken live and their whole carcasses processed, but this was very possibly supplemented by collection of washed carcasses tending to consist of articulated, meat-bearing wing portions. An alternative possibility is that bone points manufacturing using

FIGURE 8. Frequency of elements represented for shearwaters (Procellariidae) at 1CU5. Specimens which are fragmented into multiple pieces but can be clearly reconstructed as a single discrete specimen are only counted once.

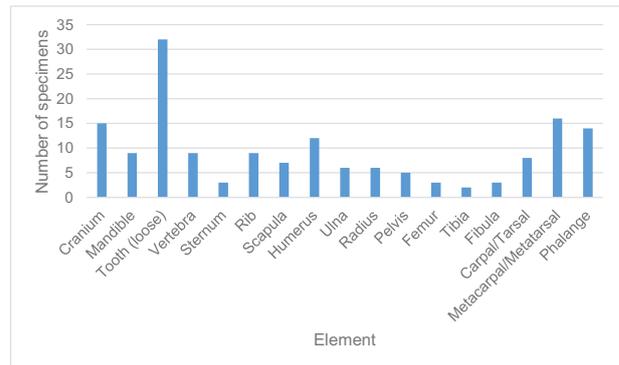


shearwater bone tended to utilise the leg elements over the wing bones, as was determined to be the case in the neighbouring Yuin cultural group at Durras North (Freeman et al., 2021), and that this has reduced the number of identifiable specimens of leg elements. However, whether 1CU5's bone points are made from shearwater vs. other bird or marsupial bone remains to be determined. There is no distinction in wing vs leg/axial element representation between the early and later phases, although it is worth remembering that in fact the "early" phase records of marine bird are typically from Squares on the slope or talus which consist to some degree of reworked more recent material.

An element-representation approach can also be helpful in investigating modes of acquisition for seals, although less so because their carcasses not infrequently wash up whole. Indeed some individuals that come ashore to recover from sickness or injury never make it back to the water (Geraci & Lounsbury, 1993). However, it is clear at least that people were not relying on carcasses in any notable state of decomposition and/or ones which had been transported long distances. In similarly sized pinnipeds, decomposed beach-washed remains are never whole and rarely are elements articulated; they rarely contain teeth or even mandibles; crania and vertebrae are over-represented, limbs under-represented, and manual/podial elements very under-represented (Liebig et al., 2003). Mandibles, teeth, limb long bones and manual/podial elements are all common in the 1CU5 seal assemblage whilst vertebrae are only moderately represented, so the distribution of elements present suggests that seals were obtained whole and processed in full at the shelter (Figure 9).

It cannot be ruled out that this occurred through collection of fresh carcasses from seals that died whilst feeding in the RNP waters. However, given the rarity of seals in those waters to begin with, waiting for them to wash up after dying would seem an unreliable way of procuring these animals. The local people would have to hope they could locate them along the very long coastline of the RNP

FIGURE 9. Frequency of elements represented for seals (Otariidae) at 1CU5. Specimens which are fragmented into multiple pieces but can be clearly reconstructed as a single discrete element are only counted once.



whilst they were reasonably fresh and then transport them before the numerous other scavengers (namely dingoes and seabirds; Behrendorff et al., 2016) could deplete them of meat. The inferred processing of whole carcasses at 1CU5 based on elements present makes long-distance transport of scavenged carcasses even less likely. The simplest answer is that the local people simply hunted them opportunistically when they came to shore at the same inlets, beaches, and near-shore waters that people were already fishing in.

Age-profiles are also relevant in determining modes of seal acquisition, although interpretations of the same biological reference data have produced varying applications to archaeological data. Elsewhere in the Southern Hemisphere, is believed that juveniles (<2 years old) of Cape fur seals (*Arctocephalus pusillus pusillus*, the South African subspecies of the same taxon represented at 1CU5) are predominantly over-represented in washes during the winter months, from July to September, when weaning occurs and young animals become weakened (Marean & Binford, 1986, p. 366), a pattern observed in other pinnipeds (Bodkin & Jameson, 1990). Hence age-profiles of archaeological fur seals predominantly (70–90% of MNI) comprised juveniles have been identified as the proceeds of regularised winter carcass scavenging (e.g., Fletemeyer, 1977). Conversely, others interpreted the same age-profiles as evidence of human hunters specifically targeting juveniles at rookeries (Binford, 1984).

As Marean and Binford (1986) explains, determining between the two options depends on whether an accessible rookery was present nearby. If a rookery was not known to be present or the potential presence of one cannot be realistically entertained, then major juvenile over-representation would probably be related to collection of washed carcasses. This is because juveniles are typically accompanied onshore by their parents, who aggressively defend them and would need to also be killed (Marean & Binford, 1986, p. 366). By the same line of reasoning, if adults are hunted it would be expected that the helpless juveniles accompanying them would also be taken (Marean

& Binford, 1986, p. 366). Hence, assemblages containing a mixture of adults and juveniles would be expected from procurement by hunting. Conversely, assemblages consisting only of adult seals, and particularly males, would more clearly indicate scavenging as the prevailing mode of seal acquisition. In the following warmer months of November to January, males are exhausted, very lean, and sometimes badly injured from their extended mating combat during the breeding season, leaving them vulnerable and more likely to die and wash up as they migrate away from breeding colonies (Marean & Binford, 1986, p. 366).

The demographic profile of 1CU5's seals includes adults (MNI = 8), both males and females although the majority of remains could not be distinguished, as well as juveniles (MNI = 6). Although the latter are more common in the upper midden (MNI = 3) than the lower midden (MNI = 1), they are not over-represented by any means. Taking this into account with the element distribution data, it seems even more likely most seals were obtained by attacking live adults accompanied by juveniles while onshore together, rather than scavenging washes. To this end it is possible that stealth was used to approach and beset onshore seals from behind, in the manner described as the typical strategy used by Tasmanian women to quickly catch seals that had come onto shore (Henley & Plomley 1990).

DISCUSSION

The well-preserved faunal sequence from 1CU5 forms an important contribution to understanding cultural Aboriginal subsistence and economies in the RNP, greater Sydney and NSW South Coast regions from around 2500 BP until European colonisation beginning in the late eighteenth century. Knowledge on this topic established by the excavation and study of other sites within the nearby area during late twentieth century and more recently (primarily in the course of cultural heritage management works) has been very limited due to a number of factors. The 1CU5 site therefore offers a unique opportunity to engage evidence from coastal southeastern Australia with pertinent models of Late Holocene economies in Australia, although regrettably the above circumstances do not permit a formal comparison with the other sites. Nevertheless, a brief consideration of local fauna-bearing sites is warranted before further discussion of the 1CU5 results.

Discounting those sites already mentioned which have not been analysed or published, the foremost amongst these problems is that typically only very small amounts of poorly-preserved vertebrate fauna (MNI/NISP < 1 per taxon) were retrieved, and/or non-fish remains are not reported on in substantial taxonomic or quantitative detail, this being the case for sites such as Gynea Bay rockshelter (Megaw & Wright, 1966), and the Loftus St and UCCC sites at Bundeena (Mary Dallas Consulting Archaeologists, 2004, 2008). Faunal analyses in these cases have focused on the far more abundant shell material. Recent excavations within a different area of the Meeting Place Precinct at

Kurnell retrieved a small amount of animal bone indicating exploitation of a broadly similar range of fish and terrestrial vertebrate species to 1CU5 (Irish, 2010). The midden is undated, but the lack of backed artefacts indicates it is likely < 1600 years old, suggesting some degree of contemporaneity with the later phase at 1CU5, but preventing any corroboration or contrast in terms of chronological change in dietary composition.

The McCue Midden, also at Kurnell, + is probably the most interesting of the recently excavated sites near to 1CU5, as it has a basal date in excess of 1800 BP and signs of continued occupation until the Contact era (Mary Dallas Consulting Archaeologists 2005). The McCue fauna are highly fragmented but otherwise decently preserved, and have been relatively well-analysed. Interestingly, relative bone weight values from this site appear to display a broadly similar taxonomic trend to that observed at 1CU5: mammal bone (apparently from macropods) is most common in the earliest stages of the midden, but is overtaken by large amounts of fish bone in the following more recent phases. Seals are absent, and the numerous bird remains are unidentified, leaving the possibility of shearwater & other marine bird exploitation as at 1CU5 unconfirmed.

A few salient points from comparisons with the above existing historical and archaeological literature can be related here. Firstly, many taxa not mentioned as foods of Dharawal people in the records of early historical observers concerning Aboriginal lifeways within this region are represented in the midden, confirming suspicions that these colonial records have substantially underestimated the dietary breadth of local peoples, and also the relative importance of different faunal resources in these regions (Attenbrow, 2010b). Significantly, in many instances taxa that are rare in previously described sites are represented in appreciable numbers at 1CU5, particularly noteworthy amongst these being the larger macropod taxa. Many of these taxa are also represented here for the first time in a RNP archaeological site, and in some cases, also within the archaeology of greater Sydney and the NSW South Coast. Finally, it is of ecological significance that multiple marsupial species which are well-represented at 1CU5 are now extinct in the RNP, although this seems to only be the result of post-Contact/colonial factors.

Further discussion of faunal trends at 1CU5 must also be prefaced with an acknowledgement of limitations. We are restricted to considering the last 2500 years of the site's > 8000-year occupational history. This means we cannot infer changes in diet relating to the initial adoption and major proliferation of backed artefacts and ground-edged axes in the region (occurring c. 4000–3500 BP) (Attenbrow et al., 2009). It also means that we cannot infer dietary changes relating to the depredations of wild dingoes (Fillios et al., 2010, 2012) and/or their novel use as tamed hunting assistants (Balme & O'Connor, 2016; Koungoulos, 2017), both of which occurred more than a millennium before the earliest preserved 1CU5 fauna (Balme et al., 2018; Koungoulos & Fillios, 2020). Here we concentrate on the implications of the 1CU5 data for larger proposed

economic models concerning technological and labour organisation, which involve both the above supposed agents of change to some extent.

Late Holocene changes in technological organisation have long been posited as reflecting changes in Australian economic strategies. Discussions regarding southeastern Australia are mainly concerned with (1) the production of backed artefact or microlith technology from ~4000 BP and its abandonment in the last millennium BP and (2) the introduction of ground-edged axes from ~4000 BP and their increasing production within the last millennia. On the NSW coast archaeological discourse has also been interested in (3) increased production of bone points for fishing spears and (4) introduction and proliferation of shell fish-hooks for line fishing (Hiscock, 2008). Implicit in such models of technological change are some kind of alterations to the makeup of hunting yields and thus in overall dietary composition.

Prevailing models for “function” of microlithic backed artefacts supposed their use as points or barbs in composite projectile armatures, used for hunting large mammal game – namely kangaroos and wallabies – and for combat (Kamminga, 1980; McBryde, 1985; McDonald et al., 2015). The main animal-procurement function assigned to ground-edged axes is for cutting footholds to climb trees and to chop out the wood from nesting holes from which marsupials were captured (McBryde, 1977; Morwood & Tresise, 1989). Presumably, economies centred on the use of microlith technologies would then be expected to emphasise macropod exploitation, and those centred on axes would emphasise arboreal marsupials as sources of meat. To this end, there has been some attempt to posit chronological associations of these technologies and faunas, although these have always been prevented in the greater Sydney region and NSW South Coast by the small and poorly preserved amounts of non-fish bone surviving from earlier than the last millennium (Attenbrow, 2010b; Kohlen, 1986).

However, both technologies had multiple (mechanical and economic) functions, including ones not related to the procurement or processing of animals, as shown through residue and use-wear analyses (Attenbrow & Kononenko, 2019; Kononenko et al., 2021; Robertson et al., 2009, 2019). Their multifunctionality is emphasised in alternative models of technological organisation which interpret their proliferation as a risk-reduction response by people experiencing resource stress under fluctuating environmental conditions, who required toolkits capable of procuring and processing a wider variety of resources than those most preferred (Hiscock, 1994; Hiscock & Maloney, 2018). Both microliths and axes are suggested to be related to increased dietary breadth in the Late Holocene, as interpreted from the increased abundances of lower-ranked small game species in various sites during this period (Fillios et al., 2010, 2012; Hiscock, 2008).

The earliest phase of 1CU5's faunal sequence coincides with the production and use of backed artefacts and the latter with their abandonment both at this site and within

the region (apart from the distinct class of eloueras, which are woodworking implements and not further considered for this discussion). From 2500 BP to about 1500 BP, both terrestrial and marine animals were exploited for food by the site's occupants. There appears to have been an emphasis on the former, in this phase, particularly as it pertains to marsupials. A wide range of taxa were exploited, potentially fitting the expectations of hunters using both microlith-armed spears for large game (wallabies, wombats, possibly dingoes) and axes for arboreal small game (ringtails). However, the larger numbers and substantial differences in their body sizes suggests that the vast majority of terrestrial meat was derived from two large macropod species and wombats. Nearly all these animals, regardless of size, preferred habitat and terrestriality or arboreality, decreased in abundance in the later period. Brushtail possum is the only exception, and even this species is only found in such miniscule numbers that it can hardly reflect a greater trend rather than chance occurrence.

Few of these trends other than the relative decrease in large marsupial consumption conform closely to any of the predictions for a switch from microlithic- to axe-oriented toolkits outlined above. There is no clear increased reliance on a greater range of marsupials smaller than wallaby, or reptiles or terrestrial birds, to offset the actual observed decrease in large macropods and wombats, although there is an apparent increase in rodent consumption. The shift in the later phase is most clearly one to increased exploitation of marine resources: fish, seals, seabirds, crabs and urchins. The last of these are of dubious and probably minor importance, unless they were mostly eaten shoreside immediately after collection and not in the shelter (or possibly used for line-fishing baits). Despite the regular use of axes at the site in the later phase, there is no evidence for an emergent reliance on arboreal marsupials following the abandonment of backed microliths, and in fact apparently the opposite occurred. However, it is worth noting that the chronology of the flaked and ground implement industries of 1CU5 require detailed re-analysis, not least in the light of our new radiocarbon dates for the site's units.

The predicted taxonomic and dietary outcomes of using bone-pointed fishing spears and fish hooks are more self-explanatory. Documented observations of their use and surviving ethnographic analogues record that both were used to capture marine fish (Attenbrow, 2010a, 2011). Some variation in the taxa captured between the two is to be expected given that spears were used primarily on or closer to the shore than hook-and-lines, which were mostly cast from canoes on open water, or more rarely from rock platforms (Attenbrow, 2010a). Further exploration of this possibility will have to await systematic analysis of the 1CU5 ichthyofauna, although it certainly seems that the use of spears and lines is likely to have facilitated the substantial increases in fish observed in the most recent units at 1CU5. However, fish aside, a model other than a causal one driven by novel technology seems to be required to explain the broader marine resource preference occurring in the last 1500 years at 1CU5. Fish-hooks postdate the

beginning of this phase by at least 500 and possibly 1000 years or more, whilst fishing spears were already well-represented during the Bondaian period (Attenbrow, 2012; Megaw, 1965, 1968, 1974).

A recent model for Late Holocene prehistory in Australia has argued that an exhaustion of high-ranked terrestrial animal resources, driven mainly by depredations of newly arrived wild dingoes and fluctuating environmental conditions, triggered major shifts in subsistence organisation (Hiscock & Sterelny, 2023). These changes are viewed through the lens of the “Red Queen” evolutionary mechanism, which identifies (biological, but in this case cultural) developments as adaptive responses necessitated by novel environmental pressures. Animal procurement activities were reoriented towards regularised exploitation of more reliable but smaller and/or harder to procure lower-ranked game species: an “economy of lower returns for more work” (Hiscock & Sterelny, 2023, p. 12). The targeted resources vary by region but include arboreal marsupials, rodents, lizards, birds, fish, crustaceans, molluscs, and seals. These are mainly taxa that were less or not at all affected by the presence of dingoes as a novel predator. Accessing them required the use of novel or previously underutilised technologies, as well as intensified exploitation of previously underutilised animal habitats – forest canopies, rivers and lakes, beaches and rocky coastlines, and offshore islands (Hiscock & Sterelny, 2023).

Changing faunal representation within the last 1500 years at 1CU5 might appear to fit the general premise of the Red Queen model, insofar as an increased reliance on various marine resources and rodents is observed in the Late Holocene. However, other proposed key aspects of the model such as an increase in arboreal marsupial or lizard exploitation are not supported here. It is also not clear that the shift to marine resource exploitation at 1CU5 was driven by a deterioration of local terrestrial resources occurring from/by 1500 BP, rather than other factors such as a change in the nature of site usage and/or intensity. The timing of subsistence change at 1CU5 is far too late to be referred to either depredations of wild dingoes of large terrestrial marsupials (from at least c.3500 BP), or the effects of ENSO-driven climate change (from c.5000 BP), the two major factors invoked by the Red Queen model (Hiscock & Sterelny, 2023). At around 1500 BP, however, the cold and dry conditions created by ENSO abated and a distinct warmer, wetter period began in southeastern Australia, until reaching the currently prevailing climate conditions (Attenbrow, 2006, p. 206; Harrison & Dodson, 1993; Thomas et al., 2022). Could climate have played a role in resource base change at Curracurrang?

In a potentially relevant case study, a major depletion of larger macropods occurring after 1200–1000 BP has been identified in sites at Mangrove Creek, just to the north of Sydney (Attenbrow, 2006, pp. 208–209). Here, in layers dated to and after this period the staple macropod taxa from earlier layers, red-necked wallaby *N. rufogriseus* and grey kangaroo *Macropus giganteus*, decline in abundance and entirely disappear from the record, respectively (Aplin,

1982). They are replaced by increasing numbers of swamp wallaby *Wallabia bicolor* and a pademelon *Thylogale* sp., which are smaller than *M. giganteus* and *N. rufogriseus*, respectively. A proposed explanation for this change, based on palynological records from the area, is that wetter conditions spurred contraction of local grassland and open forest favoured by the former two taxa, which are grazers, and supported expansion of wet, closed forest with dense understory favoured by the latter two, which are browsers (Attenbrow, 2006, pp. 208–209).

Palynological evidence from wetlands in the RNP does not suggest any particularly notable changes in vegetation communities in the last 1500 years. Some modest changes observed seem to be mainly due to changing proximity to the sea of the swamps from which sediment cores were sourced, but overall there was “very little change in the less-sensitive sclerophyllous vegetation” (Chalson & Martin, 2012, p. 65). It is worth noting, however, that at nearby Kurnell palynological research has identified an expansion in the dryland scrub characteristic of the RNP coastal heath and scrub, after 1700 BP and possibly owing to regularised anthropogenic burning (Martin, 1994). Unlike at Mangrove Creek, at 1CU5 *N. rufogriseus* are still present and quite abundant in the most recent layers, and unlike at Mangrove Creek the browsing species do not seem to noticeably increase in proportional abundance in the recent phase. The evidence for degradation of large macropod resources caused by environmental change would thus seem to be very dubious for the RNP environs.

What about the other terrestrial game species? There is no reason to suspect that warmer, wetter conditions, increased closed, wet forest with understory, or increased dryland scrub would negatively affect habitat options for wombat or ringtail possum in the RNP, to the extent where it would explain their sharp declines in the 1CU5 diet after 1500 BP (particularly given that the latter is very common in the park today). Nor would it have negative effects on the habitat of the bandicoots and potoroos which decline more modestly in representation. The difference between the sharp decline in wombat and ringtail on one hand, and the moderate decline of the others is perhaps better understood not as one of environmental change pushing hunters away from scarcer game species, but one of choices made regarding relative extractive efforts and labour.

Ethnographic evidence indicates that harvesting of wombats and ringtail possums is physically laborious, time-consuming (Bulmer in Vanderwal, 1994, pp. 50–51), and in the case of climbing trees for the latter, risks debilitating personal injury. Although the procurement of these animals is made easier by the availability of dogs (dingoes) and ground-edged axes, they still require specialised strategies to obtain which entail a great investment of time and energy relative to other sources of protein and energy within the RNP coastal landscape. Conversely, bandicoots, potoroos (and rodents) are small understory-dwelling animals that are easily enough encountered with general searching techniques, or even simply whilst travelling, particularly if one is accompanied

by a dog/dingo. We cannot interpret changes within terrestrial hunting at 1CU5 after 1500 BP as reflecting greater extractive efforts for lower returns, as the Red Queen model might predict (Hiscock & Sterelny, 2023), but rather the opposite – a decline or abandonment of high-effort strategies.

This fits well with a general reorientation of subsistence strategy away from reliance on larger sources of terrestrial protein altogether. Although the marine fish forming the staple protein of the later phase diet at 1CU5 do not provide as much meat as large wallabies or wombats, they can be caught in larger numbers, with greater reliability, and with less effort and personal risk with the aid of fishing spears and hook-and-line technology. The ability of lower-ranked smaller species to assume higher dietary importance when they can be mass-collected regularly is well-known within optimal foraging theory (Zeder, 2012). Moreover, some of the key later-phase marine resources such as seal should perhaps not even be assumed as lower-ranking at all, given that adults provide several times the meat that the largest macropods at 1CU5 do. We therefore may interpret a shift to increased marine resource utilisation not as a response to increasing marginalisation of terrestrial resources, but of people taking advantage of reliable and more easily obtained resources.

There is some evidence to suggest “pull” factors may also have been at play in encouraging the attractiveness of marine resources for local people within the warmer period of the last 1500 years specifically. Curracurrang’s staple fish species, and probably its staple meat source altogether, the Australasian snapper (*Chrysophrys auratus*) benefits from warmer water temperatures, becoming larger and surviving at greater rates as larvae, potentially offering greater yields and reliability from fishing activities (McMahon et al., 2020). Similarly, squid numbers and size also benefit from warming waters (Doubleday et al., 2016). As they are one of the main foods for seals, shearwaters, albatrosses and penguins alike, an increasing abundance of squid may have increased the numbers of these animals visiting the RNP waters and hence in turn their availability to local hunters and fishers. Closer examinations of the ecologies of the significant marine taxa at 1CU5 may reveal further means by which warmer and/or wetter conditions could benefit their abundances or seasonal availabilities.

One possibility for the ongoing development of marine resource exploitation in the recent phase of 1CU5 is that what may be described as a marine resource positive feedback loop, constituting a reorientation of the subsistence base, initially following increasing exploitation of the most immediately available and reliable marine resource – fish. This would have begun with increasing fishing spear use c.1500 BP and was compounded firmly by the adoption of hooks for line fishing after 1000 BP. People then spending more time on the shore and on the water than deep in the heath, scrub or forest were able to take better advantage at short notice of sporadic opportunities to capture visiting seals and seabirds on or near shore, including fresh beach washes. These resources might be

characterised as unreliable or unpredictable in their availability on the short-term or daily basis but with reliable windows in which their presence was predictable if animal-procurement activities were focused on the shoreline. The presence of dingo pups, seals, cetacean and muttonbirds at 1CU5 indicates its occupation during the winter months and into spring, and possibly into summer. The occupants were clearly aware of the seasonal timeframe in which they had the best chances of reliably obtaining seals and seabirds in close proximity to the rockshelter.

Other sites which suggest increased reliance on marine resources within the last 2000–1500 years in southeastern Australia include those in the Sydney area (Attenbrow, 2011) and on the NSW South Coast (e.g., Lampert, 1966, 1971), several islands off the NSW coast (Sullivan, 1982), and the Tasmanian mainland and some of its offshore islands (Stockton, 1982; Vanderwal & Horton, 1994). It is tempting to interpret the fact that many sites in these areas seem to date predominantly or entirely from within the last 2000–1500 years and are dominated by marine fauna as support of a wide-spanning trend of people shifting to increased occupation of coastlines and their resource bases at this time, driven by shared climatic factors (i.e., the warmer, wetter period). However, we cannot say with certainty that some did not have earlier phases which were relatively more terrestrially oriented (as at 1CU5) but for which bone has not been preserved owing to prevailing unfavourable soil chemistry conditions (Attenbrow, 2010b, p. 3). We cannot also be certain that middens evidencing intensive usage of the same resources at an earlier time have not simply eroded away before recording by archaeological research. The concept of broad-scale increased exploitation of marine resources in southeastern Australia during the last 2000 years requires further investigation with respect to climatic or environmental push-and-pull factors, novel procurement technologies and taphonomic/site history factors on a case-by-case basis.

CONCLUSION

Curracurrang 1, also known as 1CU5, is an important rockshelter site recording some of the earliest known human occupation of the greater Coastal Sydney area. The majority of the site’s large midden was excavated more than 50 years ago, and although it was recognised as bearing a large non-shell faunal component of potential importance this was never formally analysed until now. New direct bone dates and a revised radiocarbon chronology for the site presented here reveal that the midden captures the dietary fauna of the last ~2500 years of 1CU5’s occupation.

Zooarchaeological analysis of the fauna finds that a wide range of terrestrial and marine taxa were eaten by the site’s occupants, with the relative importance of the latter increasing notably over terrestrial animals within the last 1500 years, a shift compounded by the adoption of shell fish-hook technology in the last 1000 years. The exploitation of terrestrial marsupial fauna may have

decreased as a consequence of improving opportunities to exploit more reliable and abundant marine fish as well as fur seals, muttonbirds and other seabirds seasonally available in close proximity to the shelter. Dedicated study of the site's abundant fish remains in future holds potential for greater understanding of the development of Late Holocene economic strategies in the greater Sydney region.

ACKNOWLEDGEMENTS

This research was funded by the Australian Research Council Discovery Grant [DP210101960]. We thank the La Perouse Local Land Council for permission to carry out the work. Staff at the Australian Museum are also thanked for helping us with access to the collections, and museum study permits: Val Attenbrow, Allison Dejanovic, Mariko Smith, Rebecca Jones, Dale Higginson and Niamh Formosa. Aboriginal Heritage Impact Permits (AHIP) for the destructive sampling of dingo bones from Curracurrang were obtained from the Office of Environment and Heritage, NSW (AHIP number 4353).

Open access publishing facilitated by Australian National University, as part of the Wiley - Australian National University agreement via the Council of Australian University Librarians.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Supporting Information