Journal of Field Archaeology

ISSN: 0093-4690 (Print) 2042-4582 (Online) Journal homepage: www.tandfonline.com/journals/yjfa20

Gone with the Wind, Waves, and Walking: Prioritizing Research at Vulnerable Archaeological Sites in Coastal Zones

Ashleigh J. Rogers, Bruno David, David M. Kennedy, Russell Mullett, Joanna Fresløv, Fiona Petchey, Gunaikurnai Land and Waters Aboriginal Corporation, Jerome Mialanes, Liam Neill, Olivia Bowman, Cade Brickle-Krizanac, John Hayes & John Dow

To cite this article: Ashleigh J. Rogers, Bruno David, David M. Kennedy, Russell Mullett, Joanna Fresløv, Fiona Petchey, Gunaikurnai Land and Waters Aboriginal Corporation, Jerome Mialanes, Liam Neill, Olivia Bowman, Cade Brickle-Krizanac, John Hayes & John Dow (2025) Gone with the Wind, Waves, and Walking: Prioritizing Research at Vulnerable Archaeological Sites in Coastal Zones, Journal of Field Archaeology, 50:4, 345-361, DOI: 10.1080/00934690.2024.2398841

To link to this article: https://doi.org/10.1080/00934690.2024.2398841

JOURNAL OF FIELD ARCHAEOLOGY
2025, VOL. 50, NO. 4, 345–361
https://doi.org/10.1080/00934690.2024.2398841

Gone with the Wind, Waves, and Walking: Prioritizing Research at Vulnerable Archaeological Sites in Coastal Zones

Ashleigh J. Rogers [1,2], Bruno David [1,2], David M. Kennedy [1,3], Russell Mullett[1,4], Joanna Fresløv[4], Fiona Petchey [5,6], Gunaikurnai Land and Waters Aboriginal Corporation[1,4], Jerome Mialanes [1,2], Liam Neill [7], Olivia Bowman[4], Cade Brickle-Krizanac[4], John Hayes[4], and John Dow[4]

[1]ARC Centre of Excellence for Australian Biodiversity and Heritage, Monash University, Clayton, Victoria, Australia; [2]Monash Indigenous Studies Centre, Monash University, Clayton, Victoria, Australia; [3]The University of Melbourne, Parkville, Victoria, Australia; [4]Gunaikurnai Land and Waters Aboriginal Corporation, Victoria, Australia; [5]University of Waikato, Hamilton, New Zealand; [6]ARC Centre of Excellence for Australian Biodiversity and Heritage, James Cook University, Cairns, Queensland, Australia; [7]Verge Archaeology and Heritage Pty Ltd, Melbourne, Victoria, Australia

ABSTRACT
Climate change, rising seas, and encroaching public camping are escalating threats to cultural heritage places along much of Australia's coastline. For the Gunaikurnai Land and Waters Aboriginal Corporation of southeastern Victoria, Australia, the documentation, research, and management of vulnerable coastal archaeological sites is a key priority. Here, we present the results of archaeological excavations undertaken at the Brataua site complex in Wellington Shire, Victoria. Despite site loss through coastal erosion, agriculture, and recreation, the excavation results revealed that people repeatedly visited the area for at least 3000 years for shellfishing and to obtain local quartz pebbles for stone tool manufacture. These findings call for a refinement and rethinking of the regional archaeological sequence established by pioneer researchers in the 1960s–1980s. They highlight the importance of storytelling in places that are highly vulnerable and in danger of destruction within a matter of years, months, or even weeks.

ARTICLE HISTORY
Received 9 April 2024
Revised 3 August 2024
Accepted 6 August 2024

KEYWORDS
Aboriginal coastal lifeways; archaeological site erosion; recreational visitor impact; coastline change; Holocene shell middens; community-led archaeology; Australia

Introduction

In Australia, as elsewhere around the world, coastal environments often hold abundant and dense archaeological deposits. In some coastal landforms, especially dunes, archaeological lenses, layers, or horizons can lay one on top of the other, and where dune-faces have been eroded, such sequences can often easily be seen exposed even prior to excavation. The reasons for the formation of such rich archaeological landscapes can be varied and include: the presence of soft deposits (e.g. unconsolidated sand) preferred for a range of cultural activities; the presence of a network of adjacent habitats and ecotones, each with its own plant, animal, and mineral resources; spiritual presences; proximity to the sea, with its own supply of marine biota, many of which can rapidly recover from depletion following moderate to more intensive levels of gathering and hunting activities; and, beaches that make for easy travel routes and meeting points (Bailey and Milner 2002; Jerardino and Marean 2010).

Each and all of these factors have made the coast particularly attractive for human settlement and subsequent archaeological research, and Australia is no exception. The island-continent of Australia boasts one of the longest coastlines of any country in the world. The mainland coast is 25,760 km long—the sixth-longest coastline of any nation in the world— and when the surrounding ca. 12,000 islands are included, this figure reaches 66,530 km, extending over 30° of latitude from the tropical north to the temperate south (Australian Bureau of Statistics 2012; World Resources Institute 2014). The drowning of the continental shelf soon after the Last Glacial Maximum (LGM) means that many Late Pleistocene–Early Holocene coastal sites have been lost (Ishiwa et al. 2016). Nevertheless, tens of thousands of sites such as shell middens,[1] mounds, and stone artifact scatters remain on today's coast, some exposed on the surface, others buried by sediment (e.g. Faulkner 2009; Lambrides, McNiven, and Ulm 2019; Manne and Veth 2015; McNiven et al. 2014; see Rowland, Shaw, and Ulm 2021 for a review).

Coastal archaeological sites, however, are often severely impacted by natural processes such as those associated with wind and waves and human activities such as walking, camping, and encroaching developments, each of which can damage or remove artifacts, sites, and even whole landforms (e.g. Hassler 2006; Rowland 1989; Rowland and Ulm 2012; Rowland, Ulm, and Roe 2014). Sea level rise and changing storm patterns associated with climate change pose significant threats to coastal sites across broad sea-bordering landscapes. As sea levels rise, the impact of marine processes extends above and beyond its normal range, resulting in the destruction of sites and submergence of archaeological remains (e.g. CSIRO 2022; Smith 1998; Smith and Jackson 1990; see Benjamin et al. 2020 for a rare example of an apparently deeply submerged archaeological paleo-floor in Australia). Rising seas can also result in salinization—increasing the salt content of coastal groundwater and soil—so that the chemical composition of the soil is altered, disrupting the preservation conditions of archaeological materials, as well as growth patterns of protective vegetation (e.g. FitzGerald

CONTACT Ashleigh J. Rogers ashleigh.rogers1@monash.edu Level 8, Menzies Building, 20 Chancellors Walk, Monash University, Clayton, 3168, Victoria, Australia.
Supplemental data for this article can be accessed online at https://doi.org/10.1080/00934690.2024.2398841.

et al. 2008; Murphy, Thackray, and Wilson 2009). Events associated with climate change, such as sea level rise and changing storm conditions (e.g. hurricanes, cyclones, and catastrophic floods) can cause major, sudden damage to coastal sites and landforms through erosion, complete wash-out, and sediment displacement (CSIRO 2022; Gregory et al. 2022; Rowland 2008).

People can also pose direct threats to coastal sites. Today, 87% of Australia's population lives on or near the coast; this comes with urban and industrial infrastructure development along the coast (Australian Bureau of Statistics 2020; Cechet et al. 2011). Waterways and shorelines are popular locations for leisure activities such as boating, camping, and fishing. When not properly managed, such public recreational access can lead to unintentional adverse impacts, particularly erosion, on coastal sites and landforms. Over the past 230 years, many coastal areas have also been used for agriculture and stock grazing. Intentional and inadvertent changes to coastal landforms, such as those resulting from the removal of vegetation and soil disturbance, further exacerbate the coastal hazards threatening archaeological sites through immediate or delayed erosion (e.g. Rowland and Ulm 2012; Sullivan 1981).

First Nations communities, archaeologists, cultural heritage practitioners, land-care groups, and government management authorities have all become keenly aware of the increased vulnerability of sites and landforms—their susceptibility to damage and destruction—and this is now an acute concern (e.g. Birkett-Rees et al. 2022; Knott et al. 2017; O'Connor and Sullivan 1994; Reeder-Myers 2015; Rowland 1992; Rowland, Ulm, and Roe 2014). The complexities of the threats to coastal archaeological sites and landscapes can be a challenge, leading to new or enhanced research and action, including calls for united, partnership investigations and solutions. A number of monitoring schemes have thus been suggested, including: the regular assessment of geoindicators (dune formation and reactivation, relative sea level rise, and shoreline position) through remote sensing, historical records, and anecdotal observations (Daly et al. 2022; Rowland 1989; Rowland, Ulm, and Roe 2014); community-based site risk assessments (Carmichael et al. 2018); and, proactive identification of vulnerable locations to prioritize management intervention (e.g. cultural heritage surveys and salvage excavations) (Birkett-Rees et al. 2022; O'Connor and Sullivan 1994, 89; Reeder-Myers 2015).

The Gunaikurnai Land and Waters Aboriginal Corporation, representing the Aboriginal Traditional Owners of large parts of Gippsland, eastern Victoria, have initiated a partnership research program with university specialists (archaeologists, geomorphologists, and biogeographers) and community rangers towards the short- to long-term monitoring and management of the coastline in GunaiKurnai Country. The coast is of enormous cultural significance to GunaiKurnai Traditional Owners, for it is here that many ancestral origin stories are found, as well as highly cherished ancestral residential, subsistence (e.g. shellfishing, fishing, and black swan egg-collecting), and burial places (Gunaikurnai Land and Waters Aboriginal Corporation 2015, 38). Indeed, one of the corporation's emerging key priorities is to document, research, and manage threatened coastal archaeological sites (Kennedy et al. 2023).

In light of all the pressures of the coast listed above, a concern for all places in an interconnected GunaiKurnai land-and-seascape, and in consideration also of longer-term planning needs and aspirations, decisions and their priorities are required on a daily basis. Archaeologists around Australia, and elsewhere in the world, often focus on the larger or denser or deepest sites, either because they are more complex structurally, or because they contain multiple phases of occupation, or because their higher densities of cultural materials provide a better picture of past people's lives. Such a focus on these richer deposits, however, is often at the expense not only of the smaller sites but also of those that have already been largely destroyed, so that only their last traces remain in situ. Soon, such sites will be destroyed, and the possibility of their research, and the stories of the Old Ancestors[2] they contain, forever gone with them. How to balance, then, research in rich and relatively intact sites with those in the most vulnerable sites and landscapes? This is a dilemma that faces many First Nations communities, archaeologists, and management authorities around the world.

The Gunaikurnai Land and Waters Aboriginal Corporation has undertaken a combination of whole-landscape surveys and detailed excavations in both relatively intact and vulnerable sites and the monitoring of sites and landscapes by GunaiKurnai Rangers, each incorporating training programs, as a way to enable informed management strategies and the telling of the stories of ancestral places across GunaiKurnai Country. This paper is one such story, about a place whose archaeological traces are nearly gone through erosion along a coastal track. It represents the results of the first research-focused archaeological excavation in coastal southern Gippsland for over 40 years. We ask: what is the potential of very small archaeological sites that have nearly totally disappeared and continue to be impacted by sea level rise, climate change, and recreational public access to tell the stories of the Old Ancestors?

Previous Archaeological Research in the Area

Most of the archaeological research undertaken in coastal Gippsland was done in the 1960s–mid-1980s, with field-based cultural heritage resource surveys, salvage excavations, and desk-based reviews also available in the grey literature. Much of this research took place at Wilsons Promontory (Coutts 1970; Jones and Allen 1979; Figure 1) or the Gippsland Lakes (Hall 1989; Hotchin 1990) prior to the advent of accelerator mass spectrometry (AMS) radiocarbon dating. These studies were also mostly undertaken before calibration curves for radiocarbon dates were available, meaning that published interpretations were largely based on uncalibrated radiocarbon dates from bulk charcoal samples spanning broad excavation units or collected from surface scatters or exposed sections. The dating is thus not as accurate or precise as would be expected in more recent research programs.

Chronological trends in shell and stone artifact deposits were first investigated by Peter Coutts in 1964–1967 for his Masters thesis at Wilsons Promontory, in coastal far-southern Gippsland (Coutts 1967, 1970). Excavations in stratified sand dunes led Coutts to identify two distinct cultural phases. The older phase, which he termed Yanakie A, was radiocarbon dated to 6500–3000 B.P. and characterized by the exploitation of rocky shore shellfish such as *Turbo* spp., *Lunella undulata*, and *Cellana tramoserica*. Stone artifact assemblages were dominated by exotic quartzite and included backed blades and retouched flakes. The later

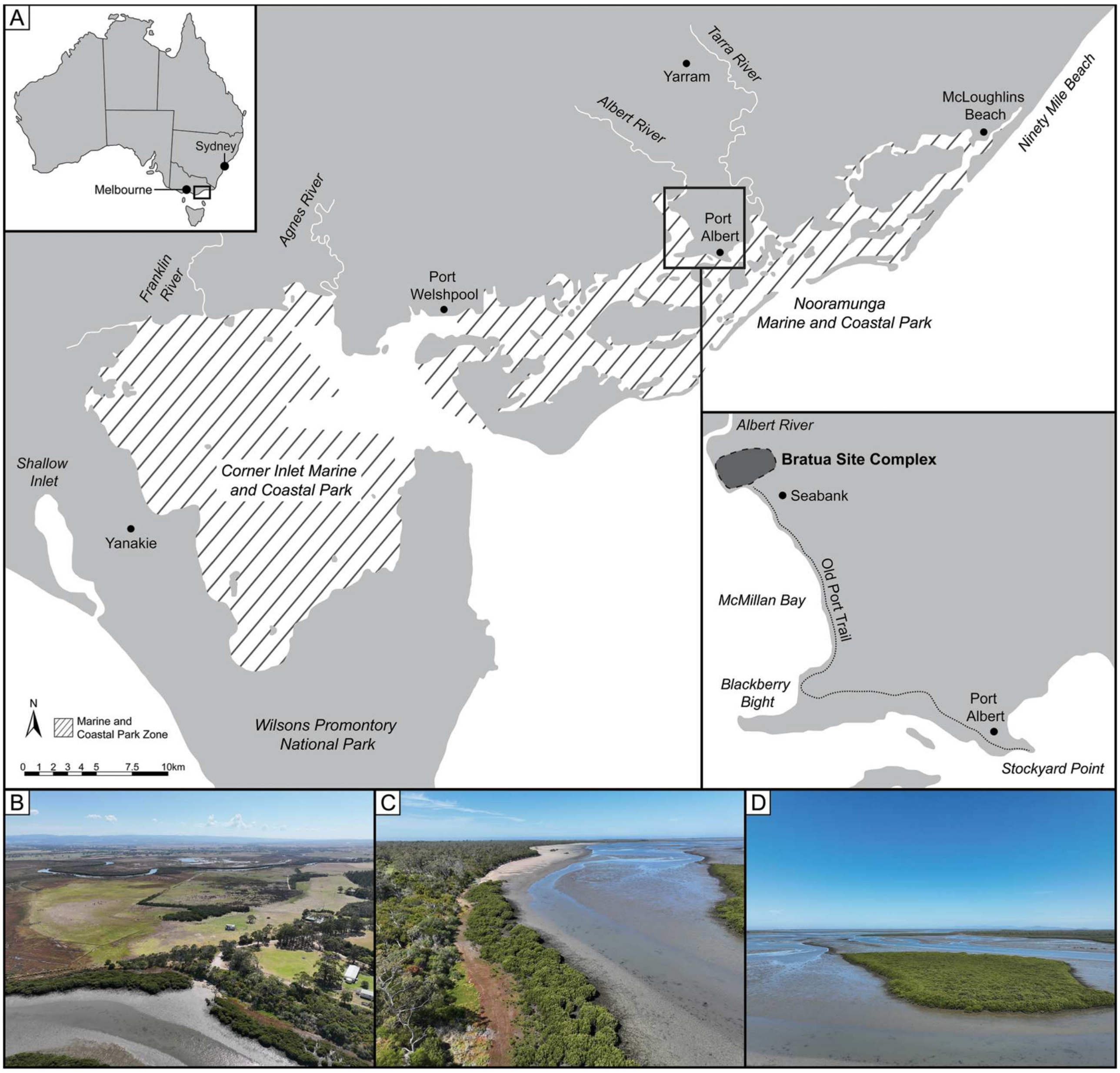

Figure 1. The study area. A) Location of study area showing localities mentioned in the text, including Wilsons Promontory, 90-Mile Beach, Nooramunga Marine and Coastal Park, Port Albert, McMillan Bay, and the Brataua site complex. B) View northeast towards the Brataua site complex, with Albert River visible in the background. C) View south along Old Port beach. D) View across McMillan Bay, showing extensive mudflats and mangrove forest.

phase, Yanakie B, dates to the past 1000 years and focused on the exploitation of pipi (*Latona deltoides*). Stone artifacts consist of flakes, cores, and edge-ground axes made from local marine chert ("flint") and quartz (Coutts 1967, 60). Coutts (1967, 49; 1970, 32, 124) suggested a possible hiatus in coastal occupation between 3000 and 1000 B.P. However, he also noted the possibility of site loss through dune erosion followed by later periods of dune rebuilding and occupation (Coutts 1967, 49–50).

At Great Glennie Island, 7 km offshore from the western coast of Wilsons Promontory, Rhys Jones and Jim Allen excavated a small granite rockshelter in 1980, which they named Glennie Island Cave (Jones and Allen 1979, 1980; see Fullagar 2015 for summarized details of the Jones and Allen [1985] unpublished excavation report). The excavation revealed five distinct shell-rich layers stratigraphically separated from each other by culturally sterile grit layers. The authors suggested that the shell layers represent a sequence of rare and short-term visits each dating within the past 1500 years. The stone artifact assemblage was similar to Coutts' (1970) Yanakie B artifact assemblage, consisting of local quartz and introduced marine chert ("flint"). The faunal remains were dominated by seal, seabird, and fish bones and rocky shore mollusks such as *Cellana tramoserica*, *Lunella undulata*, and *Mytilus* spp. (Fullagar 2015; Jones and Allen 1979, 5; see also Fullagar 1986; Gaughwin and Fullagar 1995, 45–46).

Through his analysis of archaeological sites around the Gippsland Lakes, Hall (1989) suggested that sites were concentrated near permanent or semi-permanent freshwater, with the size of sites and density of artifacts greatest near lakes, streams, swamps, and wetlands (see also Wesson and Beck 1981). He concluded that most campsites were located on gently sloping, well-drained ground elevated above the local water source, such as on coastal dunes, river terraces, along creek lines, and the margins of lakes, swamps, and claypans. He further noted that coastal sites were largely shell middens, many being associated with stone artifacts and some containing evidence of cooking activity. Slightly inland, the coastal hinterland sites consist more of stone artifact scatters and sometimes include scarred trees (Hall 1989).

In the largest field-based study yet undertaken in coastal Gippsland, geographer Kieran Hotchin (1990; see also Hotchin and May 1984) investigated occupational spatial patterns and temporal trends of the Gippsland Lakes–90-Mile Beach for his Ph.D. dissertation, concluding that for this region, the archaeology can be divided into three basic coastal site types, each attributable to a distinct chronostratigraphic phase: 1) shell middens of estuarine cockle (*Anadara trapezia*) and mud oyster (*Ostrea angasi*), together with introduced silcrete backed and other small artifacts (together termed "microliths") dating from 4000–3000 B.P., a period when the lakes were estuarine; 2) thin scatters of pipi shell (*Latona deltoides*) and sparse quartz artifact assemblages common along the coastal foredunes and dating to within the past 1000 years; and, 3) thicker middens of pipi shell (*L. deltoides*) with quartz artifacts, silcrete small artifacts and bone points located in back-beach landforms, also dating to the past 1000 years. Noticeably absent from this scheme are sites dating from 3000–1000 B.P., which Hotchin (1990, 196–198) attributed to a hiatus in coastal occupation—as Coutts (1970) had also tentatively done for Wilsons Promontory to the west—possibly because of the termination of sheltered estuarine conditions at and near Jack Smith Lake around 3000 B.P.

Most recently, in 1995, Russell Mullett and Ian McNiven conducted archaeological surveys in the Nooramunga Marine and Coastal Park between Wilsons Promontory and the southern end of 90-Mile Beach. The surveys focused on three areas along mainland sections of the coast (Rankins Hill, Tarra River, and Robertsons Beach) and on the larger Nooramunga islands (Little Snake, Snake, Sunday, Clonmel, and St. Margaret). Their main aim was to better understand the history of coastal and island use in southern Gippsland (McNiven 1995, 2000). McNiven (2000) reported 10 shell middens and 15 isolated stone artifact sites, mostly located along the mainland coast at the mouths of the Albert and Tarra Rivers. Mainland shell midden sites contained oyster (*Ostrea angasi*), spindle (*Pleuroploca australasia*), mud cockle (*Andara trapezia*), venerid (*Katelysia* spp.), mussel (*Mytilus edulis planulatus*), top (*Austrocochlea* spp.), trumpet (*Cabestana spengleri*), and pipi (*Latona deltoides*) shells. Stone flakes and cores were mainly made of quartz, with lesser quantities of quartzite, flint, grey silcrete, and brown chert. No formal tools or retouched flakes were found. On the islands, the shell assemblages were similarly dominated by oyster (*Ostrea angasi*), with spindle (*Pleuroploca australasia*) and venerid (*Katelysia* spp.) shells also present but less common. None of the shell middens on the islands contained stone artifacts. McNiven (2000, 27, 30) suggested that the recorded sites probably dated to the past 3000 years and that they were all most likely younger than 1000 years old, as quartz-dominated assemblages were regionally associated with sites dating to the past 1000 years (Hotchin 1990).

Consistently, two distinct phases of coastal occupation have thus been proposed or applied by the various archaeologists who have undertaken primary research across the Wilsons Promontory to Gippsland Lakes–90-Mile Beach coast (Hotchin 1990, 195–197). However, such research has been limited in scope, involving very limited dating of deposits, and each research program has significantly relied on its predecessor(s) to characterize the age and characteristics of each chronostratigraphic phase. The earliest of the two phases is dated between 6000 and 3000 years ago (Hotchin uses "B.P." and "years ago" interchangeably, which was common practice in Australia until the 1990s) and is marked by the presence of: 1) backed and other small artifacts (Hotchin's "microlithic industries"); 2) the use of introduced raw materials; and, 3) the exploitation of estuarine shellfish (e.g. *Anadara* sp. and Ostreidae). This phase almost simultaneously terminates alongside the hydrological change (cessation of tidal exchange and sheltered marine conditions) that took place at Jack Smith Lake around 3000 B.P. It is uncertain, though, whether this hydrological change occurred earlier, between 4500 and 4000 "years ago/ B.P.," elsewhere in the Gippsland Lakes region (Hotchin 1990, 196).

The later phase, which spans the past 1000 years, follows an apparent hiatus in coastal occupation dating from 3000–1000 B.P., as suggested by both Hotchin (1990) and Coutts (1970). It is characterized by 1) a decline in backed and other small artifacts ("microlithic industries"); 2) the use of local stone raw materials, especially quartz; 3) the use of specialized coastal technologies (nets and tied-bark canoes, as indicated by ethnography); and, 4) the exploitation of open-ocean sand-dwelling pipi (*L. deltoides*) and rocky shore mollusks (e.g. *Cellana tramoserica* and *Lunella undulata*) (Hotchin 1990, 195–202). The exploitation of pipi (*L. deltoides*) and the abandonment of backed artifact technologies in the past 1000 years is consistent with broader trends also observed for other parts of mainland southeastern Australia, including beyond GunaiKurnai Country (Coutts et al. 1976; Godfrey 1989; Hiscock 1986, 1994; Presland 1983; Simmons and Irish 1977; Sullivan 1982). For the shellfish foraging, these long-term changes have been interpreted by some researchers as responses to regional sea level stabilization and the expansion of sandy shorelines that favor pipi habitats (Coutts 1970; Hotchin and May 1984). Island-use in the Gippsland region has been explained as the scheduling of seasonal resource exploitation (fish, birds, and seals) (Gaughwin and Fullagar 1995) or as strategic refuges during periods of social unrest (McNiven 2000). It should be noted that much of the early work in Gippsland focused on regional surveys and intact middens, while the current study diverges by investigating small, damaged, and vulnerable sites.

The Brataua Archaeological Sites

Here, we report on two newly excavated sites in Nooramunga Marine and Coastal Park east of Corner Inlet in southern Gippsland. Together, Nooramunga Marine and Coastal Park and Corner Inlet form an infilled sedimentary basin of some 600 km^2. This basin is delineated in the south by the granitic peninsula of Wilsons Promontory, with unconsolidated sandy barrier islands forming its eastern margin and protecting the hinterland from deep-water ocean swell (see Figure 1). Nooramunga Marine and Coastal Park consists mainly of shallow, < 2 m deep sand and mud banks separated from each other by a complex series of 3–10 m deep channels (Figure 2). The islands forming the seaward margin of the estuarine system are predominantly sandy. They are characterized by a series of complex

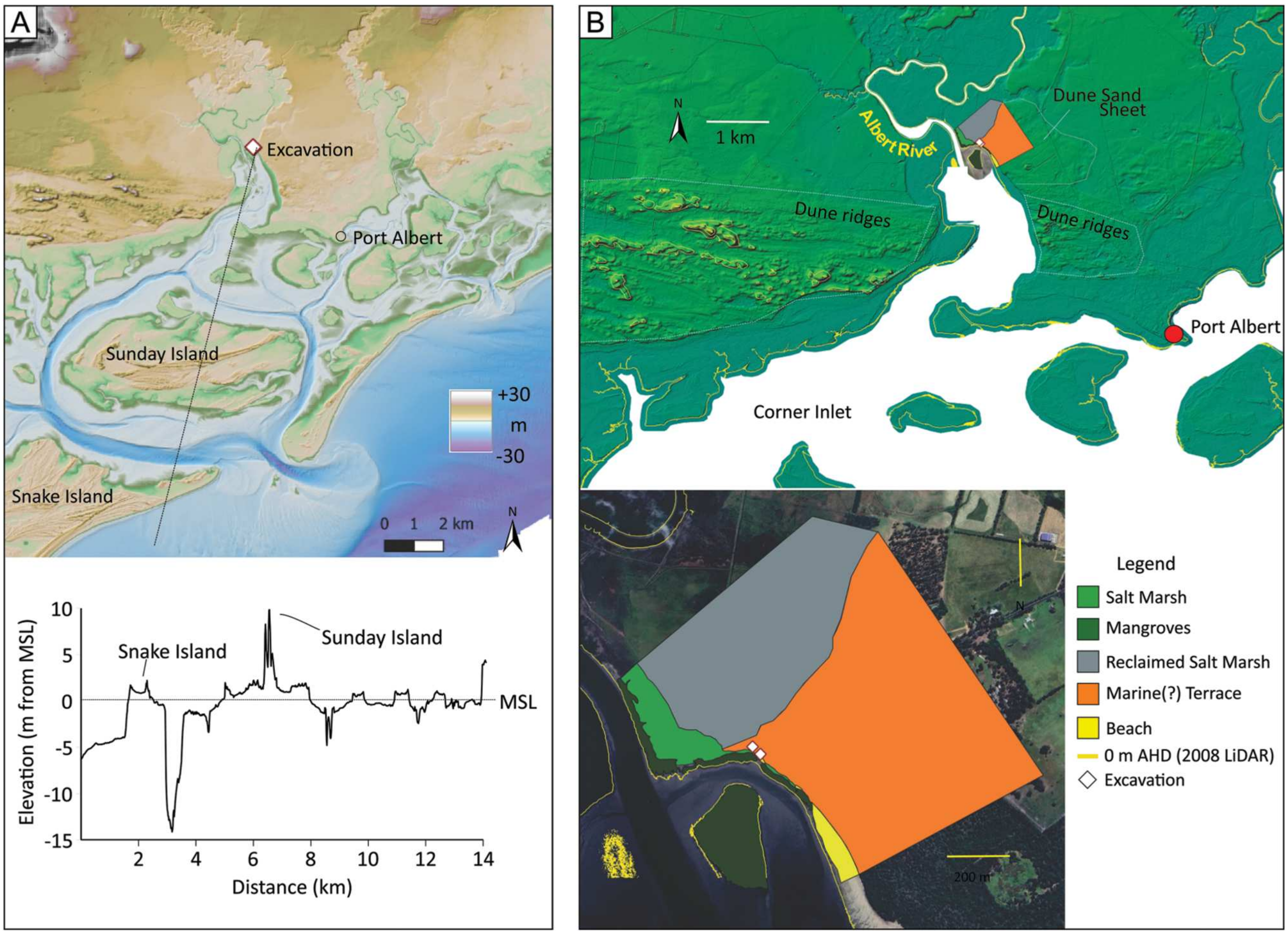

Figure 2. A) Lidar view and elevation across Nooramunga Marine and Coastal Park relative to MSL. B) Geomorphic map of the study area, near the mouth of the Albert River, Langsborough.

foredunes reaching an elevation of up to 10 m above mean sea level (MSL), with the islands generally at around an elevation of 5 m above MSL. Behind these sandy barrier islands, salt marsh and mangrove communities occur. These vegetation communities are found on the landward side of the sandy barrier islands, as well as forming islands in their own right. These mangrove-dominated islands are lower in elevation, ranging between 0.5 and 1.5 m above MSL (see Figure 2). The barrier and mangrove islands are undated but, based on the regional geomorphology (Kennedy et al. 2020a), are almost certainly Holocene in age. The region experiences mild, wet winters and warm, slightly drier summers (Land Conservation Council 1980). Today, the intricate waterways of Nooramunga Marine and Coastal Park and the deep offshore ocean attract amateur and commercial fishers seeking flathead, garfish, snapper, King George whiting, Australian salmon, and gummy shark. The area also contains some of the most extensive tidal flats in Victoria (McNiven 2000, 24; Rosengren 1989, 16), making it a popular place for recreational clam and crab foraging also. The region thus sees a high level of recreational traffic.

The archaeological sites

The archaeological sites discussed here are located on the bank of the Albert River estuary in the Nooramunga Marine and Coastal Park, 5 km northwest of the Port Albert township in Langsborough (see Figures 1, 2). Here, the embayment consists of shallow estuarine waters and broad intertidal fine sediment flats. The foreshore environment supports stands of mangrove forest (*Avicennia marina*) in the low intertidal zone before sharply transitioning into high intertidal salt marsh dominated by beaded and shrubby glassworts (*Salicornia quinqueflora*, *Sclerostegia arbuscula*, and *Suaeda australis*) and pigface (*Carpobrotus* spp.) (Figure 3). This region has a mean annual tidal range of ca. 2 m (Victorian Regional Channels Authority 2021), with the high-tide mark terminating at the base of a near-vertical cliff of mainly well-consolidated soft sediment, up to 3 m in height, formed within an undated terrace likely of Late Pleistocene age (Jenkin 1968). The surface of the terrace supports stands of coastal woodland and scrub dominated by wattles (*Acacia* spp.), gums (*Eucalyptus* spp.), she-oak (*Casuarina glauca*), shrubs (*Erica arborea*, *Bursaria spinosa*, and *Morella cerifera*), and grasses (*Gahnia filum* and *Lomandra* spp.). A number of traditional bushfood taxa are also present around the archaeological sites, including cherry ballart (*Exocarpos cupressiformis*), seaberry saltbush (*Rhagodia candolleana*), coast saltbush (*Atriplex cinerea*), pigface (*Carpobrotus* spp.), and bracken fern (*Pleridium esculentum*) (see Figure 3). Drinkable freshwater is available farther upstream of the Albert River (inland of estuarine conditions) and in local soaks obtainable less than 1 m below ground. Quartz pebbles suitable for manufacturing artifacts can also be found along the banks of the Albert River and along the coast at the high-water mark. The nearest quartz outcrops are located on Wilsons Promontory over 100 km southwest by land or 40 km by boat and in the Haunted Hill formation near Loy Yang approximately 70 km to the north. Ethnohistorical sources record GunaiKurnai people

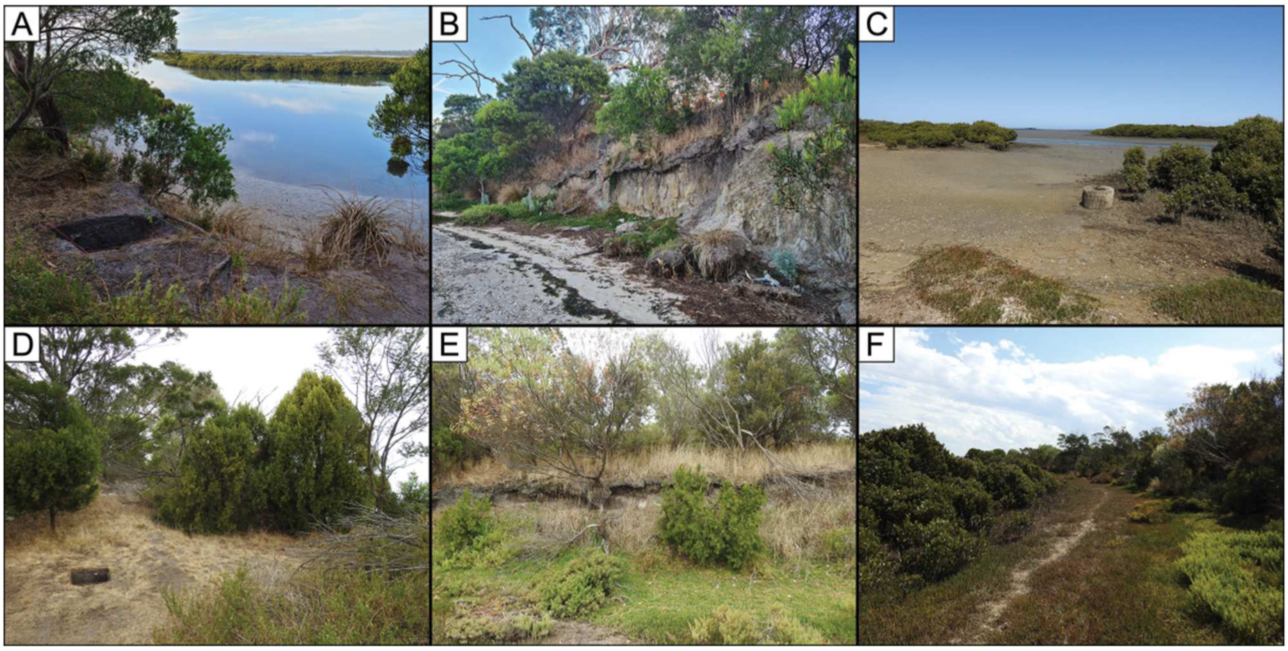

Figure 3. Environmental setting of the Bratua site complex. A) View from the top of dune near Bratua 1 across McMillan Bay. B) Heavily eroded dune cliff below Bratua 1. C) Low tide at McMillan Bay with mudflat, mangroves, and remains of old dock support visible. D) Top of the dune vegetation, including cherry ballart (*Exocarpos cupressiformis*), near Bratua 2. E) Heavily eroded dune cliff near Bratua 2, with vegetation collapsing onto the beach. F) Mangrove and saltmarsh communities adjacent to the eroding dune near Bratua 2.

travelling by bark canoe to Wilsons Promontory as a safe place to take refuge and to Rabbit Island, off the Wilsons Promontory eastern coast, to collect mutton birds and eggs (Howitt n.d.; see also van Waarden 1989, 6–7, 11). Therefore, GunaiKurnai people may also have accessed the Wilsons Promontory quartz outcrop for raw materials from the Langsborough region.

The archaeological deposits discussed here are found within a loose sand sequence which forms a veneer 1–2 m thick over an older terrace surface. The terrace is undated, having only been qualitatively mapped in the 1960s as being geomorphologically the same as that of the Inner Barrier at Loch Sport 100 km to the northeast (Jenkin 1968), which is now known to be around 120,000 years old (Oliver et al. 2018). However, subsequent geomorphological research in the Gippsland Lakes also to the east (Kennedy et al. 2020a, 2020b; Oliver et al. 2018) suggests this is unlikely to be the case. The terrace's elevation, morphology, and structure imply it is likely to be marine in origin and Mid- to Late Pleistocene in age. The sandy deposit in which the archaeological sites are found extends across the Pleistocene terrace on either side of the Albert River and is > 10 m thick in places. To the southwest of the excavations, east-west-oriented linear and parabolic dunes occur (see Figure 2).

At the mouth of the Albert River, there is one site (VAHR 8220-0081) listed on the Victoria Aboriginal Heritage Registry, the state of Victoria's official site registry. The site was originally recorded as G.M.1. by Djekic (1981) during archaeological surveys of the Latrobe Valley and southern Gippsland. Djekic (1981) identified a shell midden containing *Anadara* sp. shells and quartz and silcrete stone artifacts (including steep-edge scrapers) that had been exposed by a road cutting. He considered site preservation to be very poor due to severe erosion and bulldozer damage through the site. VAHR 8220-0081 was again recorded in the 1980s, this time as site OSB1 by Hotchin (1990). Hotchin described the site as located at the crest of a bluff at the mouth of the Albert River, judging its condition to be fair. He noted the presence of estuarine cockle (*Anadara* sp.), oyster (*Ostrea angasi*), and pipi (*Latona deltoides*) shells and stone artifacts made of quartz and siliceous rock, including an asymmetric "backed blade" (Hotchin 1990, 252). A conventional radiocarbon date was obtained from a single surface shell (*Anadara* sp.), yielding an age of 2860 ± 70 B.P. (ANU-4974) (Hotchin 1990, 170, figs. 7–14), which calibrates to 2694–2231 CAL B.P. (95.4% probability) in OxCal v4.4 (Bronk Ramsey 2009) and the Marine20 curve (Heaton et al. 2020). Subsequent site inspections of VAHR 8220-0081 by Gunaikurnai Land and Waters Aboriginal Corporation personnel in 1993, 2006, 2021, and 2022 reported that the site was relatively stable and the general area partially protected by mangroves on the foreshore but that long-term stability was unlikely and that floods, rising seas, and visitor impacts would eventually result in site destruction. With this in mind, the corporation selected VAHR 8220-0081 and the immediate surrounding location for further research while this was still possible.

We identified two distinct locations containing eroding archaeological shell remains that were geographically 35 m apart. We refer to these two sites as Bratua 1 and 2.[3] It appears from the site records that both these sites, together with other discrete scatters that have now disappeared, were amalgamated into the single site (VAHR 8220-0081) by Djekic (1981) and Hotchin (1990), who referred to it as G.M.1 and OSB1, respectively. We conducted small archaeological excavations at Bratua 1 and 2. Our aim was to investigate the last remnants of the in situ archaeology of these surface-exposed parts of the dune (see Figure 3).

Recent historical background

The Langsborough region was first visited by colonial settlers in A.D. 1841 when they constructed a small settlement named Seabank (later known as Old Port) on the eastern bank of the

Albert River (Stevens and Stevens 2007) (see Figure 1). Seabank quickly became the principal town, port, and administrative center of Gippsland. The settlement was abandoned two years later in favor of Port Albert (which had been named New Leith until then), because its anchorage consisted of deeper water more suitable for shipping activities (Stevens and Stevens 2007). The site of the Seabank township, however, continued to be frequented by colonial settlers and, in the first half of the 20th century A.D., became popular for camping and recreation such as boating, fishing, and swimming. Photos held by the State Library of Victoria show visitors to the Seabank beach in A.D. 1947 and depict the shoreline close to the Bratua archaeological sites (Figure 4). Comparing these photos with the area today, there has clearly been significant environmental change in the past 76 years—notably, the colonization by mangroves at low tide elevations and salt marsh at the high tide mark. Recollections by local residents who lived along the Old Port Road shoreline in the 1970s and 1980s also describe an environment akin to that of the mid-1900s (A. Macmeikan, personal communication 2023). At the end of the 20th century A.D., McNiven (2000, 22–23, 24) described the Nooramunga Marine and Coastal Park environment to include "waterlogged salt marshes" separated from open water by "long stretches of low white mangrove shrublands (*Avicenna*

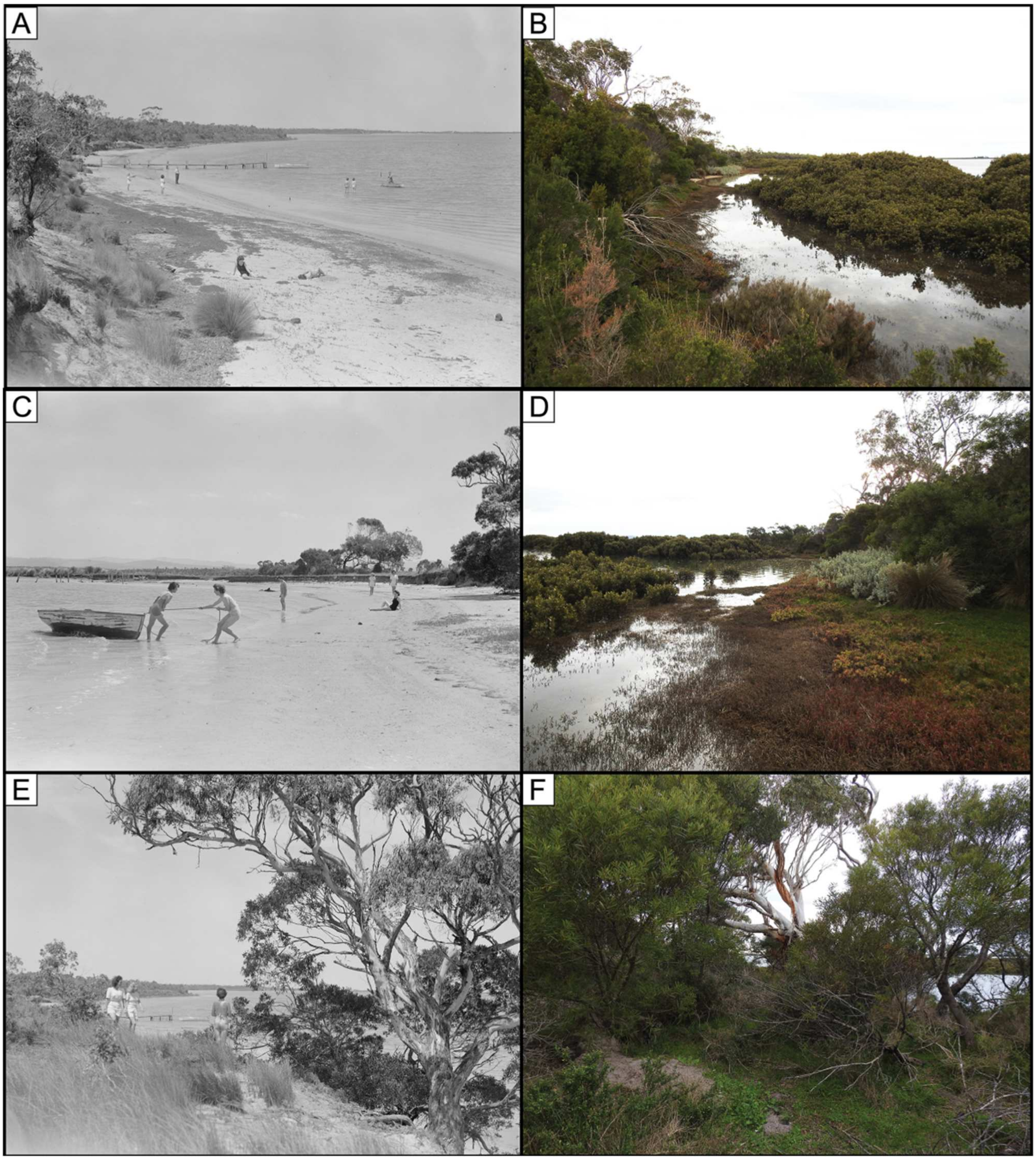

Figure 4. Coastline transformation. A, C, E) A.D. 1947 photos of Old Port beach (State Library of Victoria). B, D, E) Photos taken in 2023 from similar locations to the A.D. 1947 photos indicate the enormous environmental changes that have taken place during the intervening period, particularly mangrove and saltmarsh development.

marina)" that extended "some 3 km up the Albert and Tarra Rivers." These records and recollections suggest major environmental change for the Albert River estuary in the latter half of the 20th century A.D.—a shift from a relatively open sandy embayment to a mangrove- and salt-marsh-dominated shoreline. Both the mangroves and salt marsh indicate a depositional environment and increased protection for the terrace edge from locally wind-generated waves.

The area continued to be used for popular recreation by anglers, hikers, and campers well beyond the mid-20th century A.D. The Seabank Caravan Park, located 200 m from the archaeological sites, operated between 2002 and 2021, and illegal camping was also known to take place on the spot of the Bratua sites themselves before this practice was ended a few decades ago when Parks Victoria blocked vehicle access beyond the carpark (M. Holland, Parks Victoria and Gunaikurnai Land and Waters Aboriginal Corporation, personal communication 2023). Currently, visitors walk on or near eroding archaeological sites as they follow a small walking track down the dune-face to undertake inshore fishing or to access the trailhead for the Old Port Trail walking track (see Figures 1, 5).

The excavations

Bratua 1 is located in a sandy dune sequence at the top of the exposed cliff-face. The land surface at the midden site is elevated 4.28 m above MSL and 2.68 m above the foreshore (base of the eroded cliff). Here, a 1 × 1 m excavation square was laid, its west-east axis aligned along a bearing of 135° to follow the orientation of the cliff's edge (see Figures 3, 5). The square was positioned to include a large part of a small concentration of shell visible from the eroding dune at the top of the cliff face. The excavated area was reduced to 1 × 0.5 m and then again to a single 0.5 × 0.5 m quadrant during the course of the excavation to avoid matrix disturbances (an insect burrow, ant nest, and minor voids) (Figure 6). Upon completion of the excavation, the base of the square was manually augered for a further 115 cm. As 77 cm of deposit had been archaeologically excavated above the top of the auger sequence, the total depth of the sediment sequence from the present land surface is 1.92 m (the base of the auger hole is at 2.38 m above MSL). This represents the total sediment sequence available for geomorphological analysis.

Bratua 2 is located on top of the same dune formation, 35 m northwest and 2.4 m downslope of Bratua 1. Its surface is at an elevation of 2.93 m above MSL. Here, a 0.5 × 0.5 m excavation square was aligned north-south, 7.8 m back from the eroded seaward edge of the dune. A dispersed scatter of fragmented *Anadara* sp. shell was present 2.5 m away towards the foreshore. The excavation square was not positioned over the dispersed shell because an access track had been artificially cut through this part of the site sometime in the A.D. 1900s, disturbing not just its present surface but also slightly deeper down. Since then, the depression has acted as a shallow drainage channel, further eroding subsurface deposits (see Figures 3, 5). The drainage channel abuts a rabbit warren that had brought larger *Anadara* sp. shells to the surface (Figure 5B). The excavation square was situated just north of the old track to explore the subsurface extent of the *Anadara* sp. shell midden and to investigate the age and characteristics of its remnant in situ deposits. Bratua 2 is probably also a part of Djekic's (1981) site G.M.1. and Hotchin's (1990) OSB1, where each had identified an *Anadara* sp. surface scatter. However, there were no sign of the oyster or pipi shell that Hotchin (1990, 252) had specified at or near this location, nor of the quartz and silcrete stone artifacts recorded by both in the 1980s.

The excavations at both Bratua 1 and 2 proceeded in arbitrary excavation units (XUs) averaging 2.9 cm thick at Bratua 1 and 2.7 cm thick at Bratua 2, following the stratigraphy. The position of individual pieces of charcoal and stone artifacts was recorded in three dimensions and the items individually bagged. Bulk sediment samples were collected from each XU for sediment analyses. Excavated sediments (other than the sediment samples) were dry-sieved in 2 mm mesh in the field, and the sieved fraction was bagged and labeled for subsequent wet sieving (again in 2 mm mesh), air drying, and sorting under controlled laboratory conditions at Monash Indigenous Studies Centre, Monash University. Individual pieces of charcoal and marine shell from the excavations were sent for radiocarbon dating to the Waikato Radiocarbon Dating Laboratory in New Zealand.

Results

Bratua 1

Bratua 1 was excavated to a maximum depth of 77 cm. The excavation progressed for a further 40 cm depth beyond the lowermost archaeological materials (excepting charcoal), with hand augering indicating the clay terrace lay a further 64 cm below the base of the pit. Neither bedrock nor basal clays were reached. Four distinct stratigraphic units (SUs) were identified. From top to bottom: SU1 is the thin surface layer consisting of fine, matted grass rootlets and loose leaf litter. SU2 is a loose sand with recent cultural debris lying flat on a paleo-surface represented by the base of SU2. SU3 is an unconsolidated, fine sand with dispersed charcoal and a dense scatter of shallow-marine shell and small stone artifacts, most of which occur adjacent to but away from the shell concentration. SU4 is an unconsolidated, fine, white sand that increasingly grades to yellowish with depth (see Figure 6).

Chronology

Eight radiocarbon determinations were obtained (Table 1). Five of these are on individual pieces of charcoal. Three of the charcoal samples were collected in situ from XU8 (Wk-56240: 1239 ± 19 B.P.) and the northern profile, corresponding to XU10A (Wk-56241: 1262 ± 19 B.P.) in SU3 and XU12A (Wk-56243: 2948 ± 19 B.P.) in SU4. Two charcoal samples were obtained from XU22 in SU4 and were collected from the sieve (Wk-56621: 8120 ± 23 B.P.; Wk-56622: 8567 ± 25 B.P.). Three radiocarbon determinations were obtained from *Katelysia* spp. shell valves taken from the sieve from XU6A (Wk-56618: 1524 ± 13 B.P.) and XU8A (Wk-56619: 1540 ± 14 B.P.) at the SU2–SU3 interface and XU13A (Wk-56620: 1547 ± 14 B.P.) in SU4. The radiocarbon ages were calibrated in OxCal v4.4 (Bronk Ramsey 2009) using the SHCal20 (Hogg et al. 2020) atmospheric curve for the charcoal dates and Marine20 (Reimer et al. 2020). Calibrated results (95.4% probability) indicate that the site was occupied

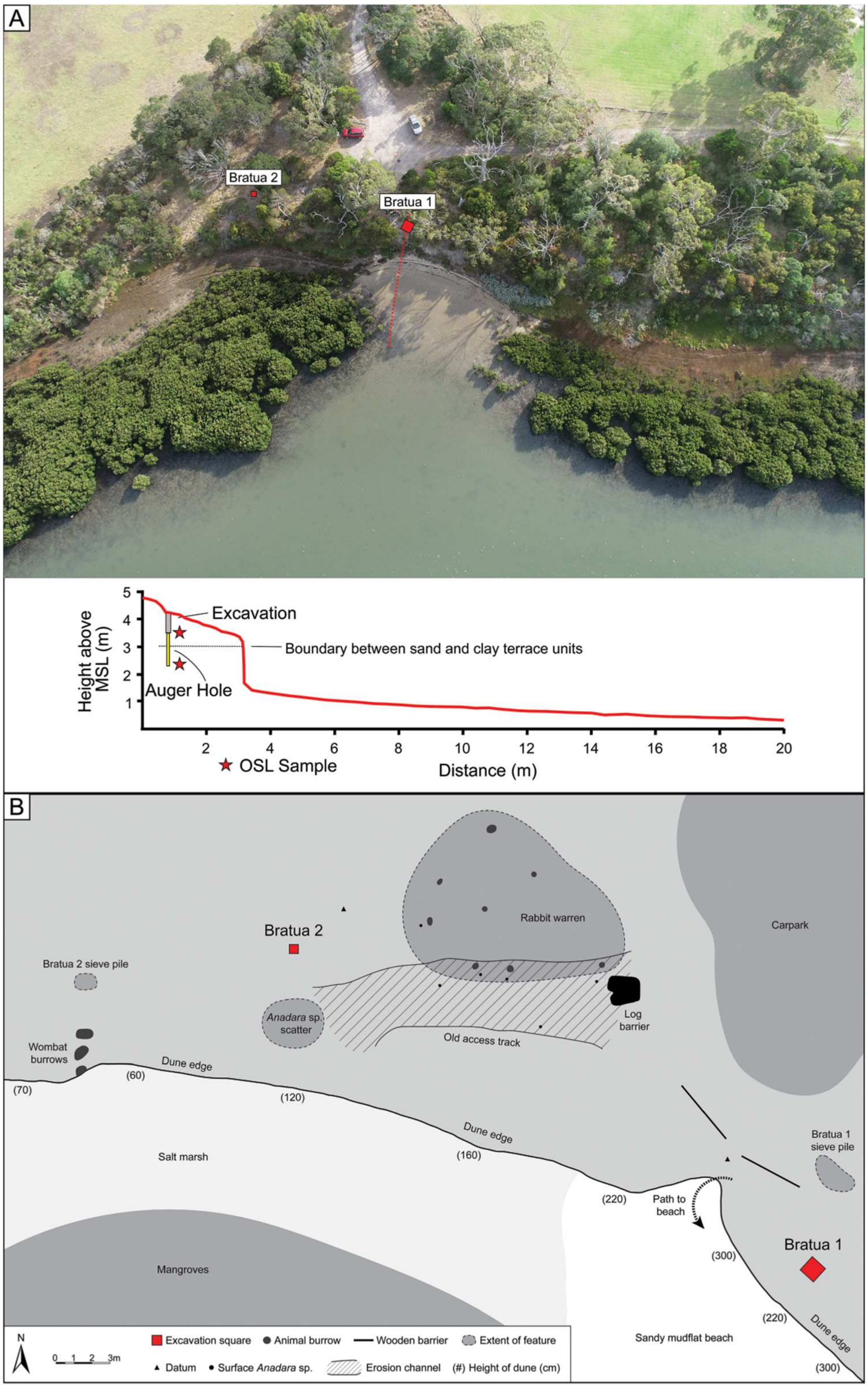

Figure 5. The Bratua sites. A) Environmental setting and location of Bratua 1 and 2 excavations and elevation transect (red dotted line). B) Tape and compass map of the Bratua 1 and 2 site complex indicating the location of animal burrows, erosion channel near Bratua 2, and the path to the beach over the dune-face near Bratua 1.

sometime after 3170–2960 CAL B.P. (see below), with frequentation continuing and becoming more common around 1260–1060 CAL B.P., when shellfish gathering intensified (see Figure 6).

Cultural materials

The excavation recovered recent cultural debris across SU1 and SU2, lying flat on a paleo-surface. This recent debris includes broken glass, metal, plastic, aluminum foil, a cigarette filter, a plastic toy spider, and fishing equipment (fishing lure and swivel connector) and was recovered from XU1–XU6A and XU9C (a large spider hole partly infilled with down-fallen sediment and isolated during excavation as a small disturbance feature) (Figure 7). These materials are consistent with the popular recreational use of this area since at least the mid- A.D. 1900s, as documented by historical records and recent oral testimony. A thin but dense scatter of shell was

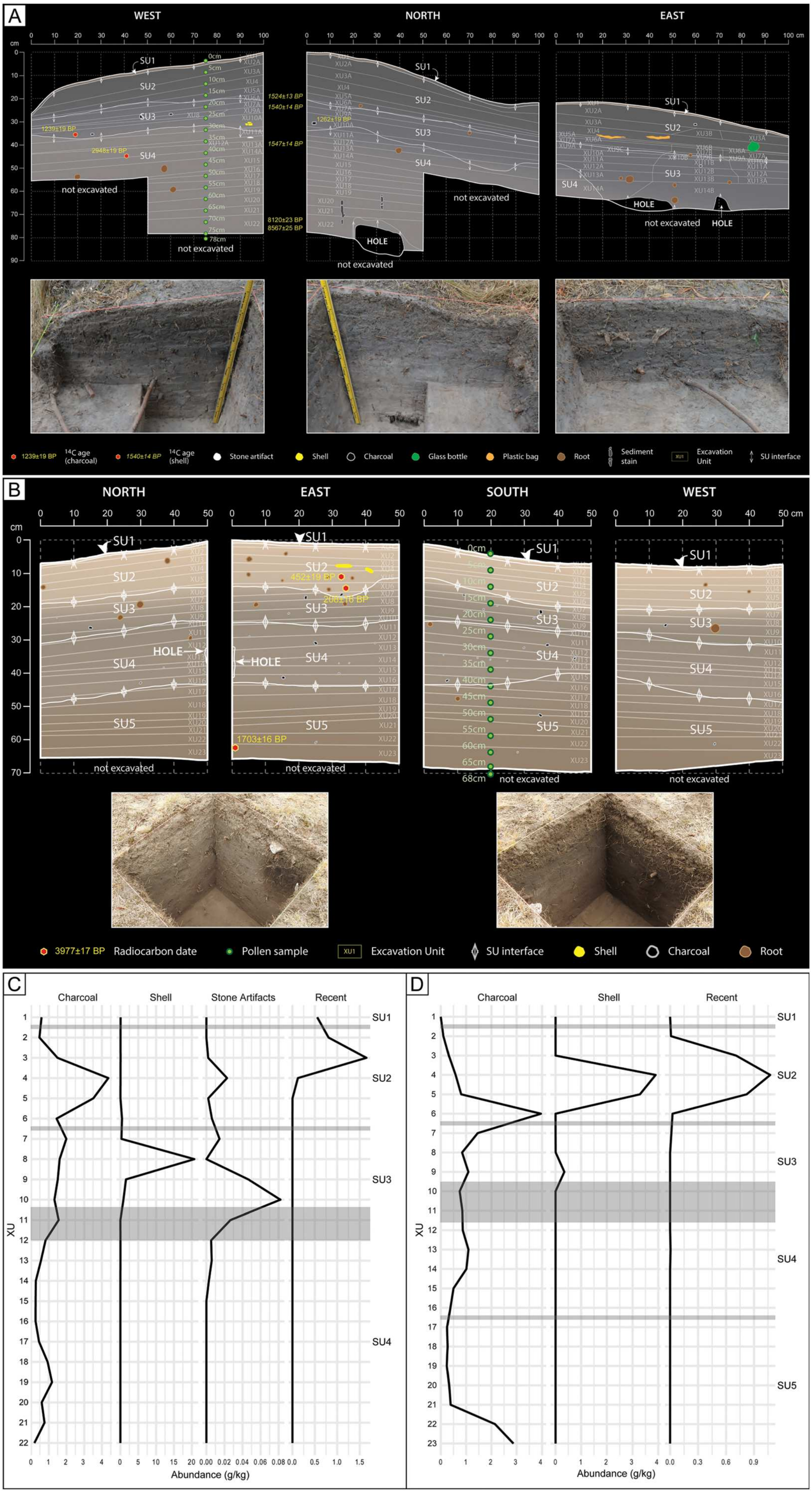

Figure 6. Section drawings after completion of excavations and distribution curves. A) Bratua 1 section drawing with radiocarbon dates projected. B) Bratua 2 section drawing with radiocarbon dates projected. C) Bratua 1 standardized abundance plot (in grams of archaeological materials per kilogram of excavated sediment) by XU. D) Bratua 2 standardized abundance plot (g/kg) by XU. The horizontal grey lines indicate the depth and thickness of the interfaces between SUs.

Table 1. AMS radiocarbon age determinations for Bratua 1 and 2 excavations. Age calibrations were performed in OxCal v4.4 (Bronk Ramsey 2009) using the SHCal20 atmospheric curve (Hogg et al. 2020) and Marine20 (Heaton et al. 2020) data for marine shell samples with a ΔR value of -123 ± 22 years from eight marine shells obtained between Wilson's Promontory and Lakes Entrance (Ulm et al. 2023).

Lab ID	XU*	SU	Sample Material	Sample Weight (g)	$\delta^{13}C$ (‰)	Conv. ^{14}C Age (B.P.)	Calibrated Age (CAL B.P.) 68.3% prob.	95.4% prob.	Median
Bratua 1									
Wk-56618	6A	2–3 interface	marine shell *Katelysia* spp.	0.77	-2.4 ± 0.4	1524 ± 13	1120–960	1190–900	1040
Wk-56619	8	2–3 interface	marine shell *Katelysia* spp.	0.86	-1.1 ± 0.4	1540 ± 14	1130–980	1220–920	1060
Wk-56240	8	3	charcoal	0.13		1239 ± 19	1180–1060	1180–1060	1110
Wk-56241	northern profile	3	charcoal	0.17		1262 ± 19	1170–1070	1260–1060	1220
Wk-56620	13A	4	marine shell *Katelysia* spp.	0.54	-2.0 ± 0.4	1547 ± 14	1180–950	1240–950	1090
Wk-56243	12A	4	charcoal	0.62		2948 ± 19	3150–2990	3170–2960	3050
Wk-56621	22	4	charcoal	0.15	-26.5 ± 0.4	8120 ± 23	9090–8990	9130–8780	9010
Wk-56622	22	4	charcoal	0.07	-27.2 ± 0.4	8567 ± 25	9540–9490	9550–9470	9510
Bratua 2									
Wk-56441	5	2	charcoal	0.06		208 ± 16	60–0	100– -10	30
Wk-56698	5	2	marine shell *Anapella cycladea*	0.23		452 ± 19	100– -10	200– -10	60
Wk-56442	22	5	charcoal	0.2		1703 ± 16	1580–1530	1590–1520	1560

*Wk-56243 (collected in situ) is considered at greater depth than Wk-56620 (collected from sieve) due to the slope of the ground surface.

recovered from SU3 that dates to between 1260–1060 CAL B.P. and 1190–900 CAL B.P. (see Table 1). This dense shell scatter overlies SU4, containing an assemblage of small quartz artifacts and sparse shell remains that were deposited from 3170–2960 CAL B.P. until the base of the dense shell scatter at 1260–1060 CAL B.P. (see Figure 6, Table 1, Supplemental Material 1).

There is very little stratigraphic overlap between the lowermost plastic and glass items (down to XU6A in the SU2–SU3 interface) and the archaeological shell and stone artifact horizon (XU6A–XU10A) that peaks in SU3, indicating good chronostratigraphic integrity (see Figure 6). Below XU4, in the SU2–SU3 interface, the recovered fragments of glass and plastic were tiny (totals: XU5A = 0.05 g, XU6A = 0.01 g, and XU9C = 0.01 g). Mixing with the very top of the archaeological shell horizon only occurred on a paleosurface that represents an old treadage zone.

Charcoal was found in all XUs and peaks in XU4–XU5, which together comprises 36.5% (238.6 g) of the total recovered charcoal. Charcoal is abundant from XU3–XU11 in SU2 and SU3 before steadily declining down to XU16 (in SU4). There are minor increases in charcoal abundance in XU18–XU19 (17.8 g; 2.7%) before a continued decline to XU22 at the base of the excavation (see Figure 6). The large XU4–XU5 peak in charcoal corresponds to the level of the recent cultural materials (plastic, glass, etc.) and represents the post- A.D. 1900s period of recreational use (see above). The charcoal abundance in SU3 is consistent and stable from XU7–XU11 and corresponds with peaks in shell and stone artifacts (see Figure 5).

Shell is present in every XU from XU1–XU13A, with the deepest XU13A shell occurring at the SU3–SU4 interface, representing a paleo-floor (see Figure 6, Supplemental Material 1) (NISP: 811, MNI: 53, and weight: 188 g). Shell density is greatest in XU6A–XU10A in SU3, with more than 40% of the shell from the midden feature coming from XU8 by all quantification metrics (NISP: 321, MNI: 26, and weight: 95.2 g).

The recovered shell consists almost entirely of the sand cockle, *Katelysia* spp., which has a total NISP of 799, MNI of 50, and weight of 184.7 g (see Figure 7). In southern Australia, the genus *Katelysia* is represented by three species—*Katelysia peronii*, *K. rhytiphora*, and *K. scalarina*—all of which are broadly distributed across the temperate coastline (Boyd 2011; Heldt and Mayfield 2020). These morphologically similar species are notoriously difficult to distinguish even when live-collected. *Katelysia* spp. are soft-shore-dwelling bivalves common to intertidal sand flats and shallow estuarine and marine embayments (Roberts 1984). They are most commonly found from the shoreline to a depth of 5 m but may be located up to 30 m depth (Boyd 2011; Heldt and Hart 2021). In South Australia, where the size of *Katelysia* spp. shells has been studied in greatest detail, the shell has a maximum length of 55 mm, but today they are more often found with maximum lengths of 30–40 mm (Boyd 2011; Miller-Ezzy, Stone, and Li 2021). The species are reproductively mature at 23–31 mm length. However, differences in maturity occur between species and locations (Heldt and Hart 2021). Most of the *Katelysia* spp. remains from Bratua 1 were too fragmented to obtain reliable size measurements. Where measurements could be obtained, the harvested sand cockles were all of a similar size and reproductively mature (median shell length: 27.73 ± 2.30 mm, n = 17) (Supplemental Material 2).

The other identified shell taxa at Bratua 1 are the bivalve *Anapella cycladea* and gastropod Littorinidae, both of which came from XU1 only and are thus associated with recent camping activity and sediment disturbance. *A. cycladea* are endemic to southeastern Australia and occupy sheltered estuaries and mudflats in sandy or muddy substrates (Boyd 2011). The species currently inhabits the Albert River estuary and was sighted in great numbers as both live individuals and tidally deposited valves in the intertidal zone near the excavation. Littorinidae, or periwinkles, are broadly distributed across Australia and can occupy a range of hard-substrate environments, including mangrove forests.

Stone artifacts were recovered from XU3A–XU14A (n = 57), with the majority (n = 30; 52.6%) coming from XU9A–XU11A (see Figure 6). The stone artifacts were analyzed to determine whether raw materials were likely to have been collected locally and flaked on-site, to investigate discard rates, and for traces of use including expedient manufacture or curation and single use. We focused our analyses on raw materials, artifact types (core, flake, or flaked piece), the presence of cortex, rates of fragmentation, and lithic refit (to inform on discard rates and taphonomy).

Figure 7. Remains recovered from the Bratua 1 (A–G) and Bratua 2 (H) excavations. A) glass from XU2A; B) metal from XU3A; C) fishing lure from XU1; D) plastic toy spider from XU3A; E) longitudinally refit quartz flake from XU10A; F) primary quartz flake (with cortex) from XU4; G) *Katelysia* spp. shell from XU8; and, H) Ostreidae shell from XU5.

Almost all of the stone artifacts are made of quartz (n = 56; 98.3%), with the addition of a quartzite flaked piece (n = 1; 1.7%). Within the quartz assemblage, the dominant artifact type is flaked pieces (n = 48; 85.7%), followed by flakes (n = 7; 12.5%) (all coming from between XU9A and XU13A) and one bipolar core fragment from XU9A (n = 1; 1.8%) (see Figure 7). Cortex is present on three flakes only. Of these, two (from XU4 and XU13A) are primary flakes (evidencing completely cortical dorsal surfaces). The other is a secondary flake (with partial cortical dorsal surface) from XU10A. Together, the use of quartz as the dominant raw material, presence of primary and secondary flakes, and predominance of flaked pieces suggests that quartz pebbles from the banks of the Albert River ca. 300 m to the west and along the coast at the high-water mark within a few meters of the site were the source of raw materials.

Three of the seven flakes are complete flakes. They came from XU10A, XU11A, and XU12B. The XU10A flake bears a crushed distal margin, suggesting hard-hammer bipolar percussion (Andrefsky 2005). Two of the four fragmented flakes are proximal flake fragments that came from XU9A and XU13A. The other two are conjoining longitudinally split flakes from XU10A. Each has a crushed distal margin, again signaling bipolar flaking. The original artifact could have broken during manufacture or through trampling. Bipolar flaking on generally heavily faulted quartz pebbles such as those of this region produces angular shatter consistent with the high abundance of flaked pieces in the quartz assemblage (n = 48; 85.7%). The presence of two conjoining small fragmented flakes in XU10A indicates good chronostratigraphic integrity. Overall, the presence of discarded flakes displaying cortex and breakage through reduction, as well as complete flakes and a core, indicates that the Old Ancestors manufactured stone tools on-site. Given the reasonably high rate of complete flake discard (n = 3; 42.9%), they were probably by-products of expediently made, single-use tools for the particular task at hand.

Bratua 2

Bratua 2 was excavated to a maximum depth of 67 cm. Excavation ceased in culturally sterile sand 45 cm below the lowermost cultural materials. Five SUs were identified. SU1 is an unconsolidated, uncompacted sand containing leaf litter below a thin surface layer of moss. SU2 is an unconsolidated, uncompacted fine sand that contains recent objects such as plastic and glass, as well as occasional marine shell and dispersed charcoal. SU3 and SU4 are unconsolidated, slightly compact silty sand. SU3 contains dispersed charcoal, with noticeably few charcoal fragments in SU4. SU5 is a very compact silty sand, more yellow-brown in color than the overlying grey-brown stratigraphic units and containing dispersed charcoal (see Figure 6, Supplemental Material 1).

Chronology

Three radiocarbon determinations were obtained (see Table 1). Two of these were on individual pieces of in situ charcoal from XU5 in SU2 (Wk-56441: 208 ± 16 B.P.) and XU22 in SU5 (Wk-56442: 1703 ± 16 B.P.). The third came from an in situ *Anapella cycladea* valve in XU5 (Wk-56698: 452 ± 19 B.P.). Calibrated results indicate that the base of the excavated deposit formed sometime between 1590 and 1520 CAL B.P. The XU5 ages indicate that the marine shell dates within the uncertainty range 200– -10 CAL B.P., and the charcoal from the same XU and associated with an Ostreidae shell dates to within 100– -10 cal b.p., essentially most likely within the past 100 years (see Table 1).

Cultural materials

The vertical distribution of recent litter (plastic, glass, etc.) largely overlaps with the SU2 shell and overlies a charcoal peak at the SU2–SU3 interface (see Figure 6, Supplemental Material 1). Most of the shell dates to within 200– -10 cal b.p. based on the XU5 shell and charcoal dates. Charcoal is abundant at the 1590–1520 cal b.p. level, but no other cultural remains occur so far down (see Table 1).

Marine shell occurs in XU4 (in SU2), XU5 (SU2–SU3 interface), and XU8 and XU9 (SU3). In total, shell has a NISP of 45, MNI of three, and weight of 45.7 g (see Figure 6, Supplemental Material 1). Most of the shell is Ostreidae (NISP = 42, MNI = 1, and weight = 42.3 g) from XU4 and XU5. The Ostreidae fragments are likely to be from the southern mud oyster, *Ostrea angasi*, which is common in estuarine embayments of this part of Victoria, as well as in other coastal Victorian middens (Hotchin 1990; McNiven 2000). A single *Anapella cycladea* valve also occurs in XU5 (see Figure 7) No *Anadara* sp. shell was found in the excavation, despite its presence on the eroded surface 2.5 m away (see Figure 5).

Discussion

Since a.d. 1841, the area of the Bratua sites has been used as an early colonial settlement, major port, animal paddock, holiday park, and popular recreational camping, fishing, and hiking location. In the past 80 years, the sites' environment changed from an open sandy estuarine beach to a mangrove sea-front with associated backing salt marsh. This recent change has led to a slowing of the cliff's rate of retreat, as evidenced by the vegetated talus now covering much of the terrace's edge. Noticeably, the area of active retreat now appears to be restricted to those areas immediately in front of Bratua 1, where a small, relatively open sandy beach (devoid of mangroves) remains. Given all these taphonomic factors, it comes as no surprise to find that the visible (surface and dune-exposed) remnant archaeology is highly damaged and nearly entirely gone. Indeed, a visit to the site five months after the completion of the excavations revealed noticeable further dune-face collapse some 6 m southeast of Bratua 1. The part of the dune that collapsed onto the foreshore contained a previously unknown archaeological assemblage of *Katelysia* spp. shell at what appears to have been a similar depth as the excavated shell horizon at Bratua 1 (Figure 8). No such shell was previously visible in the intact dune profile at the location of this recent collapse. This suggests that the Bratua 1 excavation may have captured the very back (landward extant) of a complex of small, single-event shell middens and that much or all of this shell midden complex has already eroded into the bay. Furthermore, as the Bratua 1 and 2 excavations did not recover the silcrete artifacts, formal tool types, and *Anadara* sp. and *Latona deltoides* shell taxa that Djekic (1981) and Hotchin (1990, 170, 252–256) had described from surveys undertaken in the 1980s, we can conclude that extensive, perhaps catastrophic site loss of VAHR 8220-0081 has taken place over the intervening ca. 30–40 years. The *Anadara* sp. remains eroding out of the rabbit warren and drainage channel near Bratua 2 probably represent a localized short-duration camp similar to those described by Djekic (1981) and Hotchin (1990).

Overall, the archaeology of Bratua 1 and 2 indicates that the Old Ancestors repeatedly returned to the study area for resourcing activities and that they did so from at least 3170–2960 cal b.p. This was a place to gather inshore shellfish, collect quartz raw materials, and likely forage important coastal plants, as evident from dense and varied locally growing bushfoods, and to access potable water. At Bratua 1, the Old Ancestors shellfish gathering along the coast was particularly visible from at least 1260–1060 cal b.p. until 1190–900 cal b.p. Here, the small, horizontally constrained dense shell scatter, some 40 cm wide, coupled with the recurrence of individual shell sizes of a limited range, suggest that shellfish foraging was a one-off event, rather than an intensive, continuous activity at this particular site. However, the presence of multiple small shell middens in close proximity indicates that people repeatedly returned to the area to make small, single occupation camps where they collected shellfish from the open shoreline. The Bratua 2 results suggest that shellfishing activities (including for Ostreidae) continued in this area until the early 20th century a.d. (see Table 1). Charcoal was recovered alongside the Bratua 1 and 2 shell remains, but no evidence of burning was noted on the shells themselves. The presence of charcoal and notable ashy horizons along hundreds of meters of the exposed dune-face signals more than campfire events and points to landscape-scale cultural burns across the region (for "cultural burning," see Buettel et al. 2023). The paleoecological evidence for this will be reported elsewhere.

Historical observations by Fred McCarthy (1941, 23, cited in Coutts 1967, 133) from the northern New South Wales coast reported that Aboriginal peoples there took pipi (*L. deltoides*) to fireplaces, extracted the animals, and roasted

Figure 8. View of recent (2023) dune collapse southeast of Bratua 1. A) Eroded dune collapse on the foreshore (yellow box). B) Close view of collapsed dune (yellow box) showing location of midden remains. C) *Katelysia* spp. shells contained in dune collapse (yellow arrows).

the meat in the ashes. The Bratua 1 and 2 shellfish may have been prepared in a similar way or eaten raw. The presence of *Katelysia* spp. remains at Bratua 1 from ca. 3170–2960 CAL B.P. until at least 1190–900 CAL B.P. indicates that, at the time of collection, the intertidal zone's substrate would have been sandier than the current silty intertidal sediment flats and would have more closely resembled the A.D. 1947 historic images than the present-day environment (see Figure 4). It is worth emphasizing that the sedimentology of the Port Albert River estuary may also have been different when the sites were occupied. Evidence from estuaries elsewhere in Victoria (Kennedy et al. 2020b, 2021) shows that this type of coastal system can infill rapidly. In addition, in Venus Bay (70 km to the west), it has been shown that mangrove islands, similar in shape to those offshore of the excavation, can form within a century (Kennedy et al. 2017). It is highly likely that the entire Port Albert River estuary at the time of Bratua 1 and 2's occupation was more open than it is today. The presence of primary and secondary flakes with cortex suggests that quartz nodules were then collected from local sources such as the Albert River mouth that is presently 300 m west of the Bratua site complex and flaked expediently. Given the age of the ash-stained SU3, beginning ca. 1260–1060 CAL B.P. and ending ca. 1190–900 CAL B.P. at the base of SU2 (containing recent cultural material), corresponds with the dominant period of artifact and shell deposition at Bratua 1, the implication is that people repeatedly returned to this area to clear the undergrowth with fire and to camp in small groups that gathered local, especially coastal, resources (see Table 1).

In addition to shedding light on the specific activities that the Old Ancestors undertook in this location, as described above, the Bratua 1 and 2 excavations also enable a greater understanding of what we thought we knew about the regional pattern of occupation going back some 3000 years. Until now, archaeological interpretations of southern Gippsland's archaeology divided sites into three broad types based on their contents and largely assumed (due to dating constraints of the time) chronology: 1) shell middens containing estuarine cockle (*Anadara* sp.), mud oyster (Ostreidae), and backed and other small artifacts manufactured from introduced silcrete (3000–4000 B.P.); 2) thin pipi (*Latona deltoides*) scatters with sparse quartz assemblages in coastal foredunes (1000 B.P.–mid-A.D. 1800s); and, 3) thicker pipi (*L. deltoides*) middens with quartz artifacts, small silcrete artifacts, and bone points in back-beach environments (1000 B.P.–mid-A.D. 1800s). However, based on its excavated materials and dating, Bratua 1 does not neatly fit into any of these three categories. The site was occupied between ca. 3170–2960 CAL B.P. and 1190–900 CAL B.P., outside the expected range, as, under the prevalent archaeological phase model, quartz artifact assemblages would be associated with occupation dating to the past 1000 years (note that the model is based on uncalibrated radiocarbon ages, but this does not significantly affect Bratua 1's ill-fit). The Bratua 1 radiocarbon dates exceed this by some 2000 to hundreds of years, falling into what had been thought to be a hiatus in regional coastal occupation dating between ca. 3000 and 1000 B.P. (Coutts 1970; Hotchin 1990). The Bratua assemblage is dominated by the sand cockle, *Katelysia* spp., a shell taxon that, with the exception of McNiven (2000, 27), had not previously been reported from middens of this area. Its characteristics had not, therefore, been incorporated in Coutts' and Hotchin's models of coastal occupation. The Bratua 2 radiocarbon results show that Aboriginal families continued to return to and use the area in consistent ways into the 19th and perhaps 20th centuries A.D. Future research in coastal Victoria requires more original field research combined with robust dating programs to investigate the occupational trends for the region at nested spatial scales. To truly interpret these patterns, research must also consider trends in landform development and change and their associated habitat dynamics.

Conclusion

A decade ago, Rowland, Ulm, and Roe (2014, 37) drew attention to the "few robust site monitoring programmes that focus on identifying the causes and directions of change in the coastal zone and the impacts that these changes have on heritage places." Since then, researchers in Australia have increasingly developed and implemented methods to better monitor coastal cultural heritage places that are under threat from environmental factors, including human activities (e.g. Birkett-Rees et al. 2022; Carmichael et al. 2018; Daly et al. 2022). Excavations at Bratua 1 and 2 demonstrate that highly vulnerable ("almost gone") archaeological sites can retain strong research potential to tell the stories of the past, about people and places and the activities they undertook.

Past shoreline occupation remains poorly understood for many parts of Australia, and this is compounded by the loss of Pleistocene and Early Holocene coastal sites and landscapes through post-glacial sea level rise, as well as by habitat fluctuations. Vulnerable coastal sites and landscapes will often need to be prioritized for monitoring, test or salvage excavation, and management before they are lost, a future that may be imminent in some cases. The results of the Bratua 1 and 2 excavations raise important questions regarding Victorian, and indeed southeastern Australian, archaeology. Notably, 1) is the regional coastal occupation hiatus (3000–1000 B.P.) a true phenomenon or a function of sampling bias, occupational patterns relating to past coastal habitat fluctuations or recent taphonomic factors that resulted in site loss? 2) Should quartz and pipi (*L. deltoides*) exploitation truly be temporally constrained to the past 1000 years in regional occupation models? 3) Beyond the previously recognized estuarine cockle (*Anadara* sp.) and pipi (*L. deltoides*), what other important but hitherto overlooked shell taxa featured in coastal economies at various times in the past, such as the sand cockle (*Katelysia* spp.)? Further research will undoubtedly elucidate these issues, but in some regions, entire coastal habitats, and their archaeological sites, are likely to disappear in coming decades if predicted sea level rises and storm surges are anything to go by. Investigating currently eroding sites can help tell their stories before it is too late.

Endnotes

1. We use the word "midden" (meaning "rubbish heap") here, as it is ingrained in the established archaeological lexicon. However, we note that in GunaiKurnai world views, archaeological materials including shells are not discarded "rubbish" but ancestral expressions imbued with life.

2. "Old Ancestors" is a respectful term for ancestors of the distant past used by GunaiKurnai Traditional Owners.
3. Bratua 1 and 2 were originally recorded as Old Settlement Road 1 and 2 on excavation forms and bags.

Acknowledgements

We thank the Gunaikurnai Elders Council, Gunaikurnai Traditional Owners Land Management (TOLM) Board, Monash Indigenous Studies Centre at Monash University, the Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage (CE170100015), and the Australian Research Council "Katungal: Managing Archaeological Sites Threatened by Sea Level Rise" project (IL240100034) for research support. Thank you to Val and Andy Macmeikan for their hospitality and sharing their knowledge of local environmental change and to Karen Smith from the Yarram and District Historical Society for kindly searching for and sharing archival records. Thank you to Matt Holland, Daniel Miller, and Judy Stewart (Gunaikurnai Land and Waters Aboriginal Corporation) for logistical support.

Declaration of Interest Statement

No potential conflict of interest was reported by the authors.

Notes on Contributors

Ashleigh J. Rogers is a Lecturer in Archaeology at Monash Indigenous Studies Centre, Monash University, Australia. Her research interests include zooarchaeology, island and coastal archaeology, marine-based subsistence strategies, and the archaeology of Australia and the Pacific Islands.

Bruno David is a Professor in Archaeology at the Monash Indigenous Studies Centre, Monash University, Australia. Bruno's work focuses on concepts of landscape, rock art, coastal archaeology, and Indigenous research partnerships.

David M. Kennedy is a Professor in Physical Geography, School of Geography, Earth and Atmospheric Sciences, The University of Melbourne, Australia. David specializes in coastal geomorphology and has over 20 years experience on how climate change, storms, tsunami, and sea level rise affect coastal landforms, particularly beach and dunes, coral reefs, rocky cliffs, and estuaries.

Russell Mullett is a GunaiKurnai Elder and the General Manager of the Gunaikurnai Land and Waters Aboriginal Corporation. He has decades of experience working on archaeological excavations and cultural heritage surveys on GunaiKurnai Country.

Joanna Fresløv is the archaeologist for the Gunaikurnai Land and Waters Aboriginal Corporation and previously worked as a senior advisor for Aboriginal Victoria (now First Peoples State Relations, Victorian Government). She is a leading authority on the archaeology of Victoria and, especially, of the Gippsland region.

Fiona Petchey is an Associate Professor at The University of Waikato, New Zealand. Fiona's research involves the application of radiocarbon techniques to the improvement of archaeological chronologies by the joint investigation of site taphonomy combined with sample-specific radiocarbon (^{14}C) effects in shell and bone caused by diet and environmental conditions.

Gunaikurnai Land and Waters Aboriginal Corporation are the Indigenous corporation representing the GunaiKurnai Traditional Owners of large parts of Gippsland, Victoria, Australia.

Jerome Mialanes is a Research Fellow and Laboratory Manager at Monash Indigenous Studies Centre, Monash University, Australia. Jerome is a specialist in stone artifact analysis and works on archaeological material from across Australia and Papua New Guinea.

Liam Neill is the Principal at Verge Archaeology and Heritage Pty Ltd, Melbourne, Victoria, Australia. He is a consulting archaeologist and heritage advisor that specializes in archaeological field methods and stone artifact analysis.

Olivia Bowman is Gunaikurnai Land and Water Corporation personnel and a GunaiKurnai community member who worked on the excavation program.

Cade Brickle-Krizanac is Gunaikurnai Land and Water Corporation personnel and a GunaiKurnai community member who worked on the excavation program.

John Hayes is a GunaiKurnai community member who worked on the excavation program.

John Dow is a GunaiKurnai community member who worked on the excavation program.

ORCID

Ashleigh J. Rogers http://orcid.org/0000-0003-0455-9381
Bruno David http://orcid.org/0000-0002-8567-6135
David M. Kennedy http://orcid.org/0000-0002-4878-7717
Fiona Petchey http://orcid.org/0000-0002-3308-9983
Jerome Mialanes http://orcid.org/0000-0002-6790-7542
Liam Neill http://orcid.org/0009-0002-9439-6925

References

Andrefsky Jr., W. 2005. *Lithics: Macroscopic Approaches to Analysis*. Cambridge: Cambridge University Press.

Australian Bureau of Statistics. 2012. "1301.0 – Year Book Australia, 2012: Geography and Climate." Australian Bureau of Statistics. Retrieved 10 June 2023 from < https://www.csiro.au/en/research/environmental-impacts/climate-change/State-of-the-Climate >.

Australian Bureau of Statistics. 2020. "Regional Population, 2018–19, ABS, Canberra." Australian Bureau of Statistics. Retrieved 10 September 2023 from < https://www.abs.gov.au/statistics/people/population/regional-population/2018-19 >.

Bailey, G., and N. Milner. 2002. "Coastal Hunter-Gatherers and Social Evolution: Marginal or Central?" *Before Farming* 4 (1): 1–15.

Benjamin, J., M. O'Leary, J. McDonald, C. Wiseman, J. McCarthy, E. Beckett, P. Morrison, F. Stankiewicz, J. Leach, J. Hacker, P. Baggaley, K. Jerbić, M. Fowler, J. Fairweather, P. Jeffries, S. Ulm, and G. Bailey. 2020. "Aboriginal Artefacts on the Continental Shelf Reveal Ancient Drowned Cultural Landscapes in Northwest Australia." *PLOS ONE* 18 (6): e0287490.

Birkett-Rees, J., B. David, B. D. Suttie, and D. M. Kennedy. 2022. "Predictive Modelling of the Impacts of Climate and Sea Level Change on Gippsland Lakes Aboriginal Sites." Unpublished report prepared for GKLaWAC and Parks Victoria, Victoria, Australia. https://doi.org/10.26180/21433200.v1.

Boyd, S. 2011. "Taxonomic Toolkit for Marine Life of Port Phillip Bay." Port Phillip Marine Life. Retrieved 6 June 2023 from < https://portphillipmarinelife.net.au/>.

Bronk Ramsey, C. 2009. "Bayesian Analysis of Radiocarbon Dates." *Radiocarbon* 51:337–360.

Buettel, J., B. David, R. Mullett, J. Fresløv, K. Szabo, and Gunaikurnai Land and Waters Aboriginal Corporation. 2023. *Fires in GunaiKurnai Country: Landscape Fires and their Impacts on Aboriginal Cultural Heritage Places and Artefacts in Southeastern Australia*. Oxford: Archaeopress.

Carmichael, B., G. Wilson, I. Namarnyilk, S. Nadji, S. Brockwell, B. Webb, F. Hunter, and D. Bird. 2018. "Local and Indigenous Management of Climate Change Risks to Archaeological Sites." *Mitigation and Adaptation Strategies for Global Change* 23:231–255.

Cechet, B., P. Taylor, C. Griffin, and M. Hazelwood. 2011. "Australia's Coastline: Adapting to Climate Change." AusGeo News 101: 2–9. Retrieved 8 June 2023 from <https://www.ga.gov.au/ausgeonews/ausgeonews201103/climate.jsp>.

Coutts, P. J. F. 1967. "The Archaeology of Wilsons Promontory." Masters diss., Department of Arts, Australian National University, Canberra.

Coutts, P. 1970. *The Archaeology of Wilsons Promontory. Publication No. 28*. Canberra: Australian Institute of Aboriginal Studies.

Coutts, P., D. Witter, R. Cochrane, and J. Patrick. 1976. "Coastal Archaeology in Victoria. Victorian Archaeological Survey."

Unpublished report prepared for the Town and Country Planning Board, Melbourne, Victoria, Australia.
CSIRO. 2022. "State of the Climate 2022." Commonwealth of Australia.
Daly, P., R. M. Feener, N. Ishikawa, I. Mujah, M. Irawani, A. Hegyi, K. Baranyai, J. Majewski, and B. Horton. 2022. "Challenges of Managing Maritime Cultural Heritage in Asia in the Face of Climate Change." *Climate* 10 (6): 79. https://doi.org/10.3390/cli10060079.
Djekic, A. 1981. "Latrobe Valley Coalfields 1981 Archaeological Study Update." Edited by J.W. Rhoads. Aboriginal Affairs Victoria, Melbourne, Victoria, Australia.
Faulkner, P. 2009. "Focused, Intense and Long-Term: Evidence for Granular Ark (*Anadara Granosa*) Exploitation from the Late Holocene Shell Mounds of Blue Mud Bay, Northern Australia." *Journal of Archaeological Science* 36:821–834.
FitzGerald, D. M., M. S. Fenster, B. A. Argow, and I. V. Buynevich. 2008. "Coastal Impacts due to Sea-Level Rise." *Annual Review of Earth and Planetary Sciences* 36:601–647.
Fullagar, R. 1986. "Usewear and Residues on Stone Tools." PhD diss., Department of Archaeology and History, La Trobe University, Melbourne.
Fullagar, R. 2015. "The Logic of Visitation: Tool-use, Technology and Economy on Great Glennie Island, Southeastern Australia." *Quaternary International* 385:219–228.
Gaughwin, D., and R. Fullagar. 1995. "Victorian Offshore Islands in a Mainland Coastal Economy." *Australian Archaeology* 40:38–50.
Godfrey, M. C. S. 1989. "Shell Midden Chronology in Southwestern Victoria: Reflections of Change in Prehistoric Population and Subsistence?" *Archaeology in Oceania* 24 (2): 65–69.
Gregory, D., T. Dawson, D. Elkin, H. Van Tilburg, C. Underwood, V. Richards, A. Viduka, K. Westley, J. Wright, and J. Hollesen. 2022. "Of Time and Tide: The Complex Impacts of Climate Change on Coastal and Underwater Cultural Heritage." *Antiquity* 96 (390): 1396–1411.
Gunaikurnai Land and Waters Aboriginal Corporation. 2015. "Gunaikurnai Whole-of-Country Plan." Gunaikurnai Land and Waters Aboriginal Corporation, Bairnsdale, Victoria, Australia. Retrieved 18 June 2023 from < https://gunaikurnai.org/wp-content/uploads/2021/07/Gunaikurnai-Whole-of-Country-Plan-ONLINE.pdf>.
Gunaikurnai Land and Waters Aboriginal Corporation. 2023. *Fires in GunaiKurnai Country Landscape Fires and Their Impacts on Aboriginal Cultural Heritage Places and Artefacts in Southeastern Australia*, edited by J. Buettel, B. David, R. Mullett, J. Fresløv, and K. Szabó. Oxford: Archaeopress Archaeology.
Hall, R. 1989. "An Archaeological Survey of the Gippsland Lakes." Unpublished report prepared for the Heritage Services Branch, Aboriginal Affairs Victoria, Melbourne, Victoria, Australia.
Hassler, U. 2006. "Implications of Climate Change on Heritage." *Building Research and Information* 34 (2): 175–179.
Heaton, T. J., P. Köhler, M. Butzin, E. Bard, R. W. Reime, W. E. N. Austin, C. Bronk Ramsey, P.M. Grootes, K.A. Hughen, B. Kromer, P.J. Reimer, J. Adkins, A. Burke, M.S. Cook, J. Olsen, and L.C. Skinner. 2020. "Marine20—The Marine Radiocarbon Age Calibration Curve (0–55,000 cal BP)." *Radiocarbon* 62 (4): 1–42.
Heldt, K., and A. Hart. 2021. "Vongoles 2020 Fisheries Research and Development Corporation." Fisheries Research and Development Corporation. Retrieved 6 November 2003 from <https://www.fish.gov.au/report/269-VONGOLES-2020>.
Heldt, K., and S. Mayfield. 2020. "Harvestable Biomass of *Katelysia* spp. in the South Australian Vongole Fishery." Unpublished report prepared for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, South Australia, Australia. SARDI Publication Number. F2014/000191-2. SARDI Research Report Series No. 1060.
Hiscock, P. 1986. "Technological Change in the Hunter River Valley and its Implications for the Interpretation of Late Holocene Change in Australia." *Archaeology in Oceania* 21:40–50.
Hiscock, P. 1994. "Technological Responses to Risk in Holocene Australia." *Journal of World Prehistory* 8 (3): 267–292.
Hogg, A., T. J. Heaton, Q. Hua, J. Palmer, C. Turney, J. Southon, A. Bayliss, P.G. Blackwell, G. Boswijk, C. Bronk Ramsey, F. Petchey, P. Reimer, R. Reimer, and L. Wacker. 2020. "SHCAL20 Southern Hemisphere Calibration, 0-55,000 Years cal BP." *Radiocarbon* 62 (4): 759–778. DOI:10.1017/RDC.2020.59.
Hotchin, K. L. 1990. "Environmental Evolution and Culture Change in the Gippsland Region, Victoria, Australia." PhD diss., Department of Australian National University, Canberra.
Hotchin, K., and P. May. 1984. "An Archaeological Survey of Jack Smith Lake, South Gippsland Lakes." Unpublished report prepared for the Australian Heritage Commission, Canberra, Australia.
Howitt, A. W. n.d. "Howitt Papers, La Trobe Collection." Unpublished manuscript MS 9356. State Library of Victoria, Australia.
Ishiwa, T., Y. Yokoyama, Y. Miyairi, S. Obrochta, T. Sasaki, A. Kitamura, and H. Matsuzaki. 2016. "Reappraisal of Sea-Level Lowstand During the Last Glacial Maximum Observed in the Bonaparte Gulf Sediments, Northwestern Australia." *Quaternary International* 397:373–379.
Jenkin, J. J. 1968. "The Geomorphology and Upper Cenozoic Geology of South-East Gippsland, Victoria." Geological Survey of Victoria Memoir 27, Melbourne.
Jerardino, A., and C. W. Marean. 2010. "Shellfish Gathering, Marine Paleoecology and Modern Human Behavior: Perspectives from Cave PP13B, Pinnacle Point, South Africa." *Journal of Human Evolution* 59:412–424.
Jones, R., and J. Allen. 1979. "A Stratified Archaeological Site on Great Glennie Island, Bass Strait." *Australian Archaeology* 9:1–11.
Jones, R., and J. Allen. 1980. "A Radiocarbon Date for the Final Prehistoric Occupation of Great Glennie Island Cave, Bass Strait." *Australian Archaeology* 10:21–25.
Jones, R., and J. Allen. 1985. "The Great Glennie Island Excavation." Unpublished manuscript. Victoria, Australia.
Kennedy, D.M., B. David, J. Fresløv, A.J. Rogers, R. Mullett, J. Birkett-Rees, O. Bowman, P. Faulkner, and Gunaikurnai Land and Waters Aboriginal Corporation. 2023. "Archaeology of Australia's Coastal Shoreline: The Role of Geomorphology in the Visibility and Preservation of Archaeological Deposits on Sandy Shores." *Australian Archaeology*. 89 (3): 244–260.
Kennedy, D. M., T. Konlechner, E. Zavadil, M. Mariani, V. Wong, D. Ierodiaconou, and P. Macreadie. 2017. "Invasive Cordgrass (*Spartina* spp.) in South-Eastern Australia Induces Island Formation, Salt Marsh Development, and Carbon Storage." *Geographical Research* 56 (1): 80–91.
Kennedy, D. M., S. L. McSweeney, M. Mariani, and E. Zavadil. 2020b. "The Geomorphology and Evolution of Intermittently Open and Closed Estuaries in Large Embayments in Victoria, Australia." *Geomorphology* 350:106892.
Kennedy, D. M., T. S. N. Oliver, T. Tamura, C. V. Murray-Wallace, B. G. Thom, N. J. Rosengren, D. Ierodiaconou, P. Augustinus, C. Leach, J. Gao, S.L. McSweeney, T. Konlechner, and C.D. Woodroffe. 2020a. "Holocene Evolution of the Ninety Mile Beach Sand Barrier, Victoria, Australia: The Role of Sea Level, Sediment Supply and Climate." *Marine Geology* 430:106366.
Kennedy, D. M., V. N. L. Wong, and G. E. Jacobsen. 2021. "Holocene Infill of the Anglesea Estuary, Victoria: A Keep-up Estuary in a Geologically Constrained Environment." *Australian Journal of Earth Sciences* 68 (6): 839–851. DOI: 10.1080/08120099.2021.1879266.
Knott, S., K. Szabó, M. Ridges, and R. Fullagar. 2017. "Vulnerability of Indigenous Heritage Sites to Changing Sea Levels." *Archaeological Review from Cambridge* 32:78–97.
Lambrides, A. B. J., I. J. McNiven, and S. Ulm. 2019. "Meta-Analysis of Queensland's Coastal Indigenous Fisheries: Examining the Archaeological Evidence for Geographic and Temporal Patterning." *Journal of Archaeological Science: Reports* 28:102057. https://doi.org/10.1016/j.jasrep.2019.102057.
Land Conservation Council. 1980. "Report Prepared on the South Gippsland Area, District 2." Unpublished report, Melbourne, Victoria, Australia.
Manne, T., and P. M. Veth. 2015. "Late Pleistocene and Early Holocene Exploitation of Estuarine Communities in Northwestern Australia." *Quaternary International* 385:112–123.
McCarthy, F. D. 1941. "Two Pebble Industry Sites of Hoabinhien I Type on the North Coast of New South Wales." *Records of the Australian Museum* 21 (1): 21–26.
McNiven, I. J. 1995. "Archaeological Survey of Nooramunga Marine and Coastal Park, South Gippsland, Victoria: Land-Use Patterns, Sites, and Management Recommendations." Report prepared for West and Central Gippsland Aboriginal Cooperatives, Victoria. On file at Heritage Services Branch, Aboriginal Affairs Victoria, Melbourne, Australia.

McNiven, I. J. 2000. “Treats or Retreats: Aboriginal Island use Along the Gippsland Coast, Southeastern Australia.” *The Artefact* 23:22–34.

McNiven, I. J., N. de Maria, M. Weisler, and T. Lewis. 2014. “Darumbal Voyaging: Intensifying use of Central Queensland’s Shoalwater Bay Islands Over the Past 5000 Years.” *Archaeology in Oceania* 49 (1): 2–42.

Miller-Ezzy, P. A., D. A. J. Stone, and X. Li. 2021. “Mud Cockle (*Katelysia* spp.) Stock Enhancement/ Restoration: Practical Implementation and Policy Evaluation.” Unpublished report prepared for the South Australian Research and Development Institute (Aquatic Sciences), Adelaide. FRDC Project No. 978-1-876007-38-6.

Murphy, P., D. Thackray, and E. Wilson. 2009. “Coastal Heritage and Climate Change in England: Assessing Threats and Priorities.” *Conservation and Management of Archaeological Sites* 11 (1): 9–15.

O’Connor, S., and M. Sullivan. 1994. “Coastal Archaeology in Australia; Developments and New Directions.” *Australian Archaeology* 39:87–96.

Oliver, T. S. N., D. M. Kennedy, T. Tamura, C. V. Murray-Wallace, T. M. Konlechner, P. C. Augustinus, and C. D. Woodroffe. 2018. “Interglacial-Glacial Climatic Signatures Preserved in a Regressive Coastal Barrier, Southeastern Australia.” *Palaeogeography, Palaeoclimatology, Palaeoecology* 501:124–135.

Presland, G. 1983. “An Archaeological Survey of the Melbourne Metropolitan Area.” Victorian Archaeological Survey Occasional Report Series No.15, Aboriginal Affairs Victoria, Australia.

Reeder-Myers, L. A. 2015. “Cultural Heritage at Risk in the Twenty-First Century.” *Journal of Island and Coastal Archaeology* 10:436–445.

Reimer, P. J., W. E. N. Austin, E. Bard, A. Bayliss, P. G. Blackwell, C. Bronk Ramsey, M. Butzin, H. Cheng, R.L Edwards, M. Friedrich, P.M Grootes, T.P Guilderson, I. Hajdas, T.J Heaton, A.G Hogg, K.A Hughen, B. Kromer, S.W Manning, R. Muscheler, J.G Palmer, C. Pearson, J. van der Plicht, R.W Reimer, D.A Richards, E.M Scott, J.R Southon, C.S.M Turney, L. Wacker, F. Adolphi, U. Büntgen, M. Capano, S.M Fahrni, A. Fogtmann-Schulz, R. Friedrich, P. Köhler, S. Kudsk, F. Miyake, J. Olsen, F. Reinig, M. Sakamoto, A. Sookdeo, and S. Talamo 2020. “The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP).” *Radiocarbon* 62 (4): 725–757.

Roberts, D. 1984. “The Genus *Katelysia* (Bivalvia: Verenidae) in South Australia.” *Journal of the Malacological Society of Australia* 6 (3-9): 191–204.

Rosengren, N. 1989. “Sites of Geological and Geomorphological Significance in the South Gippsland Marine and Coastal Parks.” Unpublished report prepared for the Department of Conservation, Forests & Lands, Yarram Region, Victoria, Australia.

Rowland, M. J. 1989. “Population Increase, Intensification or a Result of Preservation? Explaining Site Distribution Patterns on the Coast of Queensland.” *Australian Aboriginal Studies* 2:32–42.

Rowland, M. 1992. “Climate Change, Sea-Level Rise and the Archaeological Record.” *Australian Archaeology* 34:29–33.

Rowland, M. J. 2008. “Saving the Past from the Future.” *Historic Environment* 21:19–29.

Rowland, M., B. Shaw, and S. Ulm. 2021. “Maritime Coastal and Island Societies of Australia and New Guinea.” In *The Oxford Handbook of The Archaeology of Indigenous Australia and New Guinea*, edited by I. J. McNiven, and B. David, Oxford: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780190095611.013.29>.

Rowland, M. J., and S. Ulm. 2012. “Key Issues in the Conservation of the Australian Coastal Archaeological Record: Natural and Human Impacts.” *Journal of Coastal Conservation* 16 (2): 159–171.

Rowland, M., S. Ulm, and M. Roe. 2014. “Approaches to Monitoring and Managing Indigenous Australian Coastal Cultural Heritage Places.” *Queensland Archaeological Research* 17:37–48.

Simmons, S., and P. Irish. 1977. “Esso-BHP Snapper Pipeline Archaeological Survey Report.” VAS. Ministry for Conservation, Australia.

Smith, A. 1998. “Preliminary Results of a Midden Excavation at Arrawarra Beach, Mid-North Coast NSW.” *Australian Archaeology* 47:61–62.

Smith, A. W., and L. A. Jackson. 1990. “Assessment of the Past Extent of Cyclone Beach Erosion.” *Journal of Coastal Research* 6:73–86.

Stevens, A., and B. Stevens. 2007. *Images of Gippsland Revisited*. Victoria, Australia: Gippstar International, Yallourn North.

Sullivan, M. E. 1981. “Ninety Years Later: A re-Survey of Shell Middens on Wagonga Inlet and Pambula Lake, NSW.” *Archaeology in Oceania* 16 (2): 81–86.

Sullivan, M. E. 1982. “Aboriginal Shell Middens in the Coastal Landscape of New South Wales.” PhD diss., Department of Prehistory and Anthropology, Australian National University, Canberra.

Ulm, S., D. O’Grady, F. Petchey, Q. Hua, G. Jacobsen, L. Linnenlucke, B. David, D. Rosendahl, M.M.E. Bunbury, M.I. Bird, and P.J. Reimer. 2023. “Australian Marine Radiocarbon Reservoir Effects: ΔR Atlas and ΔR Calculator for Australian Mainland Coasts and Near-Shore Islands.” *Radiocarbon*, https://doi.org/10.1017/RDC.2023.95.

van Waarden, N. 1989. “Ethnohistory.” Unpublished manuscript. Wilsons Promontory Archaeological Project. Victoria Archaeological Survey, Victoria, Australia.

Victorian Regional Channels Authority. 2021. “Vic Tides.” Victorian Regional Channels Authority. Retrieved 16 March 2023 from <https://vrca.vic.gov.au/wp-content/uploads/2020/11/Tides-Tables-2021-Final_web.pdf>.

Wesson, J. P., and W. E. Beck. 1981. “Report on an Archaeological Survey of the Proposed Driffield Project.” Unpublished report prepared for State Electricity Commission of Victoria.

World Resources Institute. 2014. “Coastal and Marine Ecosystems - Marine Jurisdictions: Coastline Length.” World Resources Institute. Retrieved 18 September 2023 from https://web.archive.org/web/20120419075053/http:/earthtrends.wri.org/text/coastal-marine/variable-61.html.