The Long Bay Restaurant site, R10/1374: Volume 1, the archaeology (HNZPTA authorities 2015/19 and 2016/81)

report to
Heritage New Zealand Pouhere Taonga
and
Auckland Council

Matthew Campbell, Beatrice Hudson, Jacqueline Craig, Arden Cruickshank, Louise Furey, Karen Greig, Andrew McAlister, Bruce Marshall, Fiona Petchey, Tristan Russell, Danielle Trilford and Rod Wallace

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1 Introduction

Auckland Council had proposed refurbishing the Long Bay Restaurant at Long Bay Regional Park (Lot 2 DP 54616), amounting to a near full rebuild of the structure apart from the in situ foundations. Council began the project in mid-2013 with the partial demolition of the existing structure and sawing of the concrete floor slab to install new utilities. Following the discovery of human remains beneath the floor slab on 2 July 2013, work was halted. The remains were inspected by the New Zealand Police who confirmed that they were pre-European kōiwi tangata. An assessment of the site was then undertaken by Beatrice Hudson of ArchOs Archaeology (Hudson 2013) and the find was recorded as site R10/1374 in the New Zealand Archaeological Association (NZAA) Site Recording Scheme (SRS) (this site number applies to any other archaeological features associated with the wider area). Auckland Council applied to the New Zealand Historic Places Trust (now Heritage New Zealand Pouhere Taonga, HNZPT) for an archaeological authority under section 18 of the Historic Places Act 1993 to undertake archaeological test excavations to investigate the nature, extent and condition of the site, and how it would be affected by the proposed development project. Authority 2014/506 was granted on 28 November 2013 and the investigation was carried out on the 20th and 21st of January 2014 (Campbell et al. 2014) (the 2014 excavation is summarised in Chapter 3).

Auckland Council then applied to HNZPT for an authority under section 44 of the Heritage New Zealand Pouhere Taonga Act 2014 to modify or destroy any further material found during the refurbishment project, including associated car parks and footpaths. Authority 2015/19 was granted on 7 August 2014 and works resumed. On 6 November 2014 further kōiwi were found within the project footprint and work once again ceased.

Following extensive consultation with mana whenua and HNZPT, Auckland Council determined that the refurbishment would continue but it was agreed that the entire footprint of the development would be cleared archaeologically in order to provide assurance that no further kōiwi would remain within the project area. As the scope of the archaeological investigation had changed, a new archaeological authority, superseding authority 2015/19, was required and a full archaeological assessment of effects was also required in support of the authority application (Campbell and Hudson 2015). Authority 2016/81 was granted by HNZPT on 25 August 2015. This report fulfils the conditions of both authority 2015/19 and 2016/81.

Excavation began on 5 October 2015 with site clearance and removal of the concrete pad but not the ground beam foundations, while full excavation commenced on 12 October under the direction of Matthew Campbell (Excavation Director, CFG Heritage) and Beatrice Hudson (Osteologist, ArchOs Archaeology). Excavation continued until 3 November, by which stage kōiwi of a further 10 individuals had been found, bringing the total to 12. Following an onsite hui on 4 November between representatives of mana whenua, HNZPT, Auckland Council and the excavation team, the excavation was halted but mana whenua requested that the 3 possible burials that had been located but not excavated be lifted, and on 9 November the site was shut down. At a second on site hui on 9 December Auckland Council announced that they had resolved to cancel the restaurant project, but mana whenua expressed a desire that the 13 x 12 m excavation area opened up at the time be excavated to a sterile layer to lift all kōiwi. Excavation resumed on 18 January 2016 and continued until 4 March, when all kōiwi and archaeological deposits and features had been excavated.

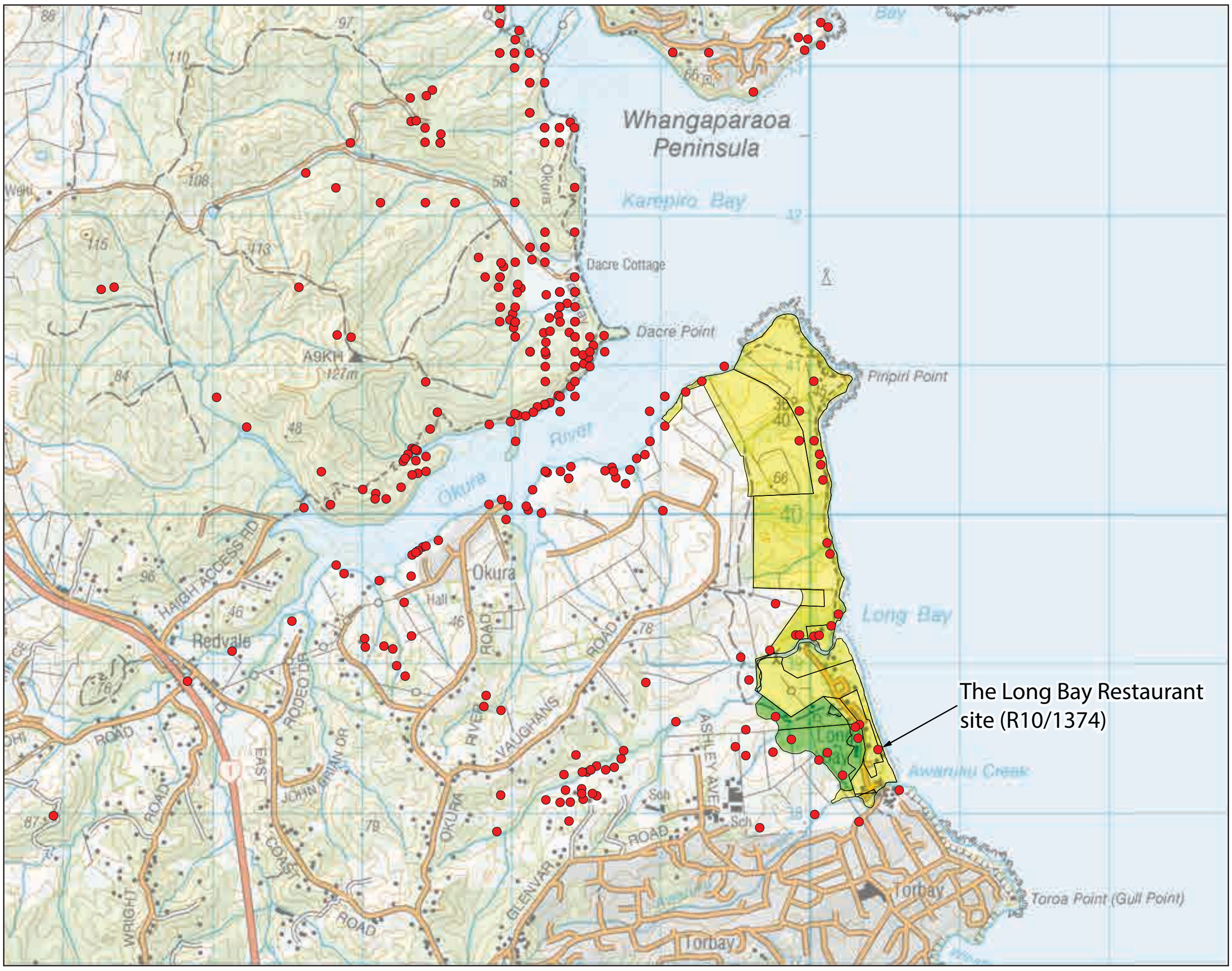


Figure 1.1. Location of Long Bay Regional Park and R10/1374, showing the Heritage Protection Zone (HPZ) in green, and archaeological sites recorded in the wider area.

The name of the site

The traditional name for Long Bay is Te Oneroa o Kahu, the long sandy beach of Kahu. Another name associated with the area is Whakarewa Toto, floating blood, which refers to bodies floating into Te Oneroa o Kahu following a battle at sea off the Whangaparaoa Peninsula (Nick Hawke pers. comm. 25 March 2019). While it is tempting to associate this history with the evidence of violence seen in some of the burials from Phase 13 (Chapter 7) there is no good evidence linking them. We prefer to refer to the site as The Long Bay Restaurant Site, and the wider area, including the nearby wetlands and the headlands and hills behind Te Oneroa o Kahu (the beach), as Long Bay.

Acknowledgements

The excavation team were: Matthew Campbell (Director), Beatrice Hudson (Osteologist), Arden Cruickshank, Tremaine Edmonds, Ben Jones, Bernie Larsen, Wesley Maguire, Nicholas Mainwaring, Andrew McAllister, Lisa McKendry, Joe Mills, Danielle Trilford and Gabriel Vilgalys for CFG Heritage Ltd; with volunteer assistance from Robert Brassey, Laura Dawson, Myfanwy Eaves, Mary Kienholz, Joss Piper-Jarrett and Rebecca Ramsay from Auckland Council.

Mana whenua consultation and involvement was facilitated by: Ringi Brown and Fiona McKenzie from Ngāti Manuhiri; Hahi Walker, Georgina Parata and Tracy Davis from Ngāti Whātua o Kaipara; Geoff Cook from Ngāti Maru; James Brown from Ngāi Tai ki Tāmaki; Rewi Spraggon, Ed Ashby and Scott Lomas from Te Kawerau ā Maki; Hau Rawiri and Mahuika Rawiri from Ngāti Pāoa; and Nick Hawke, Grant Hawke and Pani Gleeson from Ngāti Whātua o Ōrākei. Nick Hawke was the mandated cultural monitor on behalf of mana whenua.

Mat Vujcich, Wendy Ellis and Jason Maguiness from Auckland Council Parks Department provided support and assistance.

Auckland University archaeology students Zack Smith and Sian Canton volunteered their services to clean and sort midden.

2 Background

The Long Bay Restaurant site is located just behind the foredune at Te Oneroa a Kahu / Long Bay. At the south end of the beach is the mouth of the Awaruku or Waikariwātoto Creek. A drained alluvial wetland about 650 x 250 m lies just behind this. At the north end of the beach is the mouth of the Vaughan's or Awarūika Creek, with Vaughan's Flat occupying about 800 x 400 m to the south of the creek. This flat was originally an embayment that was then largely blocked by the foredune and became an alluvial wetland, but has been drained for agriculture (Phillips and Bader 2007a).

No archaeological sites are recorded at either the Awaruku Creek mouth nor the Vaughan's Creek mouth, though these locations would have been attractive sites for pre-European Māori occupation. Evidence may have been destroyed by changes in the shifting beds of the creeks or by development, or have been covered over by mobile dune sands.

A low foredune runs along the beach and behind the foredune the land is flat beach sand for 50 m before rising steeply to the Awaruku Headland, that is bounded to the north and south by the two streams. This headland is the site of an important archaeological landscape much of which is now protected as the Heritage Protection Zone (HPZ) and incorporated into Long Bay Regional Park. The East Coast Bays Formation, the geological formation that forms the headland, consists of alternating sandstone and mudstone with variable volcanic content that is subject to faulting along its bedding planes, resulting in natural terraces on the headland that were occupied by pre-European Māori (Edbrooke 2001; Kermode 1992: 45). Soils are poorly drained, podzolised Mahurangi fine sandy loams (DSIR 1954), which are unlikely to have been suitable for pre-European Māori horticulture. They are currently under pasture but would originally have been podocarp forest.

Similar landforms occur north of the Vaughan's Creek and south of the Awaruku Creek (where they have been developed as part of the suburb of Torbay), where 30–40 m high sandstone cliffs overlook the water. A terrace and possible pit with some midden (R10/392) was recorded on the slope just south of the creek mouth in 1989 but it would seem likely that evidence of pre-European Māori activity would have been present on this high ground prior to suburban development, and that some of this may survive.

North of the Vaughan's Creek mouth are sandstone cliffs up to 40 m high. Several middens have been recorded in this area.

The restaurant was built just behind the low foredune about 20 m west of mean high water. This dune consists of loose windblown beach sands which had been capped in clay in places, presumably by Auckland Council Parks staff to stabilise the dune. This dune extends almost continuously along the whole beachfront of the Long Bay Regional Park. Vegetation consisted of kikuyu grass (*Cenchrus clandestinus*) and woody weeds, while the seaward face of the dune has been planted with low profile species such as pīngao (*Ficinia spiralis*), oioi (*Apodasmia similis*), wīwī (*Juncus edgariae*), rengarenga (*Arthropodum cirratum*) and kōwhangatara (*Spinifex sericeus*) (Wendy Ellis pers. comm 17 December 2018), although naturalised introduced species persist. Directly to the south of the excavation there was evidence of a former small stream that ran south to north behind the dune before turning east to cut through the dune and empty onto the beach. This stream probably made the site attractive to occupation.

Although soils would have been unsuited to kūmara cultivation, the beach, estuaries and rocky foreshore would have provided a variety of shellfish resources and fish would have been common in the Hauraki Gulf. The wetlands would have provided harakeke (flax) for weaving

Figure 2.1. The location of the 2016 excavations, showing the indicative extent of the site beyond the excavated area and the course of the former stream.

while the forest would have provided wood for construction and carving and resources such as berries and ferns. A variety of birds would have been available in all these habitats.

Pre-European Māori history

Before European contact the region had been subject to political unrest and had at different times been controlled by Ngāi Tai, Te Kawerau ā Maki and Ngāti Whātua o Kaipara. Oral traditions state that Ngāi Tai have maintained occupation in the Hauraki Gulf since the first visit of the Tainui Canoe (McBurney 2010: 51).

Around 1600 Maki (the ancestor of Te Kawerau ā Maki) of the Taranaki iwi Ngāti Awa conquered the Tāmaki Isthmus. During this period, there were multiple battles including one on the southern portion of Long Bay known as Te Whakarewatoto (McBurney 2010: 78). These battles led to Maki and his hapū gaining control of the North Shore / Mahurangi coast and settlement and occupation soon followed (McBurney 2010: 108).

The Māori name for Long Bay is Te Oneroa o Kahu (Phillips 2010: 10), which translates as The Long Sandy Beach of Kahu. Kahu is the eponymous ancestor of Ngāti Kahu and the grandson of Maki (Murdoch 1991: 33; McBurney 2010). Ngāti Kahu, who share ties with Te Kawerau and Ngāti Whatua, occupied the area surrounding Long Bay from the 17th century onwards. Their lands stretched from Ōrewa to Okura, including a semi-permanent kāinga in Te Haruhi Bay on the Whangaparaoa Peninsula. They lived in relative peace through intermarriage with other hapū in the area until the Ngāpuhi raids in the 1820s when Ngāti Kahu experienced heavy losses. The survivors fled to the Waikato and did not return till a decade later (Murdoch 1991: 36). Ngāti Kahu were still living in the area when European settlement began in the 1850s.

European history

European involvement in the region began in the 1830s with small timber felling operations and gum digging. In 1841 the Crown purchased the entire block of land from Te Ārai Point to Takapuna, known as The Mahurangi Omaha Purchase, and timber cutting licences were granted from 1844 onwards. The Mahurangi Omaha Purchase was carried out in haste and although claims and settlements carried on till 1854, there was an influx of European settlers into the area.

Survey plan SO 892a shows lots 11 and 12 owned by Malarin and Maxwell respectively (Figure 2.2.). Although a date is not displayed on this map, SO 892b, which shows the Whangaparāoa Peninsula, is dated to 1859 and it can be assumed the two are contemporaneous. It is not known if any permanent structures were built on these lots during this period.

Following the early period of European forestry and gum-digging, two prominent settlers arrived at Long Bay: Alexander Pannill and then George Vaughan. Pannill purchased Lot 11 in 1864 and farmed there till 1877. He built several structures including a house in front of the Awaruku headland near the current ranger's station and information centre. Although the structures have been removed, the location of the house is recorded as site R10/1139. Several ditch

Figure 2.2. Detail of SO 892a, dated to around 1859, showing the ownership of Malarin and Maxwell at Long Bay. Note that the plan shows the 'Awaruika' at the north end of Long Bay and the 'Whakarimatoto' (?) at the south end.

and bank boundary fences related to Pannill's occupation at Long Bay have been investigated and recorded by Phillips and Bader (2007a).

George Vaughan settled in Long Bay in 1862, and the Vaughan family occupied the area until 1974. They had originally started with 600 acres, which eventually grew to over 1100. The family farmed sheep on the property (Phillips and Bader 2007a: 25) while the area at the south of Long Bay was opened as a campground in 1929 and ran until 1965. Archaeological evidence of this was excavated by Campbell et al. (2014).

During the Vaughan occupation it was reported that there were land clearances and ploughing carried out on the flats between the hills and the beach, probably by burning off the vegetation and planting grass in its place. Native trees were replaced with pines in an effort to prevent erosion and provide shelter (Phillips and Bader 2007a: 25). During test excavations at the Long Bay Restaurant in 2014 Campbell et al. (2014) noted a grey ashy-charcoal deposit within the plough zone that they attributed to probable historic period vegetation clearance.

Archaeological background

Auckland was known to Māori as Tāmaki Makau Rau, Tāmaki of the hundred lovers.[1] It was an ideal settlement site for pre-European Māori horticulturalists, with fertile soils, productive harbours, the volcanic cones on which impressive pā were built, and portages connecting the east and west coasts. A good quality adze rock, Motutapu greywacke, was available from several islands in the Hauraki Gulf; cherts, sandstones and basalts were also locally available; and most major obsidian sources were not far away.

Several factors have impacted on the archaeological record of Tāmaki, the most obvious one being the growth of Auckland City itself. In recent years this has resulted in numerous archaeological investigations in mitigation of development effects but for much of the city's history there has been no archaeology carried out and major sites have vanished without record. The exception is the volcanic cone pā which remain fairly well preserved, but a single class of sites cannot be made to stand for an entire archaeological landscape. On the fringes of the city and in its hinterland of farm, forest, mountain and beach the situation is somewhat healthier. However, the sheer volume of recent archaeological excavation and reporting makes a full summary of the archaeology of Tāmaki difficult. The archaeological background provided here is restricted to the East Coast Bays, an area that has received less archaeological investigation than some other parts of Tāmaki.

The East Coast Bays archaeological landscape

Figure 2.3. shows that there are long stretches of the East Coast Bays coastline with little or no recorded archaeology, while sites are clustered in the inner Waitemata Harbour and Okura River estuary. This site distribution does not accurately reflect pre-European Māori occupation patterns but is a function of the history of site recording and urban expansion. As the East Coast Bays were first developed in the late 19th to mid-20th centuries archaeological sites would have been destroyed or built over without being recorded. The site density around Takapuna / Devonport is in part due to recent redevelopment triggering the archaeological requirements of

[1] It is widely held that this was due to its being such a desirable situation and so frequently fought over (e.g., Graham 1922: 20), but there are many other explanations for the name, mostly involving being named after one historical figure or another (e.g., Daamen et al. 1996: 7), or it may be an old name that has been reinterpreted (Agnes Sullivan pers. comm. 2010).

Figure 2.3. Distribution of pre-European Māori sites on the North Shore / East Coast Bays, data downloaded from ArchSite 4 July 2018.

the Heritage New Zealand Pouhere Taonga Act 2014, resulting in the recording of new sites. The greater density of recorded sites at Long Bay and the Okura River is in part due to site recording associated with recent greenfields developments proposals. It is certain that site densities along the East Coast Bays would have originally been similar to these, and it is equally certain that numerous as yet unrecorded sites survive, albeit damaged by housing.

Pā are recorded on the volcanic cones of Devonport: Maungauika R11/ 97; Takuranga R11/109; Takararo / Mt Cambria R11/110; and Takamaīwaho / Duder's Hill R11/2402 though the status of the latter two as pā is uncertain as both now quarried away; and on coastal headlands, though again there are headlands where pā might be expected but none are recorded, perhaps due to former development.

Two early period sites are recorded in Devonport. Torpedo Bay, R11/1945, was excavated in 2009 and recently reported (Campbell et al. 2018). The site contains two phases of occupation, one dating to the late 15th–17th centuries while the early phase dates to the 14th–mid-15th centuries. Charcoal and microfossil evidence suggest that the general area was cleared of vegetation by the time the site was first occupied but enough forest trees and wood remained to be collected for burning. A slope wash of soil dating to Phase 1 and containing kūmara starch indicates that the slopes of Maunaguika above the site were probably gardened. A somewhat sparse midden was dominated by rocky shore species in Phase 1 and soft shore species in Phase 2, which is a typical pattern. The Phase 1 midden contained bone of moa and seal, both of which became extinct or extirpated early, a variety of small birds, dog, rat, tuatara and a small fishbone assemblage that contained evidence of preservation of snapper for off site consumption. Shallow hearths containing stone but little ash or charcoal are implicated in snapper preservation.

The Masonic Tavern site (R11/2517) was excavated by Geometria in 2010 and 2013; so far only preliminary reports are available (Carpenter 2010; Crown 2014). The earliest phases at the site date to the 14th century (Russell Gibb pers. comm. 10 June 2017). Several kōiwi were also uncovered. Several other early period sites are known from Auckland and the Gulf Islands, though none are substantial.

Several sites, including the Masonic Tavern site, are recorded as containing kōiwi. These sites are all coastal, in similar situations to the Long Bay Restaurant site, with burials discovered close to the shore, often just behind the low foredune. The exception to this is R10/361, an isolated partial cranium found on a rocky beach on the north bank of the Okura River.

Three kōiwi sites, R10/131 at 32 Saltburn Road, R10/1420 at 27 Muritai Road and R10/700 at 30 Audrey Road, are recorded in Milford and kōiwi were also located in a midden at 39 Saltburn Road though this has not been recorded in the SRS. At R10/131 "5 burials consisting of seven individuals in crouched position, plus a single "spade cut" humerus of an eighth individual … behind beach" were recorded in 1974. The site was recorded as destroyed during house construction. No archaeological material was found during a site visit in 2001. R10/1420 was reported in the *North Shores Times Advertiser* (14 August 1990: 5) as being from a "young Māori female." It isn't clear if the site was examined at the time by an archaeologist and there is no record of any other archaeological features associated with the site. R10/700 was recorded in 1990 as the kōiwi of an adult and a child associated with a midden. The site was badly damaged by excavation for the building foundation but the pohutukawa beneath which the burials were found was undisturbed. During recent demolition and rebuild on the property no intact midden nor any further kōiwi were observed (Felgate & Associates 2004; Campbell 2016). At 39 Saltburn Road kōiwi were found in two places during house construction in 2008 but an archaeologist was not present and the kōiwi remain undescribed (Gibb 2008). The relationship of these kōiwi to R10/131 at 31 Saltburn Road is unclear.

R11/2968 is located at 38 Hauraki Road in Takapuna, where several kōiwi were found in a redeposited shell midden beneath the house. R11/1939 is an intertidal site where kōiwi have been found along with moa bone and stone flakes of various material, including argillite These are probably eroded onto the nearby beach from the adjacent Gould Reserve.

R11/2403 is located on the lower slopes of Maungauika / North Head. The *New Zealand Herald* (23 August 1994: 2) describes the find as "numerous bones from the skeletons of two large men and a woman and child." Again, the kōiwi were not inspected by an archaeologist, but the subsequent record indicates that numerous further burials are thought to be present.

The archaeology of Long Bay

In 1977 Bruce Hayward surveyed the coastal land of the Long Bay Regional Park from the Okura River mouth to the Awaruku Creek. He recorded a series of middens which were later revisited and recorded in more detail by Susan Bulmer and Chris Chambers. There were a further six sites recorded in the area during the 1980s including midden R10/421 at Long Bay (Phillips and Bader 2007a).

Archaeological assessments increased in the mid-1990s when subdivisions were proposed on the south side of the Okura River. In 1996 Tony Packington-Hall recorded a series of sites along the bank of the river, including a pa, R10/867 (Phillips and Bader 2007a).

In 1999, Russell Foster reviewed the Okura area for the North Shore City Council who were considering a zoning change, relocating 33 previously recorded sites and adding a further 14. Later that year Clough and Associates surveyed a large area of land to the south east of that surveyed by Foster and recorded another 13 sites (Foster 1999; Clough et al. 1999). Archaeological survey of sites within Long Bay Regional Park was undertaken by Auckland Council archaeologists in 2010, resulting in updates to a number of the records for those sites.

The land to the west of the Regional Park has recently been the focus of archaeological and geophysical survey and archaeological excavations prior to extensive housing development (Phillips and Bader 2007a). In 2001, Brent Druskovich undertook a series of assessments in both the Okura and Long Bay areas for Landco Ltd (Todd Property Group) at Vaughan Road and Long Bay (Druskovich 2001a, 2001b, 2001c, 2003). At the same time Barry Baquié (2001) assisted in upgrading the archaeological sites on public land within North Shore City, and revisited all of the sites that had been previously recorded at Long Bay Regional Park, and recorded two new sites.

In 2005, archaeological evidence was presented at the North Shore Council hearings into the Long Bay Structure Plan. The Commissioners supported the implementation of a Heritage Protection Zone (HPZ) in the area immediately west of Te Oneroa o Kahu (Long Bay). This was put into effect by North Shore City Council, acknowledging the importance of this heritage landscape. Landco lodged an appeal to the Environment Court in 2006 against the decision. Landco commissioned Caroline Phillips and Hans-Dieter Bader (Geometria) to address the outstanding questions presented by the Commissioner about the "nature, age, extent and heritage significance of the area" (Phillips and Bader 2007a: 66).

Probing by Druskovich (2003) across the Awaruku Headland had previously revealed extensive patches of midden. Geophysical survey was undertaken by Bader (2007) for the appeal using a fluxgate gradiometer. This confirmed the presence of extensive middens and 'burning events.'

Archaeological investigations for the appeal included the excavation of natural terraces containing midden on the Awaruku Headland, and excavation and pollen coring of the Awaruku wetlands. On the headland the midden was predominantly tuangi (*Austrovenus stutchburyi*), with some tuatua (*Paphies subtriangulata*), pipi (*Paphies australis*) and cat's eye (*Turbo smaragdus*). Small quantities of snapper (*Crysophrys auratus*), barracouta (*Thyrsites atun*) and other species were found. Ten shell samples were radiocarbon dated, giving dates ranging between AD 1440 and 1830, with a central core of dates between about 1480 and 1700. These indicate repeated, probably short term, occupation over several centuries (Phillips and Bader 2007b).

Overlying the pre-European Māori occupation is a series of 19th century European ditch and bank fences, probably built by Alexander Pannill who farmed the land between 1864 and 1877 (Greig and Walter 2007). Evidence of 19th century gum digging was found in the Awaruku Wetland (Phillips and Bader 2007a, 2010). Finally, there are World War II military defences providing an important 20th century overlay on this archaeological landscape. The Environment Court in its decision in the 2006 appeal case that prompted the excavation noted the significance of this landscape and ordered that a large part of it be protected from future development. This Heritage Protection Zone, centred on the Awaruku Headland, is incorporated into Long Bay Regional Park.

Excavations were undertaken by CFG Heritage in 2014 at R10/1374, the Long Bay Restaurant site (Campbell et al. 2014) – these are summarised in Chapter 3

In 2017 and 2018 CFG Heritage monitored roadworks across the Vaughan Flat connecting the Long Bay subdivision to the Regional Park. Two sites were uncovered: a redeposited midden that probably originated higher up the slope as part of R10/201, and several in situ midden deposits on the flat that were part of R10/289. Radiocarbon dating of shell from R10/289 indicated deposition in the 15th century while R10/201 dated at least 200 years later.

3 Archaeology

The excavation of the Long Bay Restaurant site initially ran from 12 October to 9 November 2015 with a long shutdown over the summer break when the Regional Park and beach were busy, during which time the site remained fenced off from the public and the excavations were covered over with weed mat to protect them from wind erosion. Excavation resumed on 18 January and finished on 4 March 2016. Prior to 2015–2016 excavations, exploratory excavations were undertaken in 2014.

2014 excavations

Exploratory excavations directed by Matthew Campbell and Beatrice Hudson on 20 and 21 January 2014 were undertaken under authority 2014/506 issued by the New Zealand Historic Places Trust (NZHPT) under section 18 of the Historic Places Act 1993. These excavations followed the discovery of kōiwi beneath the foundation slab during utilities upgrades and were intended to investigate the nature, extent and condition of the archaeology ariund the restaurant, and establish the effects of the proposed restaurant refurbishment on the archaeology. The excavations are reported in full in Campbell et al. (2014) and are summarised here.

Evidence of both pre-European Māori and 19th and 20th century historic occupation was found. A grey, lightly charcoal-stained layer was found in test trenches to the west (inland) and east (seaward) of the restaurant. The eastern trench contained a sparse midden as well as some dog bone, which was radiocarbon dated to cal AD 1500–1635. It wasn't clear that this grey layer related to the nearby kōiwi, although the archaeology and burial practice strongly indicated that the kōiwi was pre-European Māori.

The western trenches also contained a grey, lightly charcoal-stained layer but this showed clear evidence of having been ploughed and the charcoal may have originated in burning off the vegetation by the Vaughan family, who purchased the land in 1862. Above this layer was evidence of the mid-20th century campground. No definite pre-European evidence was found in these trenches and no further kōiwi were found in either the east or west trenches.

Method

The known presence of kōiwi necessitated a 100% clearance strategy to ensure that all human bone was retained. Prior to excavation, removal of the concrete floor slab was completed under archaeological supervision – this had already been partly cut and removed to install utilities in 2013. The perimeter ground beam foundations were left in place. These foundations were generally 400 mm wide and 450 mm deep, extending through the base of the archaeology into the natural substrate, and forming a footing ring approximately 12 x 9 m. Once the slab was removed the area inside the remaining foundations and for 2.5 m to the west of the foundations was gridded into 1 m squares, numbered ZX–I west to east and 1–13 south to north. All layers, including non-cultural wind-blown sand layers, and all features, including grave cuts, were numbered in the project database (a full list of recorded contexts is given in Table 3.5).

All deposits were excavated by hand and sieved though either a 3 mm or 6 mm screen on site. Initially the excavated material was sorted in the sieve, with any kōiwi handed over to the osteologist and all non-human bone (mammal, bird and fish) and artefactual material separately bagged. Realising that this was too time consuming, the method was changed to picking kōiwi out of the sieve and bagging all remaining sieved material for later sorting and analysis in the

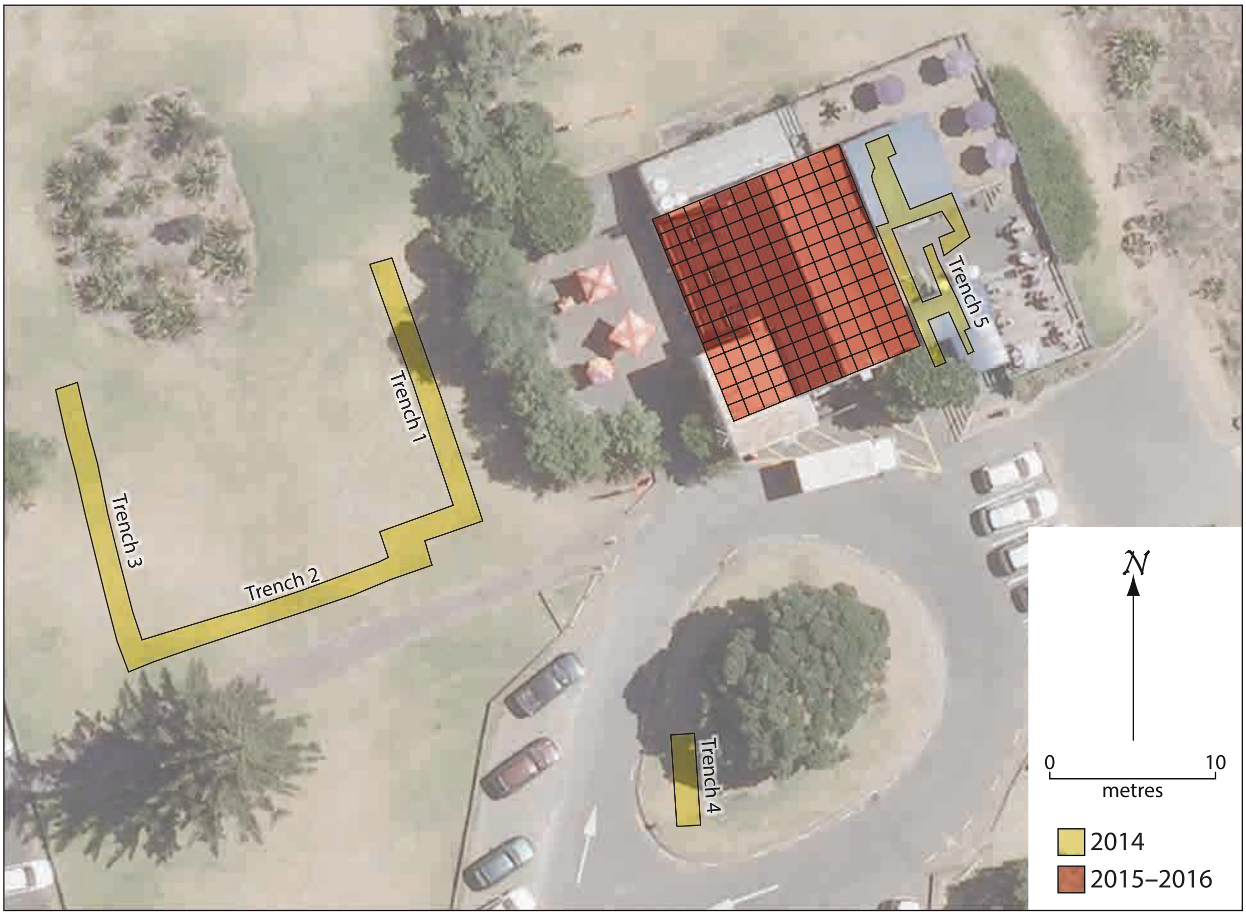


Figure 3.1. The extent of all 2014–2016 excavations. The underlying aerial image shows the restaurant, roads and car parks prior to demolition (http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer/).

lab. Each bag was given a unique LBR number in the project database. Material was bagged by feature number (including layers) and excavation square. Bulk samples, 10 litres where possible, were taken from each feature and each excavation square within each cultural layer.

Each feature, including cultural and non-cultural layers, was described on a standard feature form and the data from the form was subsequently entered into the project database. Extensive notes were taken by all the project team in the excavation note books.

Initial mapping of the site was done using an electronic total station, prior to Christmas 2015. This map was tied to the New Zealand Transverse Mercator 2000 datum. The total station was not available after Christmas and in 2016 the site was planned by hand, using tape and offset. The 1 x 1 m grid system set out with the total station in 2015 remained in use in 2016, allowing the hand-drawn plans to be georeferenced and traced into the project GIS. These maps captured extents of layers, features, and spot finds of both artefacts and kōiwi, and recorded depths below the site datum, which was taken from the concrete footing ring that remained in situ.

Features and layers were photographed with a digital SLR camera and all photos were recorded in the project database. When the weather was favourable, the site was photographed with a quadcopter drone (these general site shots were not recorded in the database).

The digger spoil heap from the 2014 works was partly sieved through a 6 mm screen. Part of the skull of Burial 2 had been exposed at the west end of the spoil heap while the digger driver indicated that the east end of the heap was the last place he had deposited soil. A 2 m section was dug out from each end by hand and sieved, but no further kōiwi were recovered.

The methodology for excavation of kōiwi is provided in Chapter 7 of this volume, and in Volume 2.

Archaeology

Archaeological excavation took place within the remaining reinforced concrete foundation and extended roughly 2.5 m to the west to incorporate the dense midden visible there. One hundred and nine separate contexts were recorded during the investigation, 97 of which were pre-European. Eleven cultural and natural layers were recorded, although the same layers could be recorded with different numbers inside and outside the concrete foundation or at different ends of the excavation, so that 21 feature numbers were assigned to layers. In addition, the burials could not be securely associated with any of these layers, resulting in a further three burial phases being recorded. Eighty archaeological features were found, including: 35 fire scoops, 23 of which are from Phase 4; 23 grave cuts; 15 postholes; 1 small pit; 2 concentrations of kōiwi; 2 firescoop rake outs not directly associated with firescoops; and 2 cooking stone caches. Other identified contexts included modern features from the construction and demolition of the restaurant (Phase 14).

Site formation processes

The site sits in the lee of in a low foredune which runs along the length of Long Bay. This dune system is typical of the east coast of New Zealand where dunes are formed by wave and wind action (Goff et al. 2003: 164). They are in a constant state of flux between stable and unstable formation processes. When vegetation can grow on the dune system it is stable, allowing soil to develop on the surface. When this soil development is disrupted by the removal of the overlying vegetation, whether through natural or, more commonly, artificial processes, the dune system becomes mobile, and redistribution of beach sands and blowouts will occur (Masselink et al. 2011: 291). Blowouts are depressions formed by wind erosion, which lead to a deflation basin in which lighter sand is removed to a level where the particles are too heavy for the wind to move (Goff et al. 2003: 173).

One of the biggest influences on dune behaviour is human induced changes to the vegetation regime. The plants that grow on dunes are typically susceptible to trampling and especially susceptible to fire. Māori utilised fire as a form of landscape modification to remove unwanted plants, provide a brief nutrient boost, clear land for gardening and encourage bracken growth. This is a typical Polynesian practice (e.g., Kirch 1994) and has been recorded throughout the New Zealand, for instance, from early dates in the Manawatū and Northland (Hesp 2001; Enright and Anderson 1988; Brook and Goulstone 1999). While sand dunes have not been studied directly in the Auckland region, pollen cores from Lake Pupuke show these processes occurring locally from the early 14th century AD (Striewski et al. 2009). More recently, introduced marram grass (*Ammophila arenaria*) has outcompeted pīngao (*Ficinia spiralis*) and other native foredune species, resulting in a denser vegetation cover trapping sand into higher foredunes backed by parabolic dunes with deflated surfaces between the two, often exposing previously buried middens and burying others (Hilton et al. 2018). While Long Bay does not have the high depositional rates of Hilton et al's. study area (Mason Bay on Rakiura), historic vegetation changes are likely to have also affected the site.

These processes have been noted by archaeologists describing dune midden deposits both internationally (Compton and Franceschini 2005; Orton et al. 2005; Robins et al. 2015) and throughout New Zealand, from Aupouri in Northland (Johnson 1990) to Hakapureirei in Southland (Walter and Jacomb 2005). At Hakapureirei, Walter and Jacomb recorded a site complex of deflated middens, some reduced to stone scatters, and noted that previously separated strata had been conflated into a single surface.

What is not clear from any of these studies is what happens to the midden shell once the dune deflates. At Omaha, 40 km north of Long Bay, Bickler at al. (2003) described a deflating midden as having active "deflation fronts" that were being eaten into by wind, with only a sparse scatter of shell beneath the front where previously there had been a dense shell midden up to 350 mm deep. This implies that the shell either blows away with the sand or, more probably, disintegrates and becomes a component of the dune sand. This in turn implies that the shell has degraded over time and that while the midden as a structure is stable if undisturbed, following deflation the individual components (the shells) break down rapidly.

At Mangawhai, 75 km north of Long Bay, the scrub on the foredune and mixed forest on the low dunes behind it were burnt soon after the arrival of humans, resulting in steeper dunes and wider and deeper swales (Enright and Anderson 1988). Middens were deposited in swales but as sand continued to be redistributed by wind, the middens stabilised the dune surface and formed caps on low dunes (this is essentially the process observed by Bickler et al. 2003 at Omaha). Similar processes may have also occurred at Long Bay, although here there is only a low foredune backed by a level terrace running up to the hills behind the beach, in other words a much lower sand budget than at Mangawhai or Omaha which are extensive sandspits.

Māori occupied the leeward or inland side of the foredune where cooking fires and occupation would have been sheltered from the onshore wind. Even a small group of people occupying the dune would have had an impact on the vegetation, causing localised instability of the dune and blowouts.

Alternating periods of dune stability and instability are the reason for the complex stratigraphy that was identified at the site. Each phase of occupation disturbed the dune vegetation which caused instability and sand movement. Blown-out sand capped the occupation midden which in turn was stabilised as the vegetation grew back. This process was repeated at least six times, but the fact that the cultural layers, as they were encountered during excavation, are not extensive indicates that they have also been partly destroyed through blowouts. Additional occupations possibly do not survive at all, or survive on parts of the dune outside the excavated area.

Potential evidence of deflated cultural layers was observed at the site. Degraded bird, mammal, sea mammal and moa bone that appeared to have been weathered through surface exposure was found in Phase 4 but only beyond the extent of the underlying Phase 1. Weathering is probably a result of being exposed for some time (not necessarily more than a few days or weeks) on the dune surface before being buried. Weathering may have contributed to their fragmented nature of some of these bones (Chapter 6). This implies that this bone was originally deposited in Phase 1, which was formerly more extensive but partly blew out, leaving the dense bone behind as a lag deposit that was subsequently incorporated into Phase 4. A similar process is evident for weathered mammal bone in Phase 7 that originated in Phase 5 (Figure 3.2), but it is also possible that some of these bones were present on the dune surface naturally and became incorporated into the archaeological deposits.

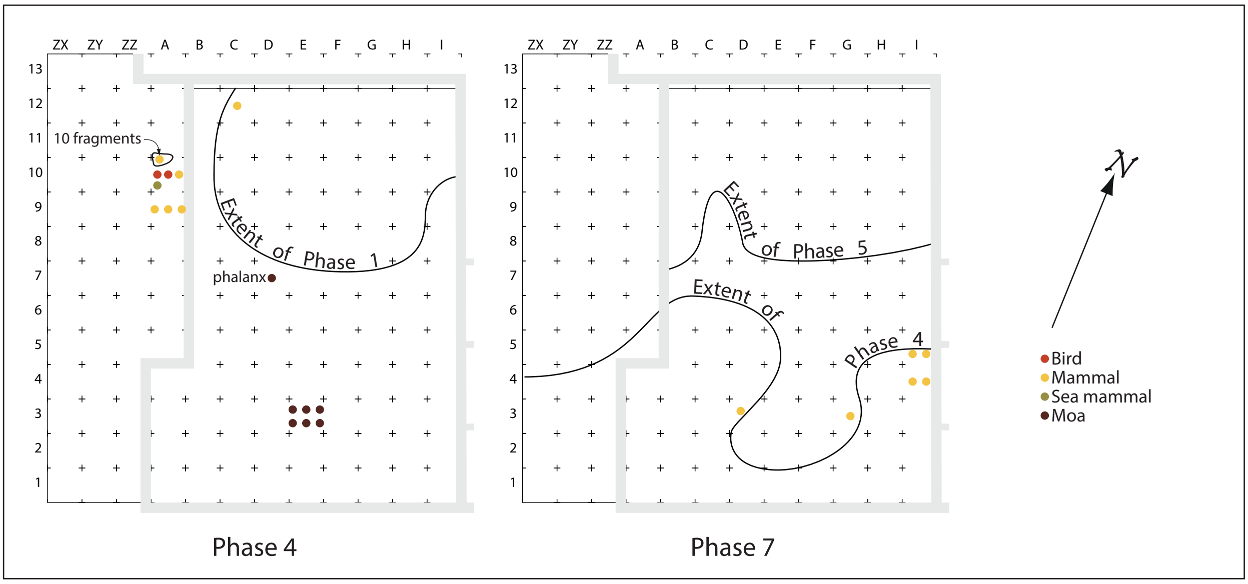


Figure 3.2. Distribution of weathered bird, mammal, sea mammal and moa bone in Phases 4 and 7.

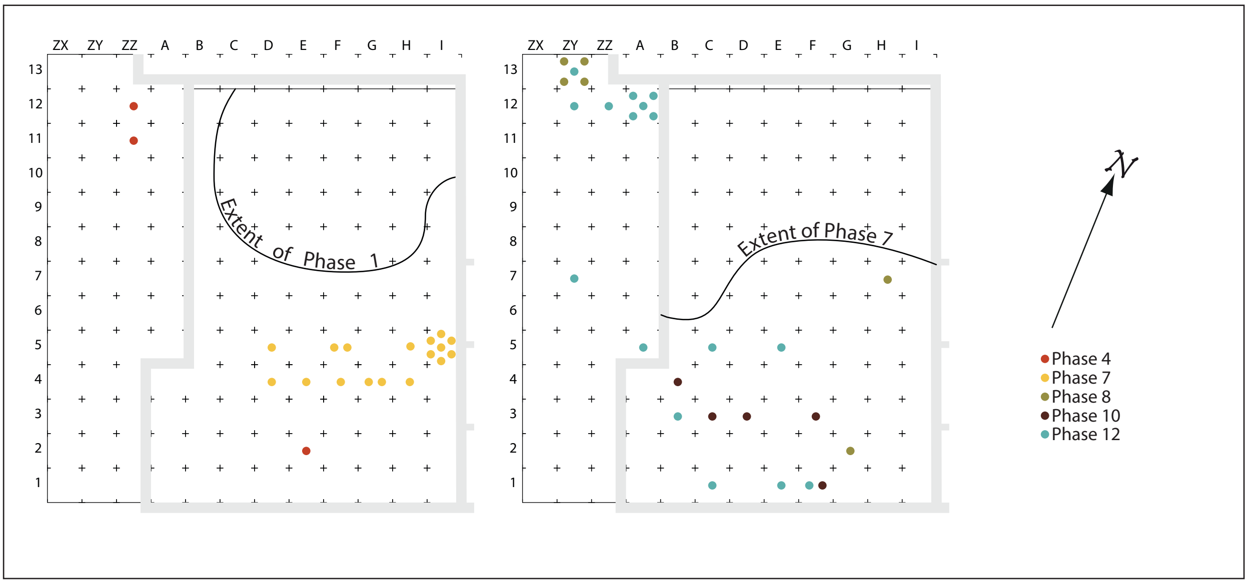


Figure 3.3. Distribution of weathered kōiwi in Phases 4, 7, 8, 10 and 12.

A similar pattern was observed for weathered kōiwi, which were all recovered from the southern part of the site, or west of the restaurant foundation. Scattered bone recovered in Phases 4 and 7 all lay south of the surviving extent of Phase 1 and probably originated in Burial Phase 3; while bone recovered from Phases 8 (an inter-occupation Phase of clean, shelly sand, see below), 10, and 12 may have originated in Phase 7 or previous Burial Phases (Figure 3.3). This bone may have been disturbed during previous occupation Phases but all of it seems to have been exposed on the surface at some stage and subsequently incorporated into later Phases as a lag deposit.

Figure 3.4. Lag deposit of fire cracked rock on the deflated surface of Phase 10.

Similarly, in Phase 10 a lag deposit of fire cracked rocks was found (Figure 3.4), which are probably all that remain from a previous phase of occupation that has otherwise been entirely wind deflated.

Historic period activities have also disturbed the site, most obviously construction and maintenance of the restaurant, with concrete ground beam foundations and services cutting through the upper layers of the site. This disturbance was particularly acute outside the foundations to the west, and some layers could not be traced here. While Phase 4 was excavated outside the restaurant it is very probable that it was intermixed with Phase 5, and Phases 7 and 10 were also not observed west of the foundation. No midden or other pre-European archaeological evidence was found in Trench 1 of the 2014 test excavation, 13 m to the west of the 2015–16 excavation.

Phasing

The primary purpose of the excavation was to recover the kōiwi and at times standard excavation methodologies had to be adapted to this purpose. It was not always possible to excavate the full area layer by layer, and the stratigraphy was complex, with layers blending to into each other and lensing in and out across the site. No layer, apart from the overlying layer of construction disturbance and demolition rubble, covered the full excavation area, and no part of the site contained all layers. Layers were often encountered out of sequence and so their numbering in the excavation database is also out of sequence. For instance, because Phase 4 was excavated in the south of the site before Phase 5 was discovered in the north of the site, Feature 50 (the

Phase 5 matrix) overlies Feature 7 (the Phase 4 matrix). Additionally, layers inside and outside the foundation were given different numbers, even though they turned out to be the same layer, for instance the Phase 4 matrix was represented by Features 7 and 30 inside the foundation and Feature 58 outside it. For ease of interpretation all reference to cultural and windblown layers will be by Phase rather than their field numbers (which are given in Appendix A).

The inter-occupation Phases generally consisted of clean, yellow-white, windblown dune sand, varying in extent and depth, with the exception of a deep lens of shelly, whiter sand in the south-east part of Phase 8. This lens was dug through for the Phase 9 burials and redeposited lenses of shelly sand were sometimes the only clear markers of grave cuts as they were excavated, prior to finding the kōiwi.

The layers to the west of the restaurant had been more disturbed by service trenches and construction than they had inside and tended to be present as discontinuous lenses. Phases 1 and 5 were not recorded here, and the midden was assigned to either Phase 4 or Phase 12. Because of the level of postdeposition disturbance and mixing, no dating samples were taken from outside the restaurant.

Cultural Phases

All main cultural layers as well as the intervening windblown sand layers have been renumbered as Phases, with Phase 1 the earliest cultural layer. Additionally, none of the burials could be assigned to any particular layer but there are at least three phases of burial, each of which is given its own phase number. The fill of the grave cuts was generally very clean and could not always be traced in the equally clean windblown sand layers, although occasionally a patch of shelly sand from Phase 8 indicated the fill of a Phase 9 burial. Some burials only became clear either once bone was found or the lighter mixed fill became visible in the darker cultural layers.

Burial Phases

In general, it can be assumed that most burials were cut from a higher level than when they first became visible. The tops of the burials may have been truncated by wind erosion of the dune, or the fill of the burial may have been the same clean sand that it was cut into so that it was not possible to pick up the cut at higher levels – this is discussed in detail in the description of Burial 18 from Phase 9, below. For this reason, burials cannot be clearly assigned to cultural phases and a number of criteria are used to assign them to burial phases that predate the overlying cultural phase and postdate the underlying one. This phasing is not necessarily as precise as the cultural phasing, where clearly defined layers of midden containing discrete features were excavated, while the burials in each burial phase may not always relate to the same occupation. The strongest criterion for assigning a burial to a phase was that it was clearly overlain or cut by material from a subsequent phase – for Phase 3 the burials were all overlain by Phase 4 midden or features. Other criteria included similarities in fill to burials that could be phased – Burial 18 from Phase 9 could clearly be seen to be overlain by Phase 10 material when it was examined in the excavation baulk, but this was not clearly visible in plan. However, several other nearby burials contained the same shelly Phase 8 sand that could be seen in the Burial 18 fill and so were assigned to the same Phase. The final burial phase was Phase 13, which contained burials at a higher level in the site, generally not reaching as deep as Phase 10. The archaeology of the grave cuts is discussed below, while a more complete description of the kōiwi is given in Chapter 7 and particularly Volume 2 of this report.

Phase 1 (Occupation Phase)

The first cultural phase covered an area of about 7 x 5 m in the northern part of the excavation in Rows 8–12 and C–I inside the foundation although disturbed lenses of similar material were found to the west of the foundation. The matrix of Phase 1 consisted of a mottled, moderately compacted yellow-grey sand containing a midden of whole shell dominated by tuatua (*Paphies subtriangulata*), with lesser numbers of cat's eye (*Turbo smaragdus*), tuangi (*Austrovenus stutchburyi*) and other bivalves and gastropods. As well as the shellfish, there was mammal, bird and fish bone, obsidian, occasional coprolites (fossilised faeces) almost certainly from dogs, charcoal and occasional fire cracked rock. Interestingly, although this is the earliest layer, no moa or sea mammal bone was found in it. The only artefacts were a shell fishhook point and an obsidian flake.

Four fire scoops were excavated in Phase 1. Features 66 and 103 were located in the north and east baulks respectively, both truncated by the restaurant foundation. Feature 66 contained a light grey ashy fill with some crushed, burnt shell, while Feature 103 contained a darker charcoal stained matrix with whole shell, predominantly tuatua, with lesser numbers of gastropods. Feature 118 was a smaller, deep firescoop with a fill of charcoal stained sand, shell, bone and whole charcoal. The largest feature in Phase 1 was a firescoop, Feature 98, measuring 1200 x 1100 mm x 150 mm deep. Although this feature was not excavated or recorded in Row 12 it is visible in the baulk left when the Row 12 excavation was complete (Figure 3.6). The matrix was generally similar to the other, smaller firescoops from Phase 1, with a denser layer of charcoal at the base and two small concentrations of bird bone. Below this firescoop was Feature 111, an oven stone cache containing seven oven stones of local sandstone, weighing 2520 g (Figure 3.8), that were located in a matrix of clean dune sand containing only a small amount of shell. Because the matrix was essentially the same as the sand into which it was dug the top of the feature was not found, but it measured 300 x 210 mm in plan. Since it was overlain by other Phase 1 features it is probably the earliest excavated feature on the site.

There were several postholes in Phase 1, some of which formed alignments. Four postholes in Row 12 (Features 72, 68, 70 and 71) may have been formed an east–west alignment but Features 70 and 71 may also have formed a north east–south west alignment with Features 117, 114 and 113, though they are not all the same size. The latter three were small postholes up to 100 mm across and 250 mm deep, while the postholes in Row 12 were all larger, between 120 and 210 mm across and up to 200 mm deep. These alignments are likely to represent structures such as wind breaks or drying racks rather than larger structures such as houses. There were also several other postholes that formed no alignments. Postholes tended to have a fill only a little darker than the surrounding matrix and were very hard to see – it seems likely that further postholes may have been present in all phases but were not recorded.

Overlying Phase 1 was Phase 2, a lens of clean windblown sand containing occasional beach shell, generally 200 mm but up to 350 mm thick, which separated it from Phase 4 and is visible in profile in Figure 3.7.

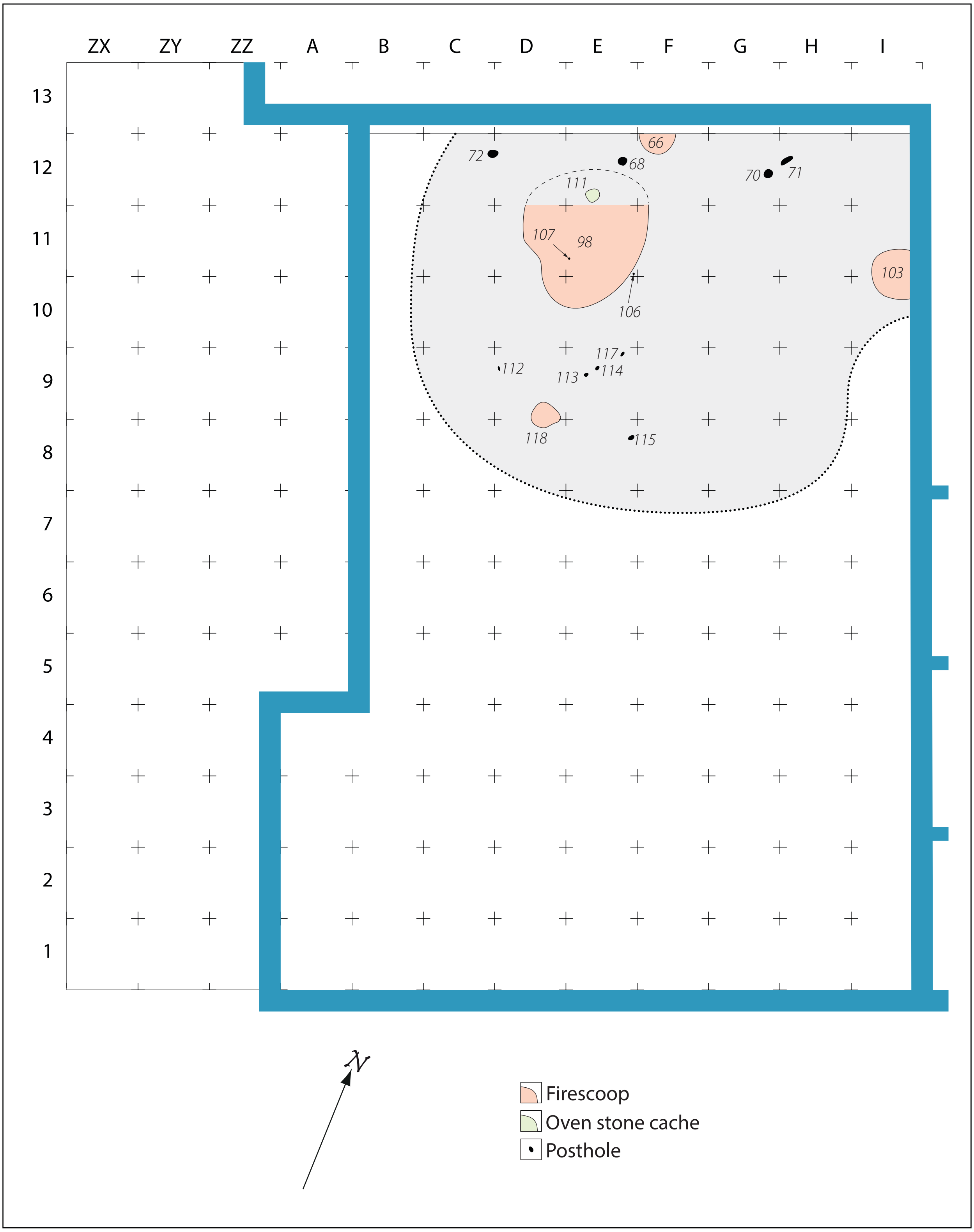


Figure 3.6. Phase 1. Feature 98 was not excavated in Row 12 but is clearly visible in profile in Figure 3.7.

Figure 3.7. Phases 1, 4 and 5 in profile in Squares E12 and F12, looking south. To the right, firescoop Feature 98 from Phase 1 is visible, overlain by the clean sand of Phase 2, with firescoop Feature 110 at a higher level from Phase 4 in the centre. The thin, discontinuous lens of clean windblown sand separating Phases 4 and 5 is also visible. Scale = 1 m.

Figure 3.8. Feature 111, oven stone cache below Feature 98. Scales = 0.5 m.

Phase 3 (Burial Phase)

Phase 3 is a burial phase containing three burials. These were all securely located beneath Phase 4 midden or Phase 4 features although none of the grave cuts were particularly deep, indicating that they may have been truncated to some degree prior to the build-up of Phase 4. Burials 12 and 15 were found beneath Phase 4 Features 123 and 119 respectively while Burial 6 was overlain by midden.

Phase 4 (Occupation Phase)

Phase 4 was the most extensive phase, covering most of the area inside the foundations as well as to the west. It was not present in Row 1 in the south of the excavated area and outside the foundation to the west had probably been mixed with Phase 5 material. The matrix of Phase 4 consisted of a lightly compacted, yellow-brown to dark brown, charcoal stained sand containing a shell midden dominated by tuatua with lesser quantities of cat's eye, tuangi, and slipper shell (*Maoricrypta costata*), along with abundant fishbone, rat and dog bone, sea mammal bone, moa bone and concentrated patches of charcoal. Obsidian and, to a lesser extent, chert flakes were common along with several formal artefacts including several shell fishhook points, a moa bone one-piece fishhook, abraders and a broken adze.

Phase 4 had 26 features, the most of any Phase, 23 of them fire scoops. These ranged in size from Feature 97, a shallow feature measuring 500 x 300 mm, to Feature 99 which, though truncated by Feature 89 (Phase 5), had a longest surviving dimension of 1420 mm. Some fire scoops showed evidence of heavy charcoal staining of the matrix and moderate heat reddening of the sand at the base of the feature (Figure 3.11). Others, while darker in plan than the surrounding midden, has more limited evidence of burning. Feature 119 was a firescoop measuring 1000 x 750 mm x 145 mm deep, with an upper layer or cap of a conglomerate of degraded bone overlying burnt shell and sandstone cooking stones in a charcoal stained matrix with a base of charcoal lenses overlying burnt red sand. This feature cut Feature 83 which was the grave cut for Burial 15 (Phase 3). Feature 123 was a firescoop that cut Feature 119 and measured 1300 x 300 mm x 180 mm deep. It had a cap of grey ash overlying some shell, bone and whole charcoal in a charcoal stained matrix with a base of red burnt sand. Feature 123 also cut Feature 83, which was the grave cut for Burial 12 (Phase 3).

Some firescoops were quite irregular in outline. Feature 91 was a long two-lobed feature 1640 x 540 mm x 170 mm deep. There was a deeper central scoop measuring 460 x 400 mm containing several cooking stones and concentrations of charcoal with ashy rakeout in the northern lobe and some evidence of rabbit burrowing. It is possible that this feature represents as many as three intercutting firescoops but this could not be confirmed during excavation. Similarly, Feature 96 was recorded as a single feature though it is clearly two intercutting features with an identical fill and it could not be seen which cut the other. Features 104, 105 and 109 were clustered together but here it was possible to distinguish them: Features 105 and 109 were not excavated in Row 7 so their length is not known, but the truncated dimensions were 800 x 460 mm x 100 mm deep and 780 x 600 mm x 70 mm deep respectively. Both these features were cut by Feature 104, which measured 780 x 350 mm x 70 mm deep. All three features were shallow and contained a homogenous fill of some shell and bone in a charcoal sand matrix – they have probably been truncated though natural or human processes but may have been more complex and intercut each other more clearly at a higher level.

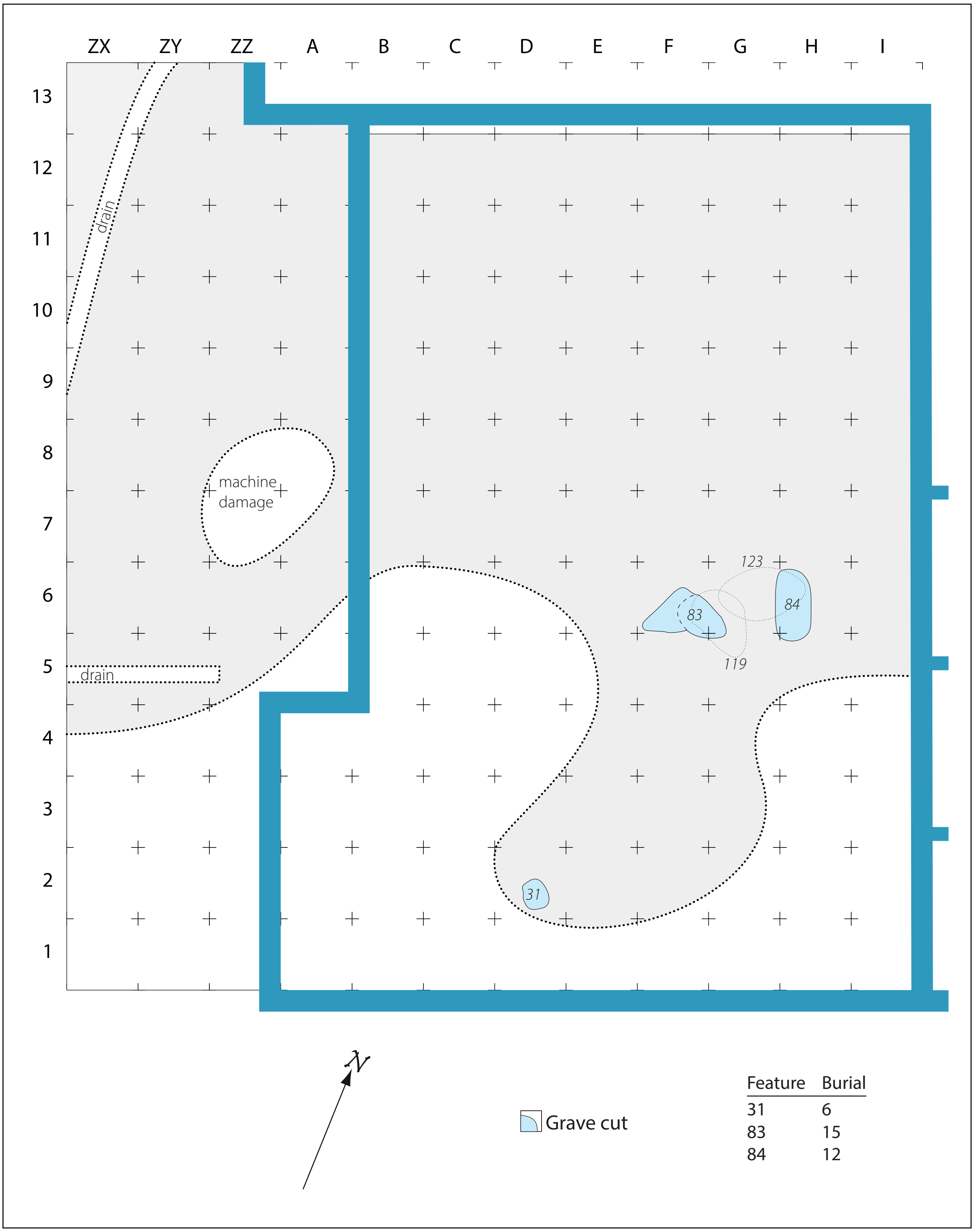


Figure 3.9. Phase 3, three burials beneath Phase 4, the extent of which is also shown.

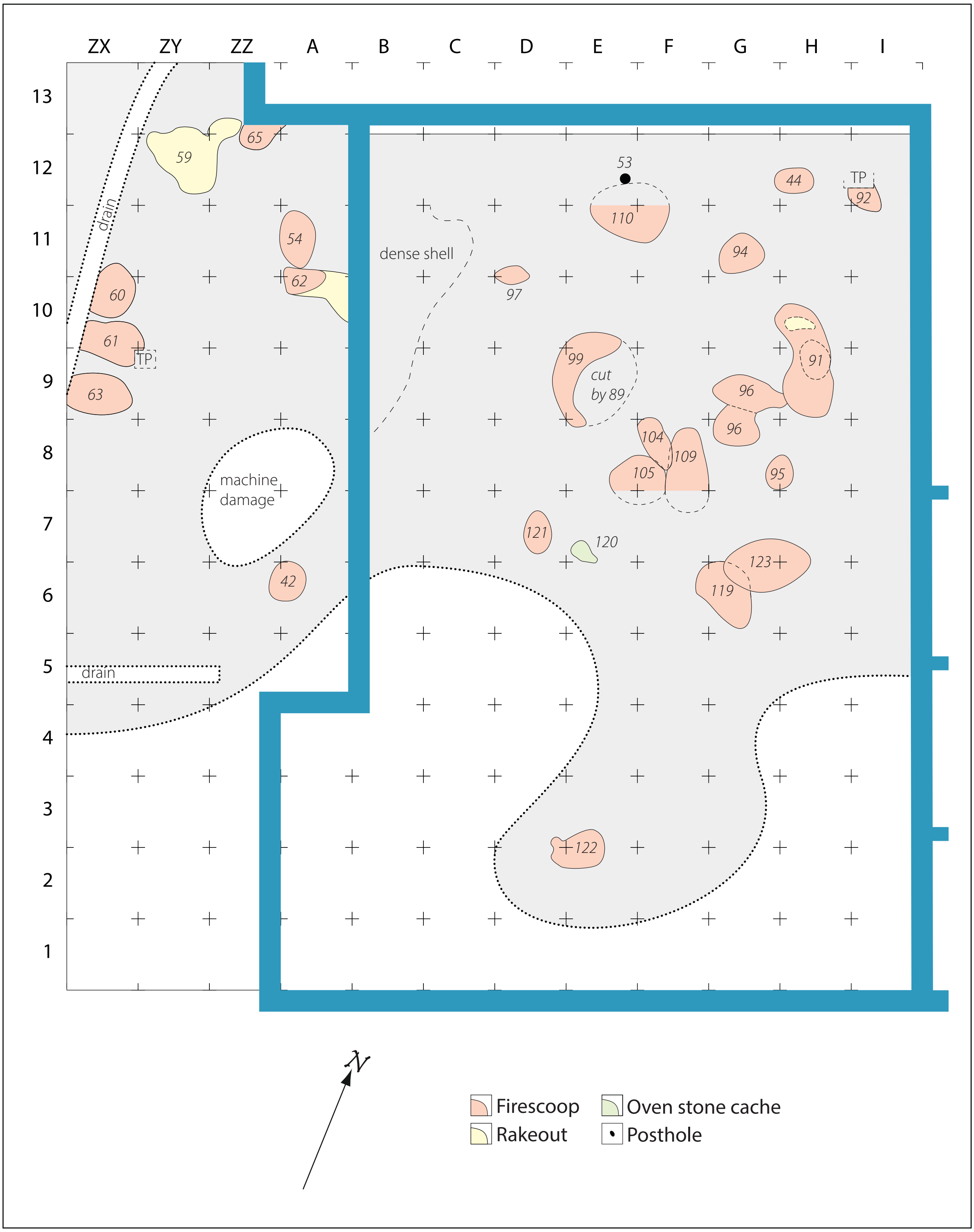


Figure 3.10. Phase 4. Features 61 and 92 were cut by test pits. Features 105 and 109 were not excavated in Row 7 and Feature 110 was not excavated in Row 12 but is clearly visible in profile in Figure 3.7. To the west of the restaurant foundation Phase 4 is somewhat disturbed.

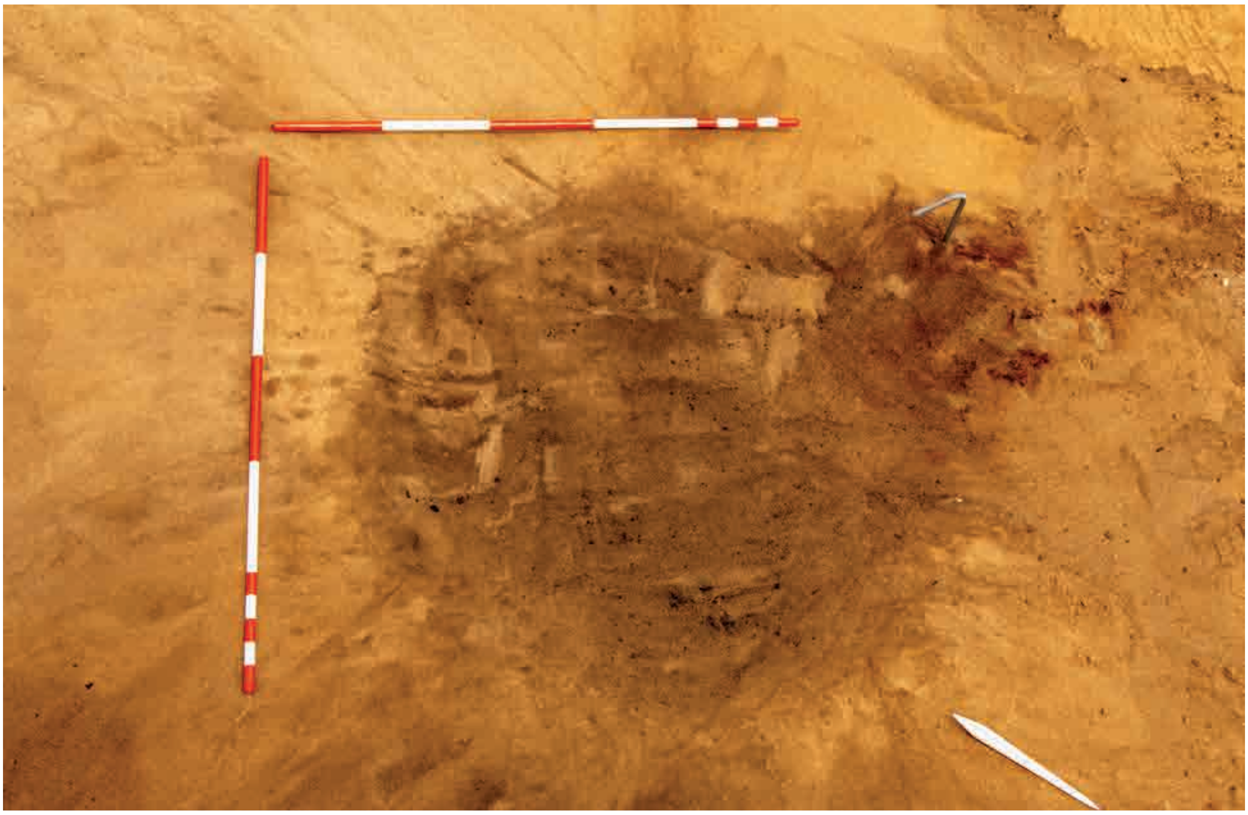


Figure 3.11. Feature 42 prior to excavation. Facing east, scales = 0.5 m.

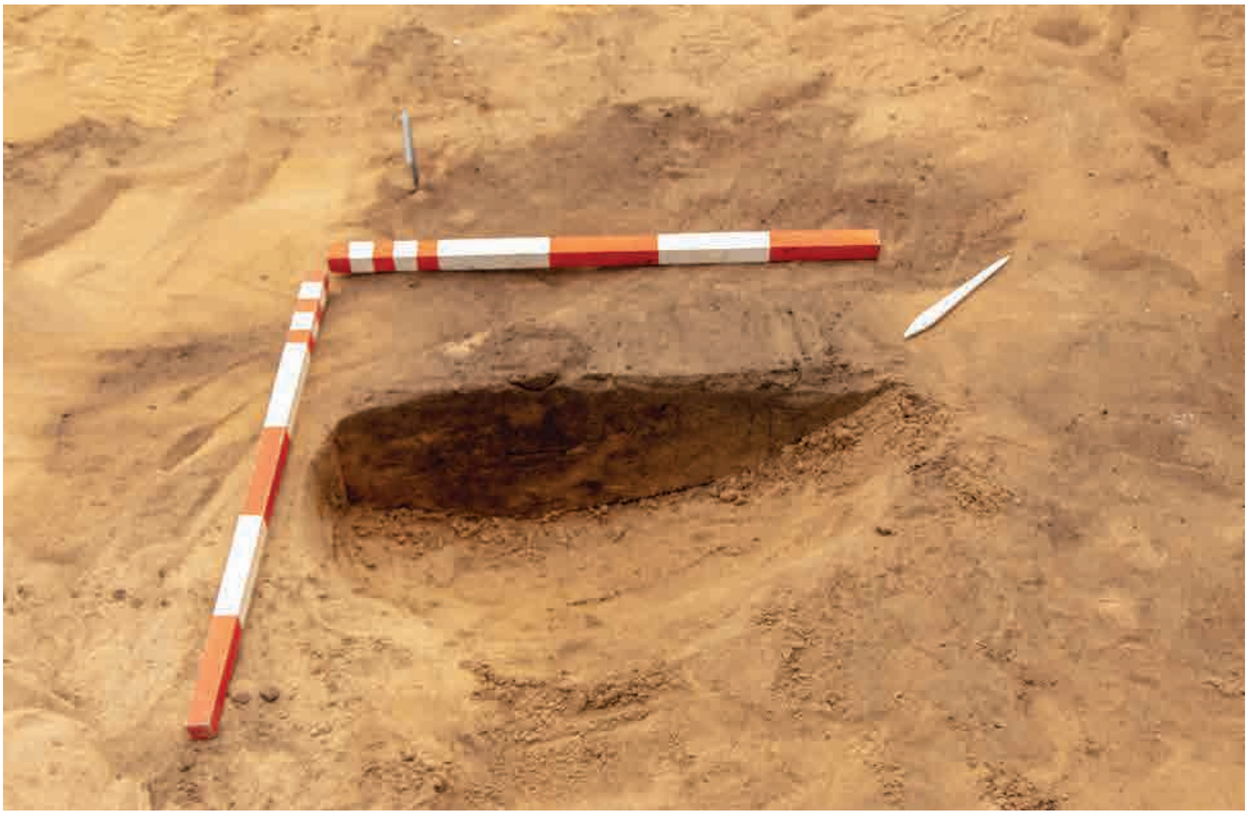


Figure 3.12. Feature 42 excavated in half section. Facing north, scales = 0.5 m.

Apart from the fire scoops, the other features included a posthole, an oven stone cache and two areas of rake out, irregular lenses of ashy crushed shell, bone, fire cracked rock and charcoal. One (Feature 59) was adjacent to firescoop Feature 65, though not necessarily derived from it while another is more securely associated with firescoop Feature 62. Feature 120 was an oven stone cache containing stones of local sandstone. Feature 53 was the only posthole found in Phase 4.

Phase 4 was separated from Phase 5 by a thin, discontinuous layer of clean windblown sand that was not given a separate Context or Phase number, visible in profile in Figure 3.7. South of Phase 5, Phase 4 was overlain by the clean, windblown sand of Phase 6, which itself lensed out so that Phase 4 was directly overlain by Phase 7 material to the south of around Row 5.

Phase 5 (Occupation Phase)

Phase 5 was found in the north portion of the restaurant foundation in Rows 8–12 but was not recorded west of the foundation where it had probably been disturbed by restaurant construction and maintenance and mixed into Phase 4. Within the foundation, it was distinguished from Phase 4 primarily on colour and texture (it was lighter in colour and less dense) – in places Phases 4 and 5 were separated by a thin, intermittent lens of windblown sand, which was not given its own context or Phase, while in other places they overlay each other directly. This relationship between the layers is visible in Figure 3.7, where a thin, relatively clean sand layer overlies most of Feature 110, a Phase 4 firescoop, but this sand lenses out in places. Phase 5 did not extend as far south as Phase 4. The matrix of Phase 5 was a yellow-grey, relatively clean, coarse sand containing a moderately dense shell midden dominated by tuatua and cat's eye, but also containing fishbone, charcoal and obsidian and chert. Artefacts included a barbed bone bird spear point, a trolling lure shank and two shell fishhook points.

Only five features were recorded in Phase 5; four fire scoops and a lens of ash (Figure 3.13). Feature 49 was a small firescoop in the north baulk of the excavation but the other three firescoops were all quite large. Feature 52 measured 1500 x 1000 mm x 200 mm deep (Figure 3.14). It had an upper lens of crushed, ashy, compacted shell and a lower lens of whole shell, fishbone, fire cracked rock and charcoal. Features 87 and 89 were similar features measuring 1140 x 800 mm x 100 mm deep and 1100 x 690 mm x 40 mm deep respectively. Both contained a mound of ashy shell fill on the surface and a darker charcoal stained fill at the base. Feature 88 appeared to be an ashy lens of oven rakeout not confined by a scoop, but the sand beneath it was stained red from heat, so it probably represents burning in situ. These four features appear to represent sizeable fires, in shallow scoops but also placed directly on the ground surface, and not extensively raked out, which is quite a different pattern from Phase 4. The comparative lack of charcoal in the matrix also indicates a different set of activities carried out.

Phase 5 was separated from Phase 7 by the clean, windblown sand of Phase 6. Phase 6 was only present in the northern half of the building footprint, between Rows 5 and 12, so that it did not underlie all of Phase 7, which in places directly overlay Phase 4. To the west of the foundation it had probably been truncated by restaurant construction and maintenance. This layer was more than 500 mm thick in places.

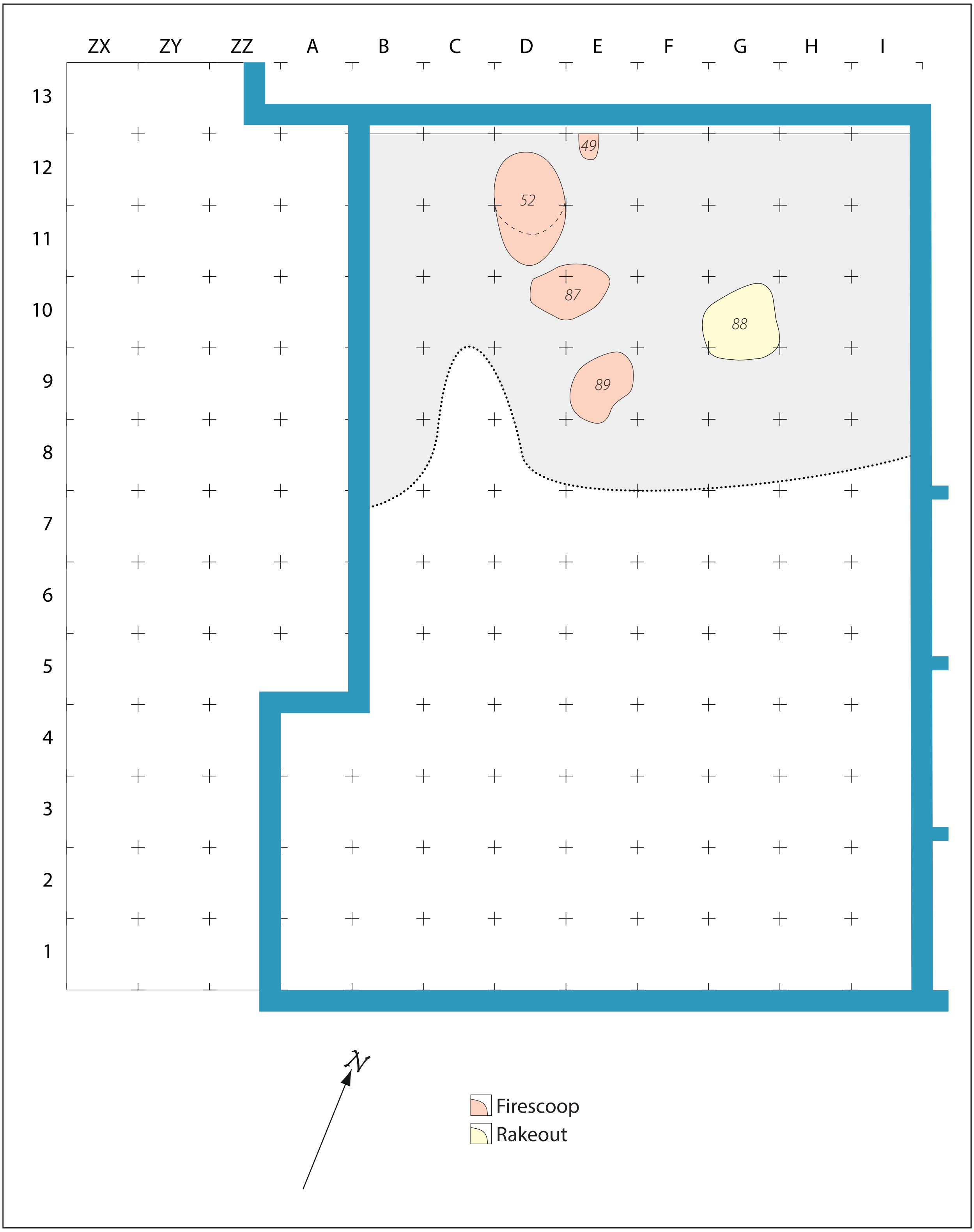


Figure 3.13. Phase 5.

Figure 3.14. Feature 52, firescoop, during excavation.

Phase 7 (Occupation Phase)

Phase 7 was found inside the foundation in Rows 1–8. It consisted of a mottled grey-brown, moderately compacted sand containing a generally sparse shell midden, though dense in patches particularly at the base, dominated by tuatua with some tuangi, cat's eye and minor taxa, mammal (including sea mammal), bird and fish bone, obsidian, dog coprolites (more abundantly than in other layers though dog bone is not overly abundant), charcoal and occasional fire cracked rock. Artefacts included a one-piece bone fishhook, possibly of whale bone, 3 shell fishhook points, a trolling lure shank, a small chisel and a larger adze. There were also numerous kōiwi fragments (>90) scattered though the layer (Chapter 7). To the west, Phase 7 and Phase 10 were no longer separated by the clean sand of Phase 8 and it was not possible to tell which Phase the material belonged to – this was separately recorded as Context 41. The Context 41 matrix was most like Phase 7 but there were no scattered kōiwi here and faunal material was more clustered – it may have been disturbed and material from the two Phases mixed prior to being covered with Phase 11 sand. Phase 7 / Context 41 was not traced outside the restaurant foundation.

The only features were three postholes, Features 77, 78 and 79, found in a tight cluster in Square G3.

Overlying Phase 7, but not Context 41, was the clean, windblown sand of Phase 8. This contained a distinctive and significant fraction of coarse, shelly mixed white sand. Phase 8 was up to 500 mm deep at the eastern baulk but tapered down to the west and disappeared around Row C. To the north of the excavation the clean sands of Phase 6 and Phase 8 could not be distinguished as they were not separated by the Phase 7 occupation.

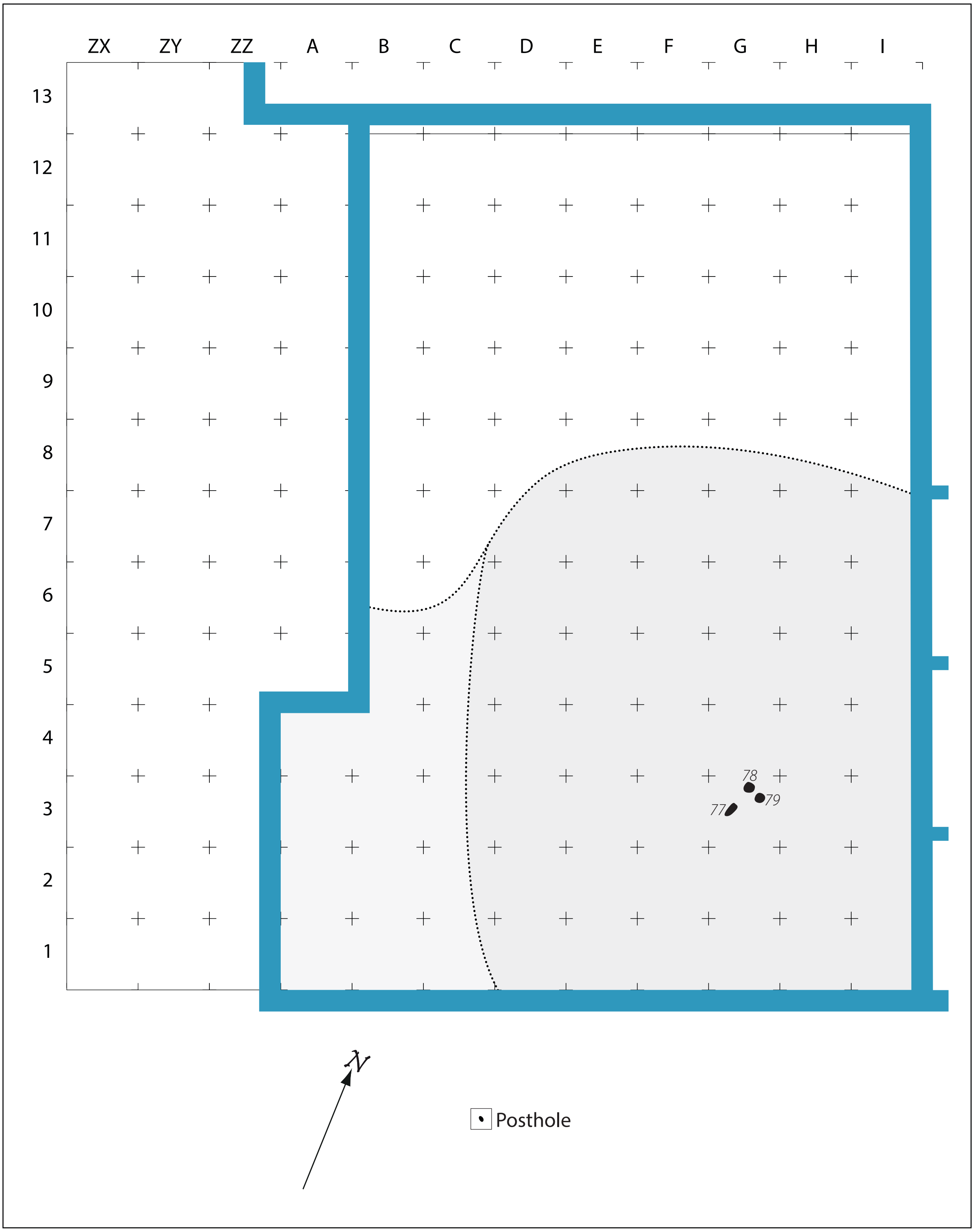
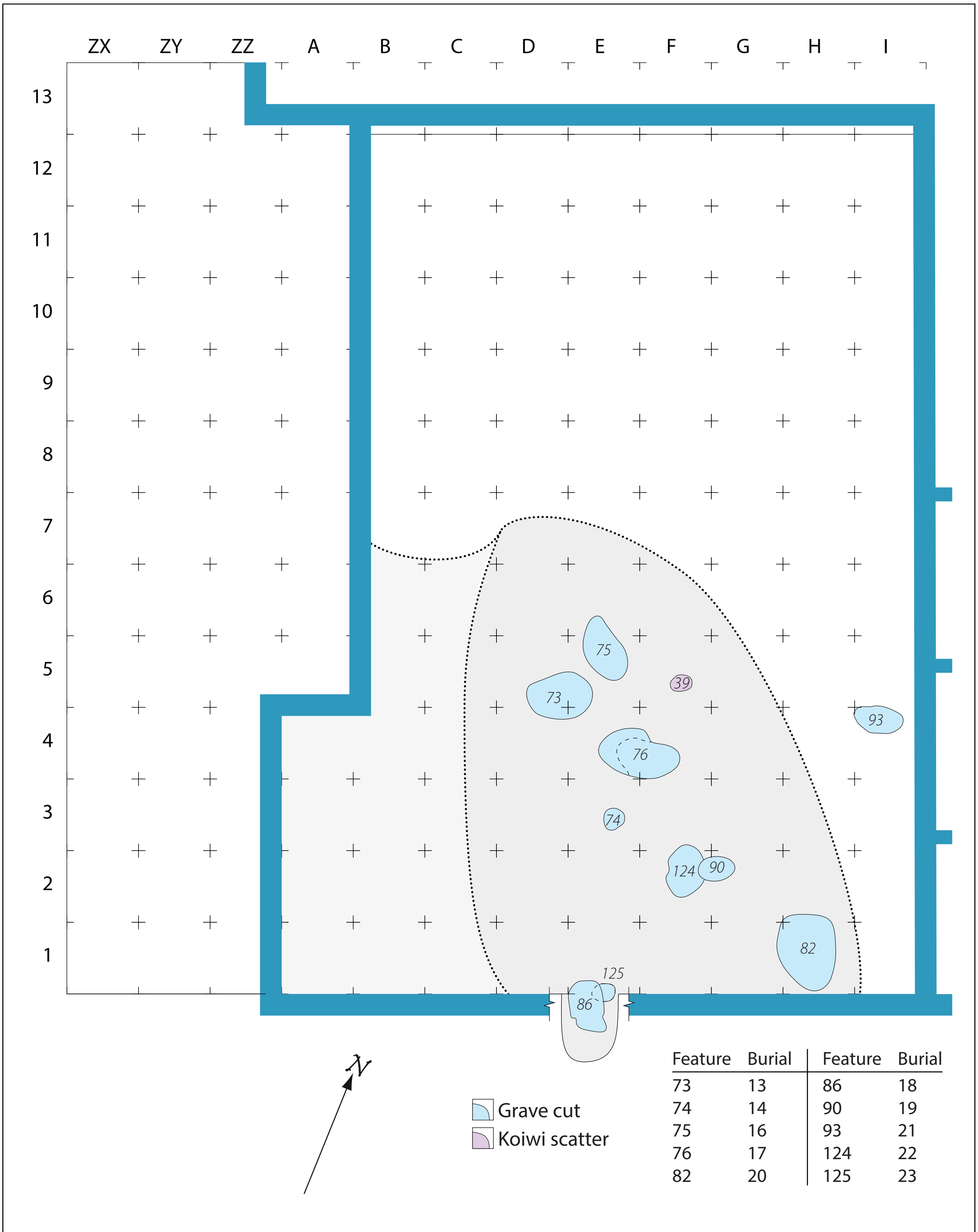


Figure 3.15. Phase 7. The lighter shading shows where Phases 7 and 10 could not be distinguished.

Phase 9 (Burial Phase)

Eleven burials, and one 'kōiwi scatter' consisting of several bones in a small feature measuring 400 x 300 mm x 170 mm deep but not given a Burial number (Feature 39), were assigned to Phase 9. Generally, the fill of the grave cuts was very difficult to distinguish from the surrounding matrix and often the grave cut was not noticed until kōiwi were encountered. Feature 86, containing Burial 18, was located beneath the south wall of the foundation and the grave cut could be observed in profile, with the top of the cut about 100 mm below the base of the concrete. Just below the concrete was the Phase 10 cultural layer and then the grave cut could be traced through the windblown sand of Phase 8 into the cultural Phase 7 and in to the clean natural sand beneath it (Figure 3.16). While the grave underlay Phase 10 it was unclear if it was contemporary with it. Burial 23, the child burial beneath Burial 18, could not be confidently assigned to any phase; as it seems likely that the two burials are related it is assigned to Phase 9, but this is not certain. Further burials that appeared to be at a similar level in the excavation, and that had similar fill, were assigned to this Phase. Phase 8, the windblown clean sand separating Phases 7 and 10, included a significant fraction of white, shelly sand and inclusions of this material in the fill of the grave cuts was a common feature of Phase 9 burials.

Figure 3.16. The south baulk of the excavation, showing Feature 86 / Burial 18, overlain by Phase 10 material. Kōiwi are pixelated – no photographs of kōiwi are provided in this report, but are in Volume 2.



Feature	Burial	Feature	Burial
73	13	86	18
74	14	90	19
75	16	93	21
76	17	124	22
82	20	125	23

Figure 3.17. Phase 9, 11 burials beneath Phase 10, the extent of which is also shown.

Phase 10 (Occupation Phase)

Like Phase 7, Phase 10 was not traced outside the restaurant foundation, and in Rows A, B and C could not be distinguished from Phase 7, where they were recorded together as Context 41. Elsewhere, Phases 7 and 10 are separated by clean wind-blown sand (Phase 8). The matrix of Phase 10 was a mottled grey-brown sand, not as dark as Phase 7, becoming more mottled toward the base, containing a sparse midden of charcoal, fishbone, small quantities of shell and fire cracked rock, four shell fishhook points as well as occasional scattered kōiwi. A lag deposit of oven stones in the western part of the layer indicated that much of the material here originated from deflation of an overlying cultural layer that may not have otherwise survived (Figure 3.4). Phase 10 seems to represent a disturbed occupation layer or layers, and only one feature could be securely assigned to it. Feature 40 was a firescoop measuring 900 x 800 mm x 100 mm deep with associated rakeout. It contained a dark, charcoal stained matrix with shell, fishbone and fire cracked rock.

Overlying Phase 10 was the clean sand of Phase 11. Some dog bone was attributed to Phase 11, which may have been disturbed out of context, a lag deposit from an underlying Phase (though none of it was weathered) or intrusive from an overlying Phase.

Phase 12 (Occupation Phase)

Phase 12 is the uppermost cultural layer that was not disturbed by restaurant construction. This may be the layer first recorded in 2014 (Campbell et al. 2014) to the east of the footings, where it was described as "the grey layer" but dates from the two excavations are significantly different (see discussion of chronology, below). The matrix of Phase 12 was generally a homogenous grey-brown sand, 100–150 mm deep, containing flecks of fine charcoal and small chunks of fire cracked rock, sparse shell and bone, several obsidian flakes and fragmented and disarticulated kōiwi. No formal artefacts were found in this layer.

Much like Phase 10, this phase did not contain many features, with two shallow firescoops and a discrete scatter of kōiwi assigned to this layer. The kōiwi scatter indicates disturbance to Phase 12 to the west of the foundation.

Phase 13 (Burial Phase)

The final Phase of burials includes Burials 1 and 2, first found in 2013 and 2014, and a further eight burials. Because the grave cuts had been truncated by restaurant construction and demolition, their origins could not be determined, but they cut through Phase 12. It seems probable that they originate in a later cultural phase that has not survived, either through natural processes or restaurant construction.

Phase 14

Phase 14 is the upper layers that had been disturbed by the original construction and subsequent demolition of the restaurant. This layer included building and demolition rubble as well as scattered shell and fishbone, and extended across the whole site and truncated the seven features assigned to it. This phase also included modern features that are related to the construction of the restaurant, including the footing trenches (Context 19) and drains as well as a rabbit burrow in the south-eastern corner of the building.

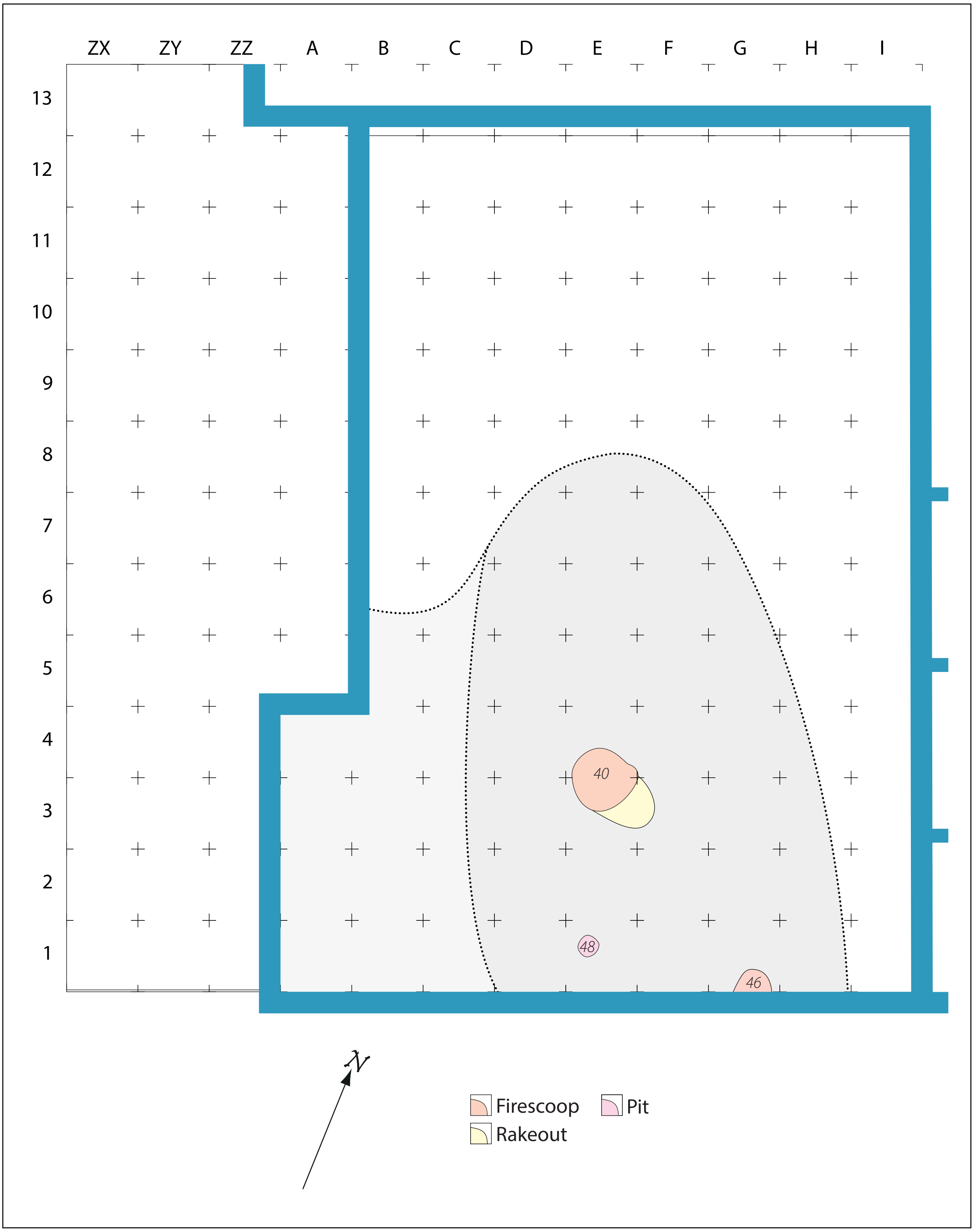


Figure 3.18. Phase 10. The lighter shading shows where Phases 7 and 10 could not be distinguished.

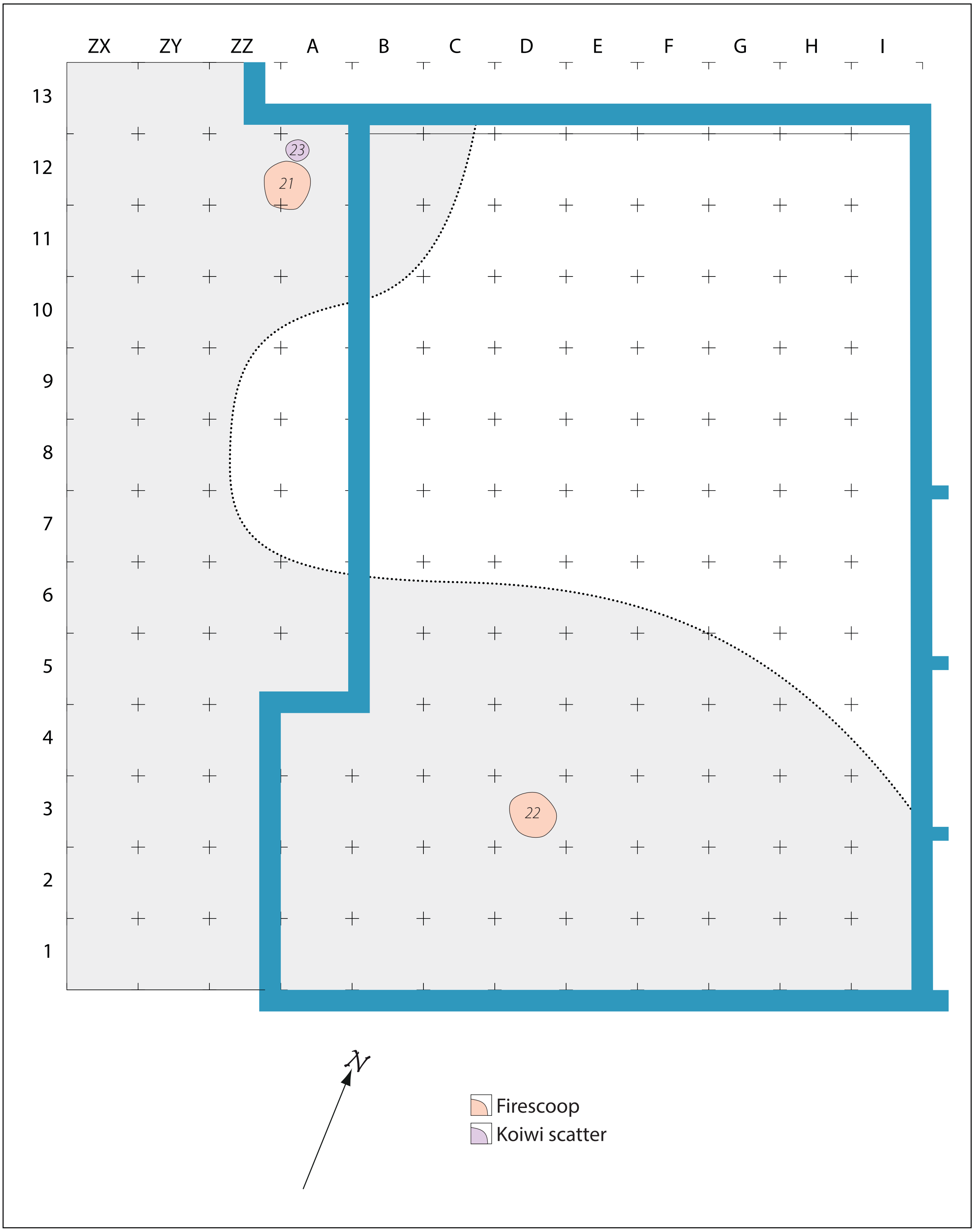
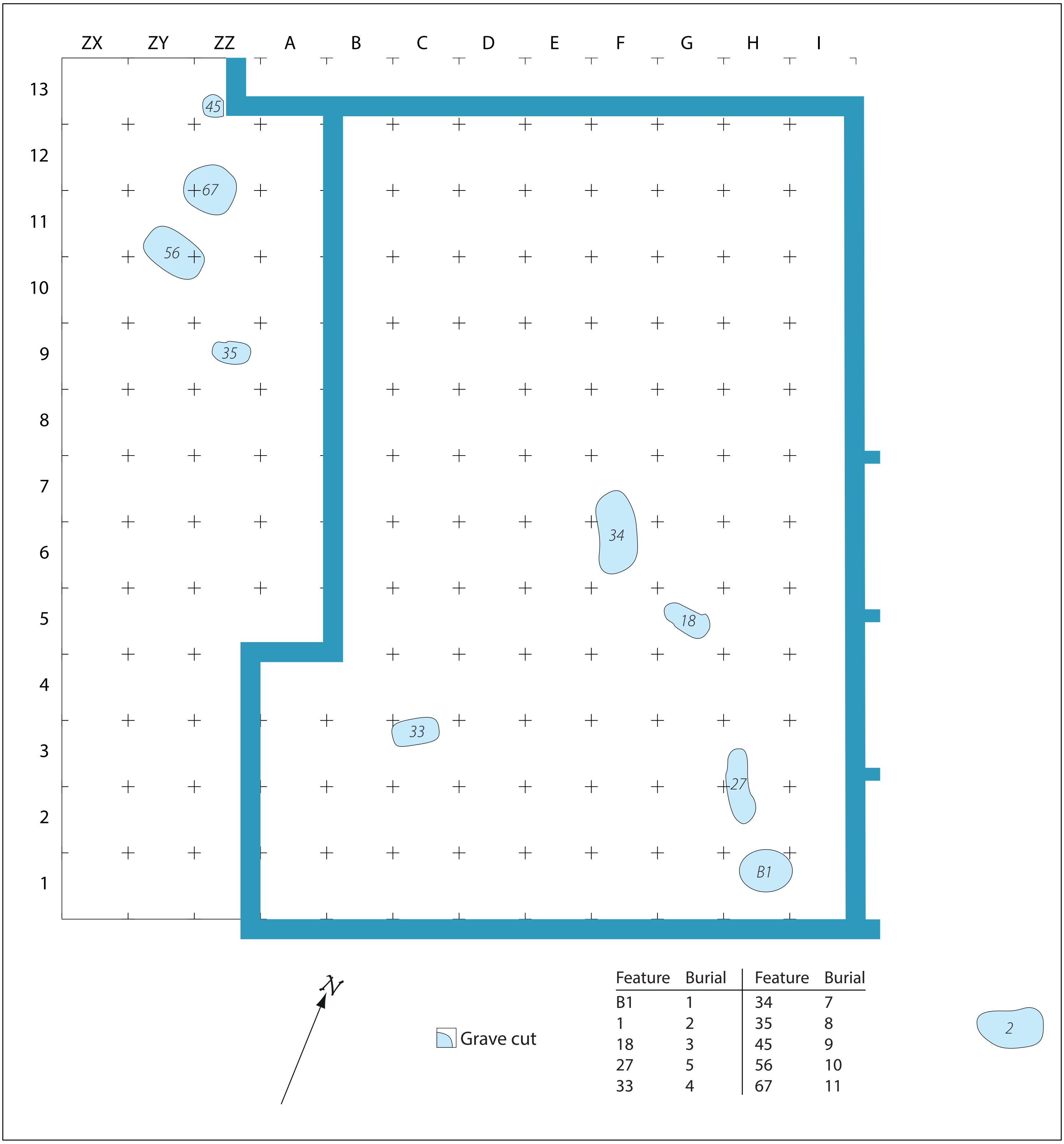


Figure 3.19. Phase 12. The midden to the west of the foundation was disturbed by historic period activities.



Feature	Burial	Feature	Burial
B1	1	34	7
1	2	35	8
18	3	45	9
27	5	56	10
33	4	67	11

Figure 3.20. Phase 13, 10 burials beneath Phase 14. The location of Burial 1 is approximate only.

The footing trenches appear to have been dug by hand, with boxing installed for the pouring of the footings. Remnants of the wooden boxing was uncovered in many of the sections of the trench. This trench has been backfilled after the boxing was installed, and lithics, shell and kōiwi were found in the fill.

Chronology

A date from the site was taken from a dog mandible excavated in 2014 (Campbell et al. 2014) and a further eleven samples were submitted to the Radiocarbon Dating Laboratory at the University of Waikato for AMS dating. For the upper and lower cultural layers, Phases 12 and 1, three samples were submitted, one each of charcoal, shell (tuatua) and fishbone (snapper, *Chrysophrys auratus*). For the intermediate Phases a single shell sample was submitted. In addition, with the approval of mana whenua, a calcified lymph node from Burial 2 (Chapter 7) was also submitted for dating, the only date on any material directly associated with the kōiwi.

Charcoal dates were calibrated against SHCal13 (Hogg et al. 2013) and shell and fishbone dates against Marine13 (Reimer et al. 2013). For Phases 1 and 12 the three dates were

Table 3.1. Radiocarbon results.

Lab number	Phase	Material	CRA BP	cal AD 68%	cal AD 95%
WK-45299	1	charcoal	519 ± 18	1420–1450	1410–1560
Wk-45300	1	shell	826 ± 19	1440–1530	1410–1620
Wk-45301	1	fish	902 ± 15	1390–1480	1330–1500
Wk-45302	4	shell	869 ± 19	1420–1500	1350–1540
Wk-45303	5	shell	853 ± 19	1430–1500	1360–1370 (0.5%) 1380–1580 (94.9%)
Wk-45304	7	shell	845 ± 19	1430–1510	1390–1590
Wk-45305	10	shell	842 ± 19	1430–1510	1390–1590
WK-45306	12	charcoal	421 ± 15	1450–1500	1450–1510 (78.5%) 1590–1620 (16.9%)
Wk-45307	12	shell	872 ± 18	1410–1490	1350–1540
WK-45308	12	fish	851 ± 18	1430–1510	1380–1580
Wk-45309	13	lymph node	430 ± 15	1450–1490	1450–1510 (85.8%) 1590–1620 (9.6%)

Table 3.2. Modelled results of the Bayesian analysis showing boundary ages, cal AD.

	68.2%		95.4%	
	from	to	from	to
Boundary start	1430	1446	1418	1452
Boundary end Phase 1	1433	1449	1424	1455
Boundary start Phase 4	1437	1453	1428	1460
Boundary transition Phase 4/5	1441	1457	1432	1465
Boundary end Phase 5	1444	1460	1436	1471
Boundary start Phase 7	1447	1465	1440	1475
Boundary end Phase 7	1435	1506	1395	1584
Boundary start Phase 10	1435	1506	1395	1584
Boundary end Phase 10	1435	1510	1397	1589
Boundary start Phase 12	1435	1510	1397	1589
Boundary end Phase 12	1460	1485	1455	1500

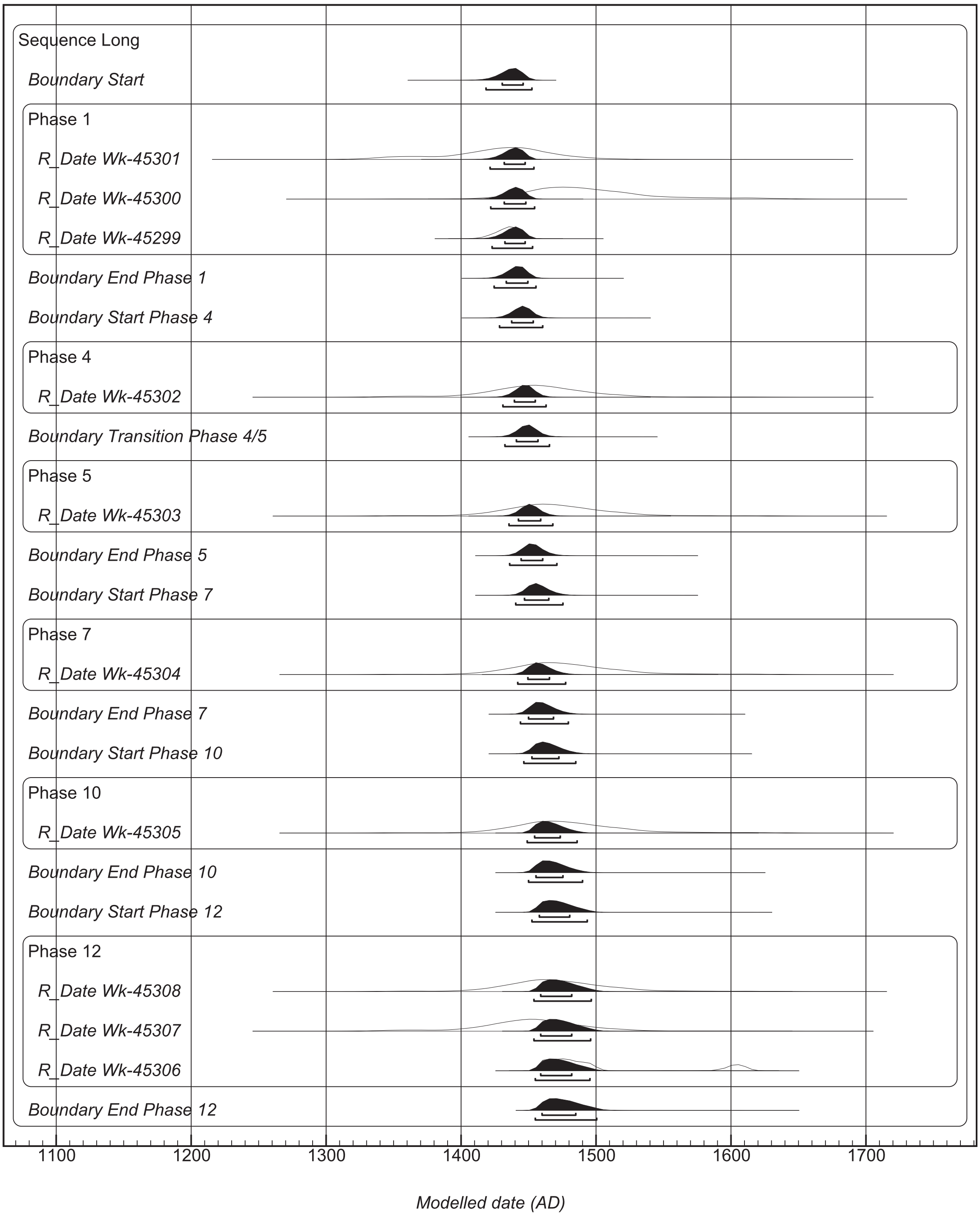


Figure 3.21. Bayesian age model for the occupation Phases at Long Bay. The light outline distributions are the unmodelled calibrated dates. Darker shade distributions represent the results after Bayesian modelling.

first combined into a single, tighter, distribution to help determine the start and end boundaries for the sequence. OxCal v4.3 (Bronk Ramsey 2018) was used to determine the age of start, end and duration of each Phase. A Bayesian Sequence Analysis was developed by Dr Fiona Petchey, Waikato Radiocarbon Dating Laboratory, where radiocarbon ages are arranged in phases according to stratigraphic information (Bronk Ramsey 2009). Most Phases were separated by clean wind-blown sand so that in the model they have been separated by uniform, sequential boundaries representing the hiatus between Phases. There was no sand layer between Phases 4 and 5, and so this is separated by a contiguous boundary in the model. The Bayesian model is presented in Figure 3.21 and modelled boundary ages are presented in Table 3.2. High convergence values (>98%) generated by the MCMC algorithms indicating the model is robust (Bronk Ramsey 1995).

All the dates fall on a steep part of the calibration curve and so the sequence is unusually tight. The Bayesian model suggests that the six occupation Phases (along with Burial Phases 3 and 9, which were not directly dated) occurred over a short period between AD 1430 and 1485 (68.2% probability). This implies, but does not demonstrate, that the six occupations were closely related, probably a family group returning to the same site on a regular basis.

A date of cal AD 1500–1635 at 68% probability has already been obtained from dog bone from the 2014 excavation, recovered from the 'grey layer' (Campbell et al. 2014), which may be equivalent to Phase 12 although the dog bone date indicates it is probably either a later deposit or that the dog bone is intrusive into the grey layer / Phase 12. The date for the Burial 2 (Burial Phase 13) lymph nodes was roughly the same, cal AD 1520–1670 at 68% probability. The grey layer and Burial Phase 13 did not form part of the same clear stratigraphic sequence as the six occupation Phases and were not incorporated in the Bayesian analysis. They appear to relate to a later, possibly unrelated occupation in the 16th to mid-17th centuries.

The Bayesian model could be read to indicate a regular, roughly decadal, re-occupation of the site. The model is based on an assumption that the windblown sand layers represent a hiatus in occupation of some years – they could do so, or alternatively they could represent a single storm event separating closely related occupations. The Bayesian sequence, then, could describe regular re-occupation of the site; or just as readily describe three closely related occupations followed by a hiatus of some decades, followed by another three occupations; or any other similar pattern.

Also, there are built-in uncertainties in such a tight sequence. It still contains several uncertainties, with dating allowing for Phases to occur out of sequence, for instance Phases 7, 10 and 12 all potentially beginning prior to Phases 4 and 5, a logical impossibility. Charcoal cannot be treated as a single year material, since even twig wood from fast-growing species may have an inbuilt age of up to 10 years. Similarly, the marine reservoir tends to have some seasonal variation. At best the chronology indicates a series of occupations between a little earlier than the mid-15th century to the late 15th century.

During roadworks across the Vaughan Flat two sites were investigated and dated (Trilford and Campbell 2018): five dates from R10/289 place the site in the 16th century and indicate either a single occupation or a series of closely related occupations, while the date from R10/201 is at least 200 years later. Dates from the 2006 exploratory excavations on the Awaruku Headland ranged from the 15th to 19th centuries (Phillips and Bader 2007). It is apparent that Long Bay and its immediate hinterland were occupied and reoccupied constantly from the 15th century. The Long Bay Restaurant excavations appear to relate to the beginnings of this sequence of occupation.

Environment

Two analyses are used to contribute to our understanding of the local environment at the time of human occupation. Charcoal analysis provides evidence on what type of wood were burnt on the site; there is generally a reasonable assumption that firewood was gathered locally, while charcoals incorporated into soils will reflect vegetation prior to burning. Charcoal analysis was undertaken by Rod Wallace of Auckland University. Landsnails were also found in abundance, particularly from Phase 7. Landsnails often live in very specific environmental conditions and so understanding which species of snails are present at the site can help determine either what the local environment was like at the time, or what environments resources have been brought onto the site from, as vegetation will often have landsnails on it when it is moved around. Landsnails were analysed by Bruce Marshall of Te Papa Tongarewa Museum of New Zealand and Jacqueline Craig of CFG Heritage.

Charcoal

A total of 52 samples were analysed, which produced 665 identifiable specimens across 25 plant taxa (Table 3.3).

In Phases 1–5 pūriri (Vitex lucens) and pōhutukawa (Metrosideros excelsa) are the dominant species accounting for around half the charcoal (Table 3.3, Figure 3.22), and they remain common throughout the sequence, reflecting the local vegetation. Other broadleaf trees are present in Phases 1–7 but drop out of Phases 10 and 12 when bracken charcoal becomes more frequent. Conifers, mostly matai (Prumnopitys taxifolia) and kauri (Agathis australis), are present throughout, along with shrubs and small trees, mainly Coprosma sp., Pseudopanax sp. and māhoe (Melicytus ramiflorus).

This general pattern implies some intact pūriri and pōhutukawa dominated costal forest was locally present in the early Phases but was replaced by a bracken dominated open landscape that included pūriri and pōhutukawa accompanied by shrubs and small trees in later Phases. Pūriri and pōhutukawa can survive forest clearance and their presence in the later Phases is not unexpected. The persistence of conifers in the late firewood samples can be accounted for if dead logs and stumps left behind after forest clearance survived in sub-fossil form as firewood sources,

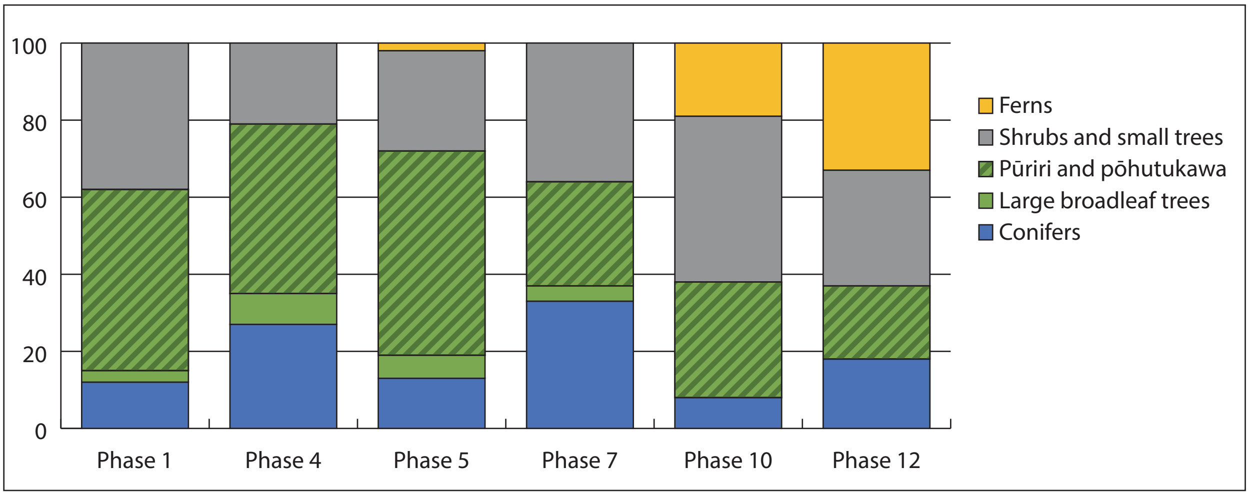


Figure 3.22. Percentage of different plant types by Phase.

Table 3.3. Summary of charcoal results by Phase.

		Phase					
		1	4	5	7	10	12
Bracken	Fern			2		24	30
Tutu			1				
Hebe			1			1	4
Coprosma sp.		14	10	11	7	11	6
Pseudopanax sp.			3	8	16	16	4
Mingimingi				1	1	1	
Corokia	Shrubs and small trees					1	
Ngaio			5	1			6
Tawāpou			1				
Mānuka			2				3
Porokaiwhiri				1	1	12	
Māpou		2			1	1	
Māhoe		11	17	3	2	14	5
Kōwhai			1				
Rewarewa		2	3		1		
Hīnau			8	4			
Maire	Large broadleaf trees		2	1	2		
Kohekohe			1				
Taraire/tawa				1			
Pūriri		1	21	1	1	2	8
Pōhutukawa		33	67	49	20	37	10
Tōtara		3	1			1	
Rimu	Conifers		2		1	3	
Mātaī		4	46	8	13	6	2
Kauri		5	3	3	12	1	14
Totals		72	198	95	78	129	93

or if firewood was transported over longer distances. This pattern of decreasing broadleaves and increasing shrubs and ferns can be seen in Figure 3.22. While the archaeology indicates that the the site was occupied by a realatively small group, it was large enough to have a noticeable impact on the local vegetation.

Landsnails

All the landsnails that could be identified came from the Phase 7 matrix – a large sample (Sample 168) from Square G5 and smaller samples from nearby squares. Snails from other contexts (Phase 1, 4 and 5) could not be identified and often appeared as a mould of the internal structure of the shell. The results are given in Table 3.4 by sample – there were several thousand snails in Sample 168 and so these were recorded as many, but not counted – the most common taxon was *Phrixgnathus* sp.

Phenacohelix giveni, *Cavellia buccinella*, *Tornatellinops novoseelandica*, *Tornatellides subperforatus* and *Mocella eta* all prefer the upper layers of leaf litter. *T. subperforatus* is also found in dry leaf litter, as well as the undersides of low arboreal plants such as angiosperms and young nīkau palms (Barker 2006: 132) , and *T. novoseelandica* and *T. subperforatus* in particular are described as "desiccation tolerant" (Barker 2006: 133). *P. giveni* are also found on the tops of logs or on low-growing young ferns (Solem et al. 1981: 466).

Table 3.4. Identified landsnail species from Long Bay, all Phase 7.

Species	Sample (LBR number)				
	1382	1508	1603	168	1502
Cavellia buccinella	3			many	
Charopa coma	1	1			
Delos coresia				many	
Fectola mira				many	
Mocella eta	3			many	
Paralaoma servilis				many	
Paralaoma sp. A				many	
Paralaoma sp. B				many	
Phenacharopa pseudanguicula				many	
Phenacohelix giveni	23	42	53	many	4
Phrixgnathus sp.	32			many	
Tornatellides subperforatus	3			many	
Tornatellinops novoseelandica				many	

Charopa coma is associated with large rocks or large rotting logs from trees such as rimu, tawa and taraire where it can get under the loose bark (Barker 2006: 137; Solem et al. 1981: 465). *Phrixgnathus* species are found in a fairly wide variety of environments although it appears the various species do tend towards more moist conditions, often preferring moister leaf litter and low arboreal environments that are unlikely to dry out (Barker 2006: 133).

Three species prefer to live on vegetation that has fallen to the forest floor. *Delos coresia* colonises fallen nikau fronds as well as larger leaves and decaying tree fern fronds. *Fectola mira* likes the slimy surfaces of nikau boles as well as fallen fronds and moister conditions midway through the leaf litter, in particular very wet and slimy areas. Solem et al. (1981: 465) characterise it as "wallow[ing] in slime." It is also found on rough textured tree trunks where it hides in the small crevices (Barker 2006: 134). *Phenacharopa pseudanguicula* likes rimu and podocarp bark chips on the forest floor (Barker 2006: 135; Solem et al. 1981: 466).

Paralaoma servilis, also a leaf litter dweller, prefers relatively humid and shady conditions (Animalbase 2018). It isn't possible to determine exactly what environment *Paralaoma* sp. A and B preferred but in general the members of that genus are leaf-litter dwellers, although some prefer the upper, dryer layers and some the lower, wetter ones (Barker 2006: 134).

In summary, all species except *Paralaoma servilis* were recorded by Barker (2006) in the forested environments of the Waitākere Ranges, which suggests that the landsnails for the site originate from a similarly forested environment. While some of the species can tolerate drier conditions, the majority of them require moist, or even actively wet, conditions which indicates they were transported to the dunes in which they were found on vegetation collected in forest environments. The presence of snails that prefer wetter leaf litter suggests that at least in parts the forest cover was fairly dense although other areas may have been drier and more open. Given that the charcoal results indicate that the local forest had largely been cleared by Phase 7, these resources may have been imported over some distance.

What is unclear is why leaf litter was being brought on site in quantities sufficient to deposit thousands of snails, though the snails from Sample 168 were all recovered from a small area of less than 1 m^2 so this may not represent a huge quantity or material. It is unlikely, but not entirely out of the question, that leaf litter was the resource being targeted, for reasons unknown. What is more probable is that leaf litter was deposited as a by-product of targeting some other forest resource.

Summary

Six midden layers were excavated within the footprint and 2.5 m to the west of the demolished Long Bay Restaurant. The middens were separated by layers of clean, windblown sand, and there is evidence that the middens themselves are partly deflated, with lag deposits of stone and bone evident. The evidence indicates semi-regular reoccupation of the site by a kin group. This group also buried their dead at the site in at least three Phases of burial, although the stratigraphy of the burials, cut into clean soft sand and filled with clean soft sand, was very difficult to make out. A Bayesian Sequence Analysis of the radiocarbon dates indicates occupation from slightly before the middle of the 15th century to slightly before its end but cannot inform us about regularity of re-occupation.

In several ways, this is an unusual site for New Zealand archaeology. Stratified middens representing repeated occupations are rare and are often early sites where the radiocarbon sequence falls in a particularly wiggly part of the calibration curve, making tight dating difficult. The Long Bay dates fall onto a smooth, steep part of the curve, and so the dating is much tighter. The site spans much of the period AD 1450–1500, when several changes are evidence in pre-European Māori archaeology, particularly the extinction or extirpation of moa at the start of the period and the beginnings of pa construction at the end. While there are no regular changes from the earliest to the latest Phases within the site, some temporal patterns are apparent when the wider context of the archaeology of Tāmaki is considered. These are discussed in the following chapters, and particularly in Chapter 8.

Table 3.5. List of excavated contexts.

Contexts	Feature type	Phase	Burial	Length (mm)	Width (mm)	Depth (mm)	Notes
1	Grave cut	13	2				From 2014
5	Layer	12					Cultural layer
6	Layer	8					Clean sand layer
7	Layer	4					Cultural layer
15	Layer	11					Clean sand layer
16	Layer	10					Cultural layer
17	Layer	7					Cultural layer
18	Grave cut	13	3	500	360	120	
20	Layer	12					Cultural layer
21	Fire Scoop	12		670	660	160	
22	Fire Scoop	12		820	770	70	
23	Koiwi Concentration	12		150	150		
25	Layer	8					Clean sand layer
27	Grave cut	13	5	1160	430	270	
30	Layer	4					Cultural layer
31	Grave cut	3	6	400	450	160	
33	Grave cut	13	4	720	240	220	
34	Grave cut	9	7	1200	600	450	
35	Grave cut	13	8	570	330	180	
37	Layer	0					Sterile base sand
39	Koiwi Concentration	9		400	340	170	
40	Fire Scoop	10		93	80	96	
41	Layer	7					Combines Phases 7 and 10
42	Fire Scoop	4					
44	Fire Scoop	4		480	600	60	
45	Grave cut	13	9	540	420	50	
46	Fire Scoop	10		700	750	880	
48	Pit	10		300	100	880	
49	Fire Scoop	5		250	280		
50	Layer	5					Cultural layer
51	Layer	2					Clean sand layer
52	Fire Scoop	5		1000	1000	200	
53	Post Hole	4		150	150		
54	Fire Scoop	4		620	690	75	
55	Layer	1					Cultural layer
56	Grave cut	13	10	920	570	300	
57	Layer	0					Sterile base sand
58	Layer	4					Cultural layer
59	Rake Out	4		690	720	110	
60	Fire Scoop	4		620	580		
61	Fire Scoop	4		440	530		
62	Fire Scoop	4		500	360	70	
63	Fire Scoop	4		800	600	100	
64	Layer	6					Clean sand layer
65	Fire Scoop	4		470	300	40	
66	Fire Scoop	1		180	500	80	
67	Grave cut	13	11	860	840		
68	Post Hole	1		120	130	120	
70	Post Hole	1		150	150	110	
71	Post Hole	1		210	90	180	
72	Post Hole	1		140	120	180	

Table 3.5. Continued.

Contexts	Feature type	Phase	Burial	Length (mm)	Width (mm)	Depth (mm)	Notes
73	Grave cut	9	13	770	520	480	
74	Grave cut	9	14	270	300	370	
75	Grave cut	9	16	790	670	480	
76	Grave cut	9	17	1085	700	320	
77	Post Hole	7		200	130	70	
78	Post Hole	7		160	140	230	
79	Post Hole	7		110	90	110	
82	Grave cut	9	20	1000	840	600	
83	Grave cut	3	15	1200	740	210	
84	Grave cut	3	12	1130	520	300	
86	Grave cut	9	18	718	469		
87	Fire Scoop	5		1140	800	100	
88	Rake out	5					
89	Fire Scoop	5		1100	690	40	
90	Grave cut	9	19	510	340	1307	
91	Fire Scoop	4		1640	540	170	
92	Fire Scoop	4		660	360	240	
93	Grave cut	9	21	720	420	270	
94	Fire Scoop	4		680	500	140	
95	Fire Scoop	4		500	450	170	
96	Fire Scoop	4		1080	1000	170	
97	Fire Scoop	4		500	300		
98	Fire Scoop	1		1100	1200	150	
99	Fire Scoop	4		1420	500	170	
103	Fire Scoop	1		700	700	30	
104	Fire Scoop	4		780	350	100	
105	Fire Scoop	4		480	460	107	
106	Post Hole	1		50	50	15	
107	Post Hole	1		60	60	40	
109	Fire Scoop	4		600	800	70	
110	Fire Scoop	4		1100	500	100	
111	Cooking stone cache	1					
112	Post Hole	1		95	60	130	
113	Post Hole	1		110	80	250	
114	Post Hole	1		75	65	180	
115	Post Hole	1		100	75	120	
117	Post Hole	1		60	60	90	
118	Fire Scoop	1		470	410	210	
119	Fire Scoop	4		1000	750	145	
120	Cooking stone cache	4		230	175		
121	Fire Scoop	4		600	405	130	
122	Fire Scoop	4		740	520	230	
123	Fire Scoop	4		1300	300	180	
124	Grave cut	9	22	759	496		
125	Grave cut	9	23	265	168		
129	Grave cut	13	1				From 2013

4 Material culture

The site provided a large collection of artefacts, both formal taonga of stone, bone and shell, and informal artefacts of flaked stone. Taonga were analysed by Dr Louise Furey of Auckland Museum, and registered with the Ministry of Culture and Heritage as taonga tūturu under the Protected Objects Act 1975 (Table 4.1). In accordance with the wishes of mana whenua, the taonga have been reburied with the kōiwi.

Usually very few artefacts are recovered during an archaeological investigation. The overall lack of material culture from securely dated contexts makes inter-site comparisons, and therefore an ability to synthesise regional stylistic change over time, difficult. A general stylistic change from the early to late period can be identified nationally (Golson 1959; Furey 2004) but the nuances of the change across artefact types and its timing are poorly understood. An analysis of the material culture for the Auckland region, and in particular the inner Hauraki Gulf area, is hampered by few excavations producing a range of artefacts (Davidson 1978), much less the same location having multiple occupations over time. One exception is the NRD site (R11/859) at Ihumatao on the shores of the Manukau Harbour which produced a significant number of artefacts but not all are from the same period. The Phase I occupation, dating to the 15th century, produced few artefacts, with most coming from later occupations dated to the 16th and 17th centuries (Campbell 2011: 58). More recently a number of artefacts were also recovered from excavations at the 14th century Masonic Tavern site (R11/2517) in Devonport and are currently undergoing analysis (Russell Gibb pers. comm.). The excavation at Torpedo Bay (R11/1945), also in Devonport, had relatively few artefacts including three two-piece shell fish-hooks, an adze and a sinker. Sites on Motutapu Island dating to the 1400s include the Sunde site (R10/25) where a number of adze roughouts were recovered, in addition to a small assemblage of other material (Davidson 1970; Nichol 1988), and Pig Bay (R10/22) where a more diverse range of fishing gear and other items, as well as numerous stone adzes and roughouts, were found (Davidson and Leach 2017). The Westfield site (R11/898, Furey 1986) and Taylor's Hill (R11/96, Leahy 1991) in the Tāmaki area have artefacts reported but investigations of coastal sites in the Hauraki Gulf are relatively few in number so it is difficult to make comparisons based on material culture. A large number of objects from the wider Auckland area are held in Auckland Museum but these are rarely identified to a specific location beyond suburb.

The Long Bay Restaurant site objects are listed by Phase in Table 4.1. The majority are from Phases 4 and 7. Numerous *Antalis nana*[1] beads and several awls were associated with burials (Burials 3 and 5 respectively) but the majority of objects were from general midden deposits. In particular, the large number of shell fishhooks is significant as they are rarely found in dateable contexts in archaeological excavations (Law 1984). The total number of objects is misleading as the individual *Antalis* beads, with one exception, were found with a single burial in a position to suggest they were strung together as a necklace. The single bead was found close to the same burial and is most likely from the same context.

Nine of the awls (Z20004–20012) were recovered from Burial 5. They were buried with a young adult female, placed near the right side of her face and the end of her left hand. The awls were in a tight group, and had possibly been wrapped together in a bundle, although they didn't all have the pointed end facing the same way (Figure 4.1). They are fashioned from bird bone and, where the articulating end of the bone is present, the awls are identified as gannet (*Morus serrator*) and shag (*Phalacrorax* sp.), specifically the humerus and ulna. One awl (Z20004) is from a bird larger than a gannet, possibly a mollymawk (*Thalassarche* sp.). The bundle included an

[1] *Antalis nana*, a tusk shell (Scaphopoda), was previously referred to as *Dentalium nanum*. Archaeologists are more familiar with the term 'Dentalium bead.'

Table 4.1. Taonga recovered from the Long Bay Restaurant site.

Z number	Description	length	width	depth	context	Phase
Z20406	Fish hook, two-piece, point, shell, *Cookia sulcata*	27.9			Feature 98	1
Z20772	One Antalis bead, ground both ends	10			Feature 98	1
Z20075	Fish hook, two-piece, point, shell, *Cookia sulcata*	28.8	3.2	3.8	Square B9	4
Z20076	Fish hook, two-piece, point, shell, *Cookia sulcata*	24.8	10.3	2.19	Feature 104	4
Z20077	Fish hook, two-piece, point, shell, *Cookia sulcata*	32.2	7.5	5.4	Square B9	4
Z20078	Fish hook, two-piece, point or shank, shell, *Cookia sulcata*	34.2	7	4.89	Feature 95	4
Z20079	Fish hook, two-piece, point, shell, *Cookia sulcata*	36	5.95	3	Square D11	4
Z20080	Fish hook, two-piece, point, shell, *Cookia sulcata*	27.05	4.89	2.09	Square E12	4
Z20081	Fish hook, one-piece, moa bone	40.2	11.44	7.79	Square D10	4
Z20082	Fish hook, one-piece, moa bone	41.34	9.08	7.4	Square D10	4
Z20083	Fish hook, two-piece, point, shell, *Cookia sulcata*	31.24	4.88	4.36	Square D11	4
Z20087	Worked bone, possibly moa	25.86	8.5	5.51	Feature 91	4
Z20088	Adze butt, possibly Tahanga basalt	53.44	44.25	34.51	Square A12	4
Z20090	Fish hook, two-piece, point, shell, *Cookia sulcata*	36.14	7.35	4.56	Square G6	4
Z20091	Worked bone, possibly whale auditory ossicle	54.72	19.4	12.31	Square F6	4
Z20098	Worked (?) dog cockle (Tucetona laticostatus) shell	62.5	59.47	4.5	Square O10	4
Z20110	File, sandstone	44.9	16.3	12.6	Square ZX8	4
Z20129	File, sandstone	35.5	26.6	19.5	Square I11	4
Z20133	Adze flake, polished chip	30.3	18.6	4.4	Square A12	4
Z20408	Fish hook, two piece, lashing attachment and limb, shell, *Cookia sulcata*	26			Feature 104	4
Z20412	Fish hook, two-piece, shank, shell, *Cookia sulcata*	39.2			Sqaure E8	4
Z20414	Fish hook, two-piece, fragment, shell, *Cookia sulcata*	15.5			Feature 123	4
Z20773	Fish hook, two-piece, fragment, shell, *Cookia sulcata*	49			Feature 95	4
Z20774	Awl, bird bone shaft	49			Square D12	4
Z20085	Barbed bird spear, bird long bone shaft	75.49	7.39	1.74	Feature 87	5
Z20086	Trolling lure shank, bone (possibly moa), broken	33.96	8.77	8.41	Square E10	5
Z20128	File, sandstone	68.8	26.4	15.4	Square F9	5
Z20130	Hammer stone	70.5	50.6	22.9	Feature 87	5
Z20134	File, sandstone	40	17.7	12.64	Square G8	5
Z20404	Fish hook, two-piece, fragment, shell, *Cookia sulcata*	32.6			Feature 52	5
Z20407	Fish hook, two-piece, fragment, shell, *Cookia sulcata*	25.6			Square D11	5
Z20084	Fish hook, one-piece, bone (possible sea mammal)	26.3	6.3	3.52	Square G6	7
Z20089	Adze, plano-convex cross section, Hauraki Gulf greywacke	136.17	44.02	25.41	Square I3	7
Z20092	Trolling lure shank, bone (possibly moa), broken	29.4	10.8	7.68	Square F7	7
Z20093	Chisel, Hauraki Gulf greywacke	36.9	30.24	7.56	Square E6	7
Z20095	Abrader, sandstone	48.75	22.99	17.99	Square D3	7

Table 4.1. Continued.

Z number	Description	length	width	depth	context	Phase
Z20095	Abrader, sandstone	48.75	22.99	17.99	Square D3	7
Z20109	Fish hook, two-piece, point, shell, *Cookia sulcata*	38.6	8.3	5.9	Square F2	7
Z20405	Fish hook, two-piece, fragment, shell, *Cookia sulcata*	27.5			Square D9	7
Z20413	Fish hook, two-piece, shank, shell, *Cookia sulcata*	24.1			Square G5	7
Z20409	Fish hook, two-piece, point, *Cookia sulcata*	32.5			Feature 40	10
Z20410	Fish hook, two-piece, shank and lashing head, shell, *Cookia sulcata*	30.9			Feature 40	10
Z20411	Fish hook, two-piece, shank and lashing head, shell, *Cookia sulcata*	35.4			Feature 40	10
Z20415	Fish hook, two-piece, shank, shell, *Cookia sulcata*	25.3			Feature 40	10
Z20131	Hammer stone	63.8	40.2	30.2	Feature 67	11
Z20004	Bone awl, large sea bird	117	12	5	Burial 5	13
Z20005	Bone awl, left humerus of gannet	124	9	8	Burial 5	13
Z20006	Bone awl, bird	94	11	4	Burial 5	13
Z20007	Bone awl, right ulna of gannet	65	9	7	Burial 5	13
Z20008	Bone awl, left humerus of shag	107	9	7	Burial 5	13
Z20009	Bone awl, sea bird	103	10	8	Burial 5	13
Z20010	Bone awl, right ulna of gannet	142	9	8	Burial 5	13
Z20011	Bone awl, left ulna of gannet	105	8	7	Burial 5	13
Z20012	Bone awl, bird	35	6	2	Burial 5	13
Z20013	323 Antalis beads varying in length from 2–20 mm, total 3100 mm				Burial 3	13
Z20132	Adze flake, polished chip	22.2	7.8	3.2	Trench fill	14

unmodified gannet radius. The awl recovered from a general context (Z20774) was also fashioned from bird bone but was represented only by the point and a short section of bone shaft.

Three awls from the burial context had the articulating end present (Z20007, 200010, 20011), two had a ragged upper end indicating where the articulating end had been snapped off the bone shaft (Z20005, 20008), and one had been cut across the upper end of the complete shaft (Z20009). Three (Z20004, Z20006 and Z20012) had been fashioned from a split shaft with ground sides and crescentic cross-section but only two were complete and had a cut end to the shaft. The sides of all awls the sides tapered at the distal end and were deliberately shaped to a sharp point with lengths between 8 and 15 mm. One awl (Z20006) had a short point and stepped out sides to the shaft. The remaining awls had been cut or broken diagonally across the bone shaft at one end and then ground to a sharp point. Z20011 was missing the end of the point but remnant use polish present on the broken edges indicates it snapped just above the point. The extent of the use wear polish from the tip of the point indicates how far the point penetrated the material it was being used on. As referred to above, the length of wear was 8 mm on the split shaft awl type and between 15–19 mm for those awls where the shaft was intact, perhaps suggesting the two types were used for different activities. In all cases the usewear was polish to a high sheen on the bone surface indicating the awls were not used on coarse or hard objects.

The absence of organic materials in archaeological sites makes it difficult to determine what the awls were used on. The points were obviously designed to penetrate some organic material either to make a hole, or possibly to penetrate between the fibres of leaf material to split it. The amount of use sheen on each object would require repeated use in a consistent manner. Although punching holes in animal or bird skins is a possibility, as has been a suggested use for

Figure 4.1. A bundle of bone awls buried with Kōiwi 5, placed in front of her face.

Figure 4.2. Awls from Kōiwi 5.

Figure 4.3. Usewear on awls Z20005 (right) and Z20004 (left).

awls from Rekohu / Chatham Island (Cave 1976), there is little in the way of surviving organic pre-contact textiles to suggest possible uses. The woman who owned these awls was probably a specialist, most likely related to the making clothing or fibre working. The length of all shafts suggests the activity being carried out either required a good handgrip on the shaft, or it was ergonomically better to have a handgrip.

A single 183 mm long unmodified right radius of a gannet was with the awls and was possibly raw material to be made into an awl. The bone has a narrower diameter shaft than the awls although Z20012 was possibly from a similar bone. Three of the awls had damage to the points: Z20011 was broken across the shaft above where the point would have been, Z20008 had a damaged tip as did Z20007. The retention of damaged awls suggests they were curated, probably intended for repair, and the presence of an unmodified bone also suggests raw material was kept on hand to make new awls, in the same way that a fisherman's kit contained both the finished fishhooks and the bone from which to make them (Fairfield 1933; Leach 2007).

Burial 3 was an infant (11–16 months, Chapter 7) burial that had been badly disturbed by restaurant construction (Chapter 7). *Antalis* beads were found above and below the infant's bones, indicating that the beads had surrounded the body at the time of burial. In one place, a small group of beads appeared to be arranged in parallel rows (Figure 4.4), which suggests the beads had been on an ornament or garment of multiple beaded strands, or were wrapped around the child's body, or attached to a garment which enclosed the child. Some beads were found in the surrounding matrix over an area of about 2 x 2 m, where they, along with several of the infant's bones, had been disturbed out of position.

Figure 4.4. Antalis beads in situ during excavation.

Figure 4.5. Antalis beads associated with Burial 3.

The individual beads vary in length from 2 to 20 mm with the majority between 8 and 12 mm. There was a total of 323 beads with a combined length of 3.1 m. Collectively, the 323 beads were registered as Z20013, with an additional bead found nearby registered as Z20272. It is rare that *Antalis* beads are recovered in quantity in any site. Not only are the shells fragile and subject to damage or decomposition, but a large quantity implies a necklace or other composite object, which is only likely to be found with a burial, for example at Wairau Bar in Marlborough (Duff 1977), Paremata (Smart 1962) and Wairarapa (Leach and Leach 1977). Elsewhere worked shells which have the tapered and curved lower end cut off are found as single beads.

Antalis nana shells are not common, as scaphopod molluscs are found in deep water. They are poorly researched, but it seems unlikely that the fragile shells would survive wave action and being washed up on a beach. No specimens in museum collections have been obtained from beaches – they are all dredged from deep water ranging from 50–200 m (Dell 1956). Scarlett (1958) described a large number of *Antalis* shells grouped together in a dune blowout at Opito, which he referred to as a 'workshop', again from a location not within the known natural distribution of the animal (Leach 1977). The shells are however known to occur in shallower water in the Manukau Harbour and Leach (1977: 481), after a discussion of habitat and historic accounts, concluded they could be harvested in selected shallow waters and traded.

Two adzes and one chisel, or small adze, were recovered. The chisel and one adze are fragments represented by the blade and the butt respectively. The broken chisel (Z20093) is 30 mm wide and is a thin rectangle in cross section. The surface is ground, with deep flake scars present on the front. Numerous small flakes have been detached from the cutting edge. The stone appears to be greywacke similar to that found on Motutapu and other islands in the inner Hauraki Gulf. The adze butt (Z20088), made from basalt, is rounded on the poll and has remnant ground surfaces with flake scars also present. There is a transverse break across the body, and with the flaking occurring after the grinding it is likely it broke during refurbishment. The cross section is rounded rectangular. The complete adze (Z20089) is made on a flake of greywacke and is 136 mm in length. The sides are irregular and deeply scalloped with flake scars. The back is ground on the bevel as is the front while the body on the front is bruised. The blade edge is rounded and asymmetrical, and the cross section plano convex. There are also three adze flakes with a polished surface. Each has been detached from the corner of the blade. Two are greywacke and one is basalt.

Figure 4.6. Adzes.

Sandstone files are typically found where fishhooks were being manufactured or repaired. All five files are fashioned from sandstone and would have been used to shape fishhooks and other bone and shell objects. Z20095 tapers to the intact end which has two flattened surfaces and is oval in cross section, rotated at right angles to the rounded cross section at the base. Typically, short fragments broken at both ends are found in assemblages and the Long Bay Restaurant site is no exception.

The bird spear (Z20085) is 75 mm long and has six barbs on one side and a sharp point at the end. The haft area is plain, tapering slightly towards the squared base of the haft. All edges are ground and appear to be made from one side of a bird bone shaft. While there are few bird bones present in the faunal material (Chapter 6), some of those species present may have been hunted with bird spears. The tool may also have been curated and have no direct relevance to activities being undertaken at a particular place. The style of bird spear is commonly found in sites including Oruarangi (Furey 1996), but bird spears are rare in Coromandel early sites.

Figure 4.7. Sandstone files.

Figure 4.8. Bird spear.

Fishing gear is represented by three one-piece fishhooks in moa bone, two moa bone trolling lure shanks and 22 shell two-piece fishhook points.

Two of the moa bone hooks are shanks, the other is a point limb with inturned point tip. All three are broken through the bend, and from the dimensions at the break are from different fishhooks. The point limb is quite curved and the tip is a continuation of that curve. The complete hook is likely to have been quite rounded in shape, possibly with a narrow gap between tip and shank limb. The lashing heads of the two shanks are not alike: one has a notch/step on the inner edge and a short outward projection on the outside along with a shallow notch in the top of the head. This is a typical style of lashing head common in early sites on the Coromandel Peninsula and also at Houhora in the Far North (Furey 2002). By contrast, the second shank has a reduction on the inner edge and a deep notch at the upper surface of the head creating a V-shaped appearance, and is unlike fishhooks from other excavated assemblages. However there are always variations on the common styles, due to personal preferences and ways of lashing the snood to the head, and possibly also incorporation of manufacturing irregularities. Because the hooks have broken through the bend, the length of the shanks will be equivalent to the finished length of the hook. One is 40 mm, the other 41 mm. The point limb and tip is much shorter at 26 mm.

The two trolling lure shanks are also made from moa bone. One (Z20086) tapers slightly to the end where there is a groove two thirds of the way around the circumference for holding the line lashing in place. The cross section is rounded but is flat on one side, possibly following the natural shape of the bone from which it was made. The second shank (Z20092) does not taper to the end, but has a groove around three quarters of the circumference. The cross section is rounded oval. Both styles in moa bone are commonly represented in museum collections such as those from Whitipirorua and Cabana Lodge (Davidson 1979).

Most of the 22 shell fishhook pieces are clearly from two-piece hooks with the hooks lashed to a shank at the base. All were manufactured from the gastropod Cook's turban (*Cookia sulcata*), but the absence of manufacturing debris of tabs and shaped sections of shell suggests the hooks were not made at the site. The size and shape of the individual gastropod shell dictates the maximum size of the hook pieces and their shape. Each piece is made from a large whorl of the shell, and from a horizontal segment, or one on a slight angle so that the ridges of the original shell can be seen on the convex side of the hook. Two fragments comprising point limb and tip

Figure 4.9 (above). Moa bone one-piece fishhooks.

Figure 4.10 (left). Trolling lure shanks.

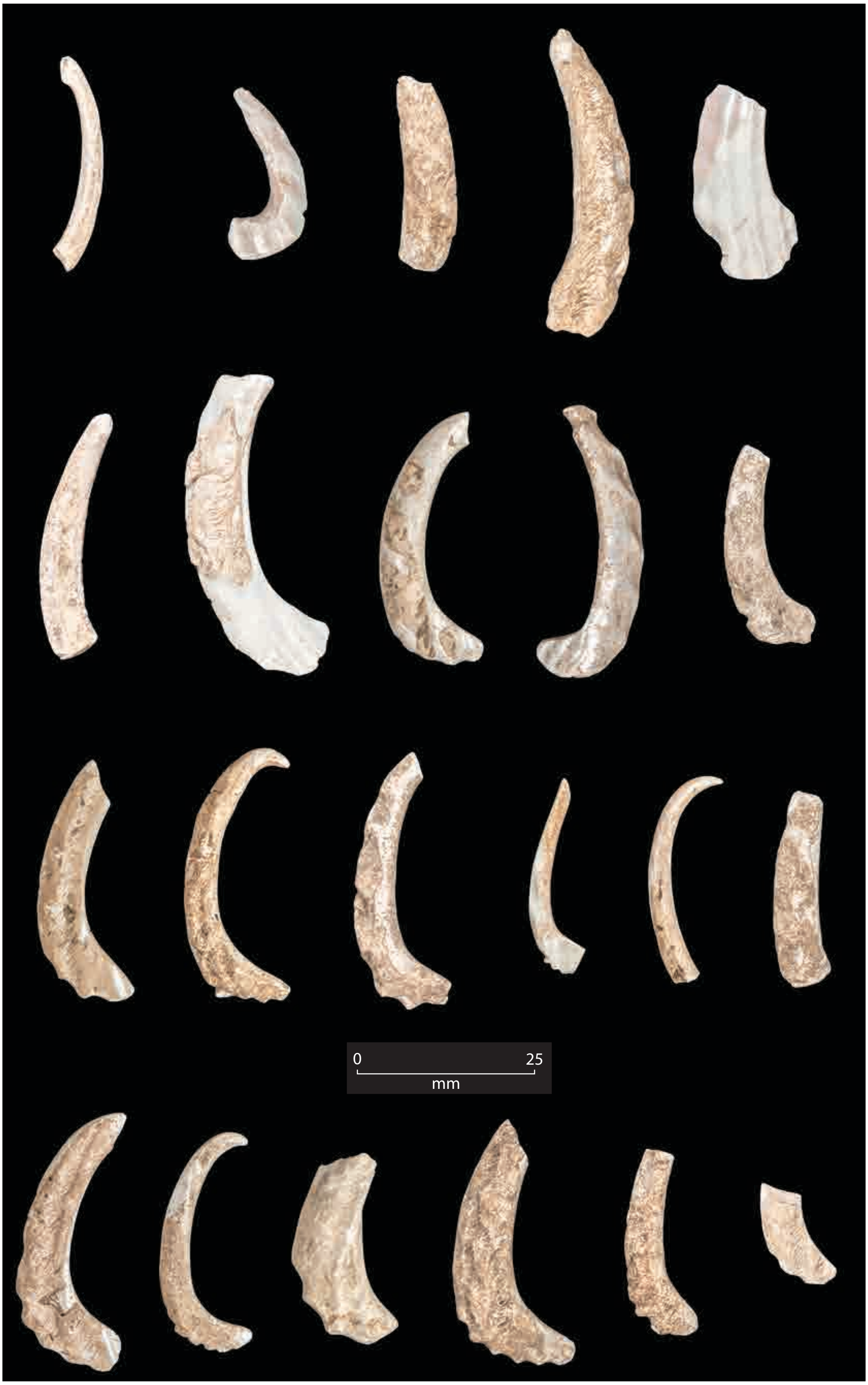


Figure 4.11. Shell fishhook points.

(Z20406 and Z20075) are round in section suggesting that they are part of one-piece hooks (based on comparison with one- and two-piece hooks in the collection of Auckland Museum).

There is only one recognizable shank (Z20411) with the line lashing area intact. There are no lashing notches at the base for attaching the point, and the shank is also very curved laterally so it may have been rejected as unsuitable before it was finished, or was a blank carried around for completion when needed. There are nine complete or near complete points, and 12 fragments representing either the base with notches, or a limb fragment broken at both ends. There are no broken inturned tip fragments on their own, suggesting that this is the most vulnerable part of the point and most likely to be lost while fishing. The low frequency of shanks relative to points reflects Law's (1984: 5) observation from museum collections, which he attributed to shanks more commonly being made of wood than shell.

All of the intact points have a slightly inturned tip, and following Law's (1984: 10) discussion about whether the hook points were oriented to the left or right, an appraisal of this assemblage indicates that right handedness of points predominates as it does in general museum collections. The bases of all the points intact enough to examine have notches on the outside curve near the end, or on the base of the curve itself. The base of the point is generally curved or rounded off rather than having a squared finish. Therefore, the points are predominantly lashed to the shank limb by the two pieces overlapping and binding cord used to join them together with the notches holding the cord tight. One has a squared-off base (Z20408) that was possibly for a butted join but given the fragility of the shell it is difficult to be sure whether the squared edge is deliberate shaping or a break across the shell. The number of notches on the outside curve at the base varies from one to four and may be small and shallow or broad and shallow.

Point lengths are relatively small: the four intact points have lengths of 27, 28, 31 and 32 mm. The one complete shank is 35 mm in length. Larger hooks are indicated by incomplete fragments: Z20412 which is 39 mm, Z20409 which is 38 mm and Z20773 which is 49 mm. As discussed above, the size of the shell dictates the size of the hook point or shank, with point limbs of longer length possibly having a longitudinal curvature from the curve of the natural shell.

Shell fishhooks are present in sites of all ages, and in the Hauraki Gulf area are known from the Pig Bay and Sunde sites on Motutapu Island and from Torpedo Bay and the Masonic Tavern site at Devonport. In Auckland Museum there is also examples of points from Pōnui Island and Kawau Island, and from the site of Owhiti Bay on Waiheke. While the Sunde and Pig Bay site assemblages might be early in the context of occupation of Auckland, radiocarbon dates indicate the majority of the artefacts including the shell fishhooks are from contexts post-Rangitoto eruption and are likely to be mid to late 1400s (Davidson and Leach 2017). Further away within the wider Hauraki region, several known sites of early age from either radiocarbon determinations, or the type of material culture present, include Opito (T10/160, Murdoch and Jolly 1967), Cross Creek site (T10/399, Sewell 1988) and Whitipirorua (T12/16, Furey 1990). At Cross Creek it was noted that the number of shell fishhooks through the stratigraphic sequence increased as hooks made of moa bone decreased, and Sewell (1988: 16) argued that there was a shift in type of material used after the 15th century as moa bone was no longer available. However, bone two-piece hook points made from mammal bone, including human, have always been more common than shell points and were a more likely and more durable direct replacement.

The Long Bay Restaurant site, occupied on several different occasions, has a limited range of material culture. The fishhooks include examples in moa bone, a resource which was no longer available by approximately the mid-1400s, and there are no fragments of the unworked moa bone suitable for tool manufacture in the faunal assemblage (Chapter 6), and Cooks' turban shell which is undiagnostic for indicating age as it is present in sites of different ages. The most interesting components of the assemblage are the awls, about which very little is known of their uses, and the *Antalis* beads.

Burial 'grave goods' are more commonly reported to be ornaments and adzes (Duff 1977). There are other accounts of use of *Antalis* beads as strung anklets and necklaces with burials, such as at Kaikōura where there were two adult burials with anklets (Trotter 2011), but more relevant are the descriptions of shells in association with burials of children (Leach 1977). At Paremata site near Plimmerton, Wellington, a child burial contained *Antalis* beads (Smart 1962), and at Washpool Midden in Palliser Bay, Wairarapa, the beads were over the lower limbs of the child burial aged about four years. Leach concluded that the shells were attached to a cloak, or apron, draped over the body (Leach 1977; Leach and Leach 1977: 208). The Washpool Midden site is also chronologically early, although the reported dates appear too old when compared to other sites.

5 Flaked Stone

Flaked stone artefacts are all those that have no formal tool type, generally basic cutting implements and waste flakes from tool manufacture. They tend to have a limited use life with little or no curation. They are often found in the context in which they were created and used, providing valuable information about artefact manufacture, task separation within a site and changes in procurement patterns of raw materials over time.

Of the 484 flaked stone artefacts recovered,[1] 367 had a maximum dimension greater than 10 mm and were analysed in depth. The remaining 117 were classified as shatter and no further analysis was undertaken. Analysis was based on methods outlined in Beyin (2010), Holdaway and Stern (2004), Turner (2005), Phillipps and Holdaway (2016) and Cruickshank (2011).

Method

Flaked stone was initially separated into four categories based on rock type: obsidian, chert, basalt and greywacke. The obsidian and chert were further separated based on their colour and quality (Moore 1988; Cruickshank 2011), with the chert colour based on the Munsell Soil Colour Chart.

Geochemical sourcing

Geochemical analysis of obsidian was undertaken to determine the likely sources of the material. Analysis was undertaken at the Department of Anthropology, University of Auckland using a Bruker Tracer III SD portable X-ray Fluorescence analyser (pXRF) (McCoy and Carpenter 2014; Sheppard et al. 2011; Cruickshank 2011; Phillipps et al. 2016).

Use-wear

Use-wear was analysed macroscopically using a 10 x hand lens. For a finer analysis of striae, edge scarring or abrasion a microscope would be required. Caution must be employed when making inferences about an assemblage based on macroscopic use wear analysis. Although macroscopic damage often forms on artefacts, many activities where these artefacts are used in a New Zealand context would not show macroscopic damage. Often flake may have been used for a single task and then discarded. It is less likely that flakes would be kept and repeatedly reused, unless access to high quality material was infrequent. Generally, the situations in which macroscopic damage will form are when a thin-edged tool comes into contact with a hard substance such as bone, stone or wood. It may rarely form on thicker-edged tools that have prolonged use, i.e., greater than several hours (Lambert-Law de Lauriston 2015).

Because of the inherent issues with identifying use wear, it was only recorded on flakes with clear evidence. The most easily identifiable use wear is from scraping, which is created when a flake is dragged at an obtuse angle across an item, causing damage to the trailing edge. This results in visible uni-facial micro-flaking of the surface of the flake.

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[1] Further flakes have been identified during subsequent midden sorting but are not included in this analysis.

Cortex

Cortex was recorded on the dorsal side of flakes, and assigned one of four categories: 0%, 1–50%, 51–99% and 100%. Because Tūhua obsidian generally occurs in flow selvages, as opposed to pebbles, cobbles and boulders of other sources, it does not often display cortex. Pieces that were smaller than 10 mm^2 were also discounted as no information other than count was recorded for these. It is likely that the flakes of non-Tūhua obsidian material came from cobbles and boulders, so all pieces over 10 mm^2 also had cortex recorded.

Obsidian

There were 447 flakes of obsidian (matā or tūhua) recovered from the site, representing 92% of the flaked stone tool assemblage by count. Obsidian is a volcanic glass that owes its vitreous structure to rapid cooling of viscous high-silica lava (Ward 1973). It is widespread throughout certain volcanic regions of the world, such as the Mediterranean, Mexico, North America, Japan, Iceland and New Zealand and Rapanui (Green 1967).

Obsidian played an important role in Māori society prior to the arrival of metal implements. It is likely that most people had a core of obsidian or a high quality local stone on hand at all times to carry out a range of day to day tasks such as butchery, scraping and finishing wooden tools, carving and producing muka – flax fibre used for making cordage (Turner 2005). It was an expedient technology, such that a flake would be struck off the core and used as it was needed. Eventually the core would get too small to create sufficient flakes and would in turn also be discarded. Because of the brittle nature of the material and the multitude of uses it had, it was discarded frequently and as a result it is common in pre-European sites throughout New Zealand (Green 1967).

In New Zealand obsidian is found in at least 30 known sources in four distinct regions associated with tertiary and quaternary rhyolitic volcanism: Northland, Mayor Island,[2] the Taupō Volcanic Zone (TVZ) and the Coromandel Volcanic Zone (CVZ) (Sheppard et al. 2011). Although these four geological areas are restricted to the top half of the North Island, exchange networks and access rights allowed its movement throughout the country, as far afield as the Chatham and Kermadec Islands (Leach et al. 1986).

Method

Colour is one of the most distinctive features of obsidian. Under normal reflected light it usually appears black, but when viewed through a transmitted light source like sunlight, it can be separated into three categories based on colour: green (Type A), red/brown (Type B) and grey (Type C). This can provide a basic idea of which sources are likely to have been exploited at a site.

There are three sources of green (Type A) obsidian: Tūhua in the Bay of Plenty, Kaeo in Northland and Waihi in the CVZ. Tūhua is by far the most exploited and dominant of the green obsidian sources, but the other sources should not be discounted, especially for sites in Northland or Tāmaki where Kaeo obsidian has been identified (Furey 2002; Campbell 2011;

[2] Mayor Island is traditionally known as Tūhua, which is also the name given to the obsidian that naturally occurs there. To avoid confusion the island will be referred to as Mayor Island, and the obsidian source will be referred to as Tūhua.

Moore 2012), and for the Lower Coromandel or Western Bay of Plenty for Waihi (Moore 2005).

Red/brown (Type B) obsidian is the rarest colour to encounter in archaeological sites. With the exception of recent work undertaken on the Poor Knights Islands (Robinson 2016), it has only ever been found in low numbers in archaeological assemblages. Raw material has been obtained from Waihi (Moore and Coster 1989), Great Barrier Island (Cruickshank 2011) and Ben Lomond near Taupō (Moore 2011). A chemically distinctive source is known only from archaeological sites, mainly Tawhiti Rahi in the Poor Knights Islands (Robinson 2016) and in small amounts on the Northland mainland. This source has been tentatively identified as 'Poor Knights' obsidian (Moore and Coster 1989) but the source has not been identified.

Grey (Type C) obsidian is the most common colour in New Zealand, and least useful for differentiating sources. With the exception of Tūhua, every source in New Zealand appears to have some grey material associated with it, and differentiating these visually relies on the presence or absence of flow banding, spherulites or crystal inclusions (Moore 1988).

Regardless of colour, all obsidian sources display a distinctive geochemistry that allows each source to be differentiated and allows identification of archaeological samples to source, which can provide information about exchange networks and exploitation of lithic resources.

Of the 447 pieces of obsidian recovered from the site, 102 were recovered from insecure contexts, mostly the Phase 14 demolition layer, so were not geochemically analysed. A further 98 pieces smaller than 10 x 10 mm were also discounted due to their size, leaving 247 flakes (53%) that qualified for analysis (Table 5.1). Time and money are always important considerations in any analysis, and so initially a subsample of 150 flakes was selected using a targeted sampling strategy that ensured all obsidian types, Phases and contexts were analysed:

1 only flakes larger than 10 x 10 mm x 2 mm thick were analysed;
2 the exception is red/brown obsidian (Type B), for which all flakes were analysed regardless of size were analysed due to its rarity. Analysing small flakes potentially give erroneous results, and these were subsequently discounted;
3 a minimum of one flake of Types A and C was analysed per Phase;
4 all obsidian found in grave fills was analysed.

The three sources of green (Type A) obsidian can be easily distinguished based on their zirconium, rubidium and strontium levels (Figure 5.1). These distinctions can be made with the pXRF in 15 seconds as opposed to the normal testing time of 120 seconds. Consequently all 111 Type A flakes were able to be analysed in an hour, and the time saving allowed for all 247 suitable flakes to be analysed.

Table 5.1. Obsidian flakes suitable for XRF analysis by Phase.

	Phase								
Type	1	3*	4	5	7	9*	10	12	13*
A	1		28	16	52	5	1	4	4
B					6		1	2	
C		1	12	2	69	1	19	22	1
Total	1	1	40	18	127	6	21	28	5

* burial Phase

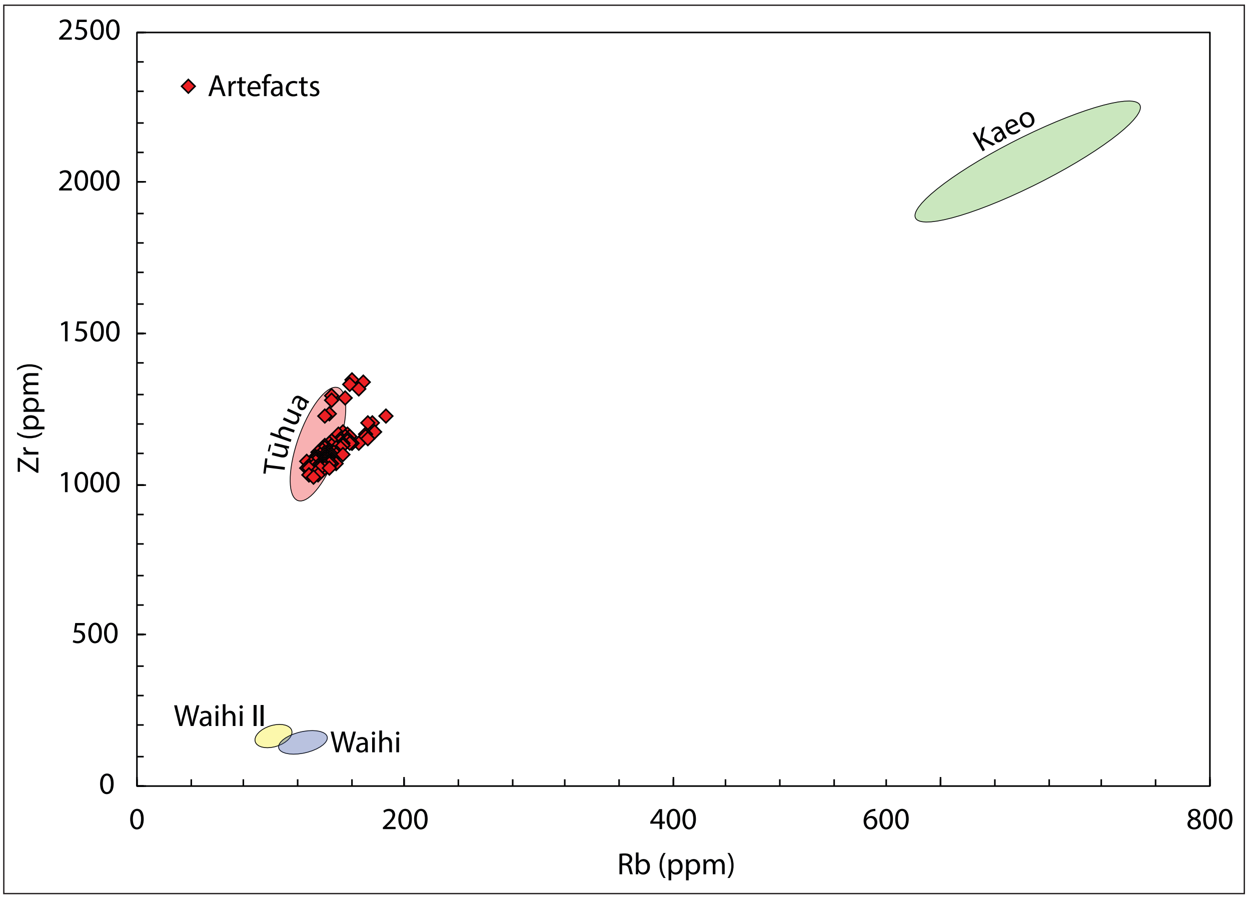

Figure 5.1. Scatterplot showing the distinctive groupings of Tūhua, Waihi and Kaeo obsidian based on Zirconium (Zr) and Rubidium (Rb) levels.

Results

Nine flakes produced erroneous readings so were removed from the results as outliers. Of the remaining 238, the majority derive from Tūhua (n = 108) or the Te Ahumatā source on Great Barrier Island (n = 109) in almost equal numbers. The mainland Coromandel sources of Hahei and Cooks Beach are each represented by single specimens. Type B flakes (n = 9) all cluster together and were assigned to the Awana source on Great Barrier Island. However, their concentrations of yttrium are beyond the range of the Awana source, and red/brown obsidian is not known from Awana. With current knowledge, it is not possible to assign these samples a definite source, but evidence points to a location somewhere on Great Barrier Island. A single cobble of red obsidian was retrieved from Okupu near Te Ahumatā in 1999, and is the only known occurrence of red obsidian on the island (Cruickshank 2011). The final group of artefacts were assigned to the "Poor Knights" source (n = 10). The precise location of this source cannot be specified but chemical analysis indicates that this material is similar to sources on Great Barrier and Fanal Islands, suggesting it derives from an island source related to the Coromandel Volcanic Zone, most likely near to Great Barrier or Fanal Islands.

Table 5.2. Results of obsidian XRF sourcing by Phase.

	Phase								
	1	3*	4	5	7	9*	10	12	13*
Awana					5		2	2	
Cooks Beach			1						
Hahei				1					
Tūhua	1		27	16	52	3	1	4	4
Poor Knights		1		1	7			1	
Te Ahumatā			11		60	1	18	18	1
Total	1	1	39	18	124	4	21	25	5

* burial Phase

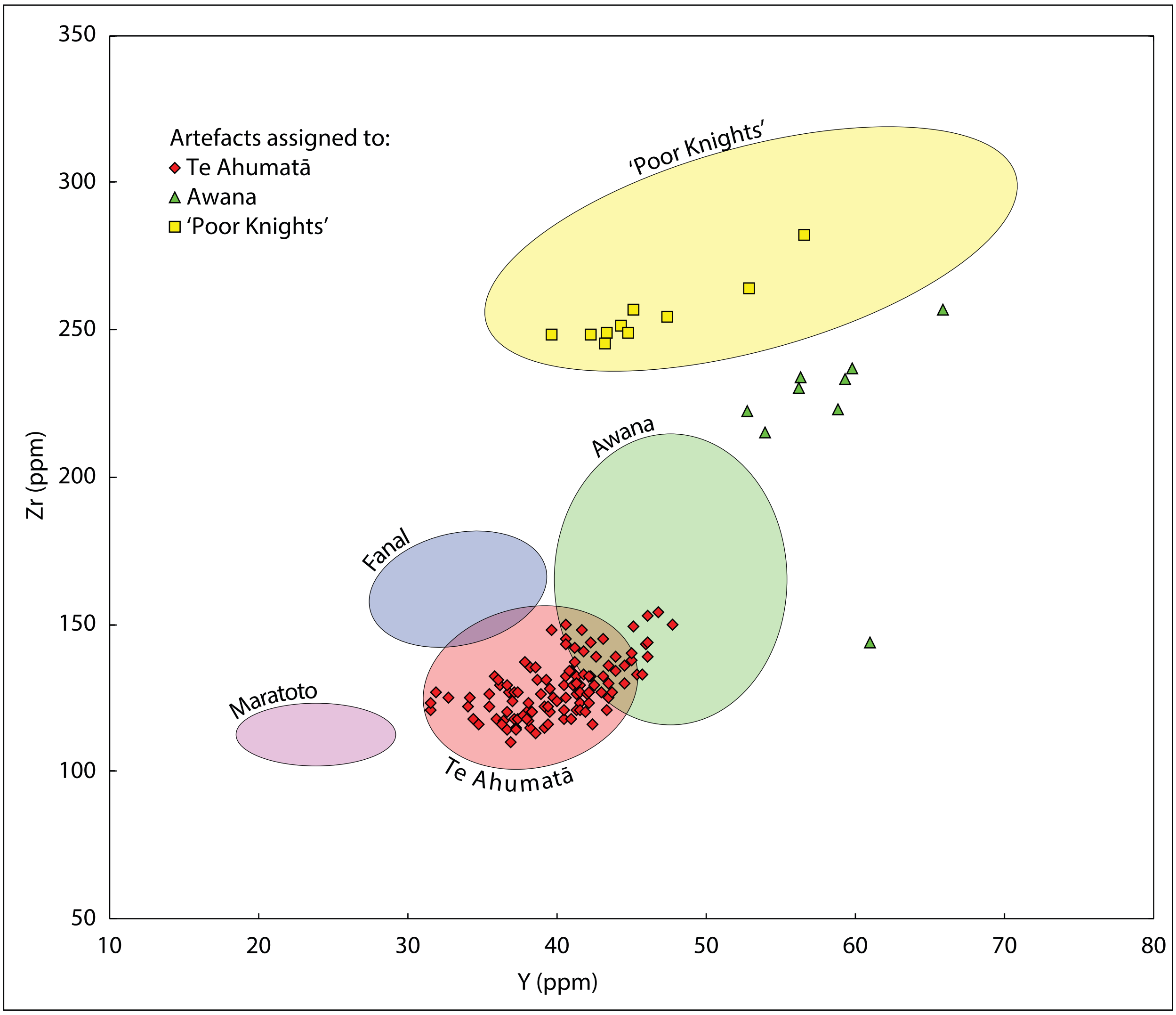

Figure 5.2. Scatterplot of Type B obsidian showing the Yttrium levels compared to Awana.

Use-wear

Use-wear was observed on 33 pieces of obsidian from this assemblage. Twenty-four of these flakes had use wear consistent with scraping, and nine with cutting.

Cortex

Of the 187 pieces of obsidian which qualified for cortical analysis, 53 (28%) displayed cortex. None of the flakes displayed 100% cortex, which would be an indicator of primary reduction (the first flakes removed from a core).

Chert

Fifteen flakes recovered from the site were recorded as chert. One was a piece of shatter and no further analysis was undertaken. The term 'chert' is used here as described by Moore (1977) and Cruickshank (in Campbell 2011) as all material that appears to be a highly siliceous, sedimentary, metamorphic or igneous rock that cannot be classified into other well-known stone types in hand specimen.

It should be noted that terms such as flint, chalcedony and jasper are not used in this report, as they cannot be confidently assigned to artefacts. To assign these terms correctly would require a much finer grained petrographic study of the artefacts, and often the differences are so subtle that they can only be discerned within the source deposits themselves, which is not possible with archaeological samples. It is better to assign these pieces to an all-encompassing group than assign them to one of those often incorrectly used terms (Moore 1977).

Good, flake-quality chert occurs in three main areas in New Zealand: Marlborough, the East Coast of the North Island and the Coromandel and Auckland Northland Peninsulas (Moore 1977: Figure 1). This final group overlaps with many of the high-quality lithic resources which have been identified within the site, including most of the obsidian sources identified, Tahanga basalt and Motutapu greywacke. Chert occurs on Motutapu, Waiheke and Ponui Islands within the Hauraki Gulf, on the mainland in South Auckland, most notably around the Manukau Harbour, and the Hunua and Waitākere Ranges (Moore 1977).

Chert is difficult to source precisely, as it is widely distributed and chemically indistinct (Sheppard 2004). Although geochemical sourcing of chert can be undertaken, it is generally destructive and often inconclusive (Best and Merchant 1976; Malyk-Selivanova et al. 1998). Weathering of chert can also lead to absorption of certain chemical elements, which can affect their geochemistry (Sheppard and Pavlish 1992).

Generally, in New Zealand chert sourcing is based on macroscopic physical characteristics and comparing them to known local and well documented sources (Moore 1977; Cruickshank in Campbell 2011; Phillipps et al. 2016). The cherts from the Long Bay Restaurant site were separated into groups based on appearance and quality, with colour analysed by eye using a Munsell soil colour chart. Quality is categorised as High, Medium or Low based on criteria described in Cruickshank (2011). This does not provide high quality sourcing information, but by comparing the different qualities it is potentially possible to discern different collection strategies or deposits which were accessed.

Results

Six chert types were identified on the basis of colour and quality (these 'types' are specific to the Long Bay Restaurant site; the same labels are used for different cherts at different sites).

- Type A was a medium to high quality, cryptocrystalline silica which exhibits three different colours, grey (GLEY1 5/N), pale red (10R 5/4) and yellowish brown (10YR 5/4).
- Type B was a medium to high quality, cryptocrystalline silica, which is light brown (7.5 YR 6/4). It is similar to the Type C material but does not have the red flecks in it.
- Type C was a medium to high quality, cryptocrystalline silica which is predominantly light brown (7.5 YR 6/4) with minor flecks of red (10R 5/6). There is a single patch on one of the samples (385) which is weak red (10R 5/6) which appears to have been caused from heat damage.
- Type D was represented by a single flake of high-quality chert, which was bluish black (GLEY2 2.5/10B) and exhibited a water rolled cortex. Black chert has been identified in the Tupou Complex of sandstones around Whangaroa Bay in Northland, but cannot be ruled out as occurring in other locations (Moore 1977; Edbrooke and Brook 2009).
- Type E was represented by a single flake of high-quality chert, which is dark reddish grey (10R 3/1) and dusky red (10R 3/4). This flake has moderate translucency.
- Type F was a single flake core of high-quality cryptocrystalline silica which is a mix of grey (5Y 6/1), greenish grey (GLEY 2 6/5PB) and bluish grey (GLEY 2 5/10B). It exhibits a water rolled cortex which is yellowish red (5YR 5/6).

It is not known where these chert flakes were obtained from, as there is no obvious source of chert in the vicinity. The chert is also vastly outnumbered by other stone types, making up only 3% of the assemblage by count. In a recent study undertaken at Tauroa Point, Northland, the chert artefacts made up 50% of the assemblage by count, 86% of which appear to be locally occurring material (Phillipps et al. 2016). This is what would be expected if there was a locally occurring lithic resource, but as no identifiable source is in the vicinity of Long Bay, it is likely the chert, along with the other lithic resources, has been bought from another location, possibly from somewhere in the Hauraki Gulf or Coromandel region.

Use-wear

Only one chert artefact displayed use-wear. At first glance, this appeared as retouch but the micro-flake scars are stepped and abrupt and unlikely to be created through typical retouching methods. This damage to the flake is probably associated with it being used for cleaving or some other similar task.

Table 5.3. Chert types by Phase.

	Phase						
Type	4	5	7	9*	10	12	14†
A	2		1	1	1	1	
B				3			
C					1		2
D	1						
E			1				
F		1					
Total	3	1	2	4	2	1	2

* burial Phase
† disturbed upper demolition layer

Cortex

Of the 14 pieces of chert which qualified for cortical analysis eight displayed cortex. None of the flakes displayed 100% cortex.

Greywacke

There were 21 flakes of greywacke recovered from the site, from Phases 4, 5, 7 and 10, including one piece from the disturbed Phase 14 (formal tools of greywacke and flakes off formal tools are described in Chapter 4). One piece was recorded as shatter and no further analysis was undertaken. Greywacke is the basement rock of New Zealand, and occurs in outcrops throughout the country (Edbrooke 2001). One such outcrop is the Waipapa group of basement and sedimentary rocks which occur throughout the Hauraki Gulf, referred to by archaeologists as Motutapu greywacke, since evidence of quarrying was first recorded on Motutapu Island. Quarrying has also been identified on Rakino and Motuihe Islands. It is also available on the mainland near Kaiaua, but fine-grained material is relatively rare in the mainland deposits. The Motutapu deposits were most likely the main focus for exploitation (Turner 2000).

Sources

The pieces are all high quality and appear to be Motutapu greywacke. The closest known source to Long Bay is Motutapu Island, approximately 16 km southwest of this site, from where they could be directly procured.

Use-wear

No pieces of greywacke recovered from this site displayed any macroscopic use-wear. There was also no evidence of grinding or polishing and it is possible that the flakes are remnants of early or abandoned tool manufacture, rather than flaked off formal tools during use.

Cortex

Of the 20 pieces of greywacke which qualified for cortical analysis eight displayed cortex. None of the flakes displayed 100% cortex.

Basalt

A single, complete flake of basalt was recovered from the site, from within a natural wind-blown layer (Phase 6) (formal tools of basalt and flakes off formal tools are described in Chapter 4). It is of medium quality and has some remnant cortex. It does not display any use wear, grind-

Table 5.4. Greywacke by Phase.

	Phase				
	4	5	7	10	14*
Greywacke	6	7	9	1	1

* disturbed upper demolition layer

ing or polishing. It is possible that this flake is part of the early stages of adze manufacture, but it appears to have been disturbed out of its original position and no further inferences can be made about it.

Fire cracked rock

Fire cracked rock was identified in different contexts throughout the site, within fire features, cooking stone caches and within deflated layers as a lag deposit. These were primarily examined in the field but a number of samples were retained for further analysis. The vast majority of samples were locally occurring sandstone, easily procured from either end of the beach, with lesser numbers of fragmented greywacke pieces and locally occurring basalt pebbles and cobbles. Feature 111 (Phase 1) and Feature 120 (Phase 4) were identified as cooking stone caches, and these contained exclusively sandstone.

There seemed to be a correlation between size of fire cracked rock fragments and how blackened they were. The lighter coloured samples such as Feature 111 are generally larger, and the much darker pieces are much smaller and more shattered. It is likely that the sandstone can only be used a limited number of times before its structural integrity is compromised and the rocks are discarded for new ones. Although sandstone is not the best material for using for oven stones, its abundance on the beach ensured a constant supply of oven stones.

Kōkōwai

Two samples of kōkōwai (red ochre) were retained from the excavation, one each from Phases 10 and 12. These both have the appearance of heat modified sandstone which can later be ground down to form ochre. While sandstone was the primary cooking stone, and could be the source of the kōkōwai, the two samples were not found within the vicinity of any fire scoops.

Probable kōkōwai staining was observed on some of the kōiwi (Chapter 7).

Discussion

Although the assemblage is dominated by Tūhua and Te Ahumatā obsidians, there is still exploitation and transportation of several minor sources. While there have been attempts at working out the supply zones of these sources (e.g., Moore 2012; Moore and Coster 2015), emphasis has been placed on individual sources rather than larger scale procurement areas.

In considering transport costs, it is probable that the procurement of one material was embedded within the acquisition of another (Phillipps et al. 2016: 117). One example of this would be the procurement of obsidian from Mayor Island by those living in the Tāmaki region and further afield. A trip to Mayor Island from the Hauraki Gulf, if it was intended for direct procurement, would not be undertaken in a single day, and there are several harbours along the Coromandel which would not only provide an adequate camp, shelter from adverse weather and also contained their own high quality stone sources, such as obsidian, chert and Tahanga basalt. Once in the Colville Strait, it would only be a short detour to the west coast of Great Barrier Island to obtain obsidian and chert, and then to Motutapu for greywacke. In one journey from Mayor Island to Long Bay, it is possible to visit and procure most of the identified sources of lithic material recovered from the site. This type of voyaging could be responsible for the low, yet present numbers of lesser sources, such as Whangamatā and Cooks Beach obsidian in assemblages recovered from the Tamaki region (Campbell 2011; Cruickshank 2011; Sheppard et al. 2011).

Use-wear

Use-wear was identified on 34 flakes of obsidian and a single flake of chert. Twelve of the pieces displayed evidence of use for scraping, and ten for cutting. The remaining flakes displayed different types of use wear which could not be easily attributed to either of these tasks and would require further investigation. For instance, the single piece of chert that displayed use wear at first glance, appeared as retouch but the micro-flake scars are stepped and abrupt and unlikely to be created through typical retouching methods. This damage to the flake is probably associated with it being used for cleaving or some other similar task.

The artefacts identified in this assemblage as displaying use wear should not be viewed as the only flakes which were used. It is probable that if microscopic analysis was performed on the assemblage, a much larger number of flakes would display use-wear and the range of wear types would be.

The low number of flakes exhibiting macroscopically identifiable use wear is most likely due to the ease of procurement of obsidian and other fine-grained stone, negating the need to intensively use a flake to exhaustion. If the flakes are being discarded and replaced frequently, rather than rejuvenated there would be little evidence of use-wear in an assemblage as a whole.

Cortex

Cortex was observed on 29% of the eligible flaked stone assemblage. Full cortical analysis was not undertaken for this report, but some basic observations have been noted. The absence of primary flakes, especially from Te Ahumatā, is contrary to what would be expected. McCoy and Carpenter (2014) theorised that lack of cortical (presumably primary) flakes in assemblages is due to the removal of it at the source, to reduce weight for transportation. This seems an less likely explanation for this assemblage as the Te Ahumatā deposits are easily accessed by canoe directly from Long Bay and returned directly to the site. Removing cortex would be time consuming, and more likely to be wasteful and unnecessary as it would not be difficult to return for more material.

There have not been any large-scale studies on obsidian cortex undertaken in New Zealand, with it usually mentioned as a side note as part of obsidian analysis. Moore (2012) discusses it briefly and states that if material was being directly procured, a high proportion of cortical flakes would be expected. If removal of cortex had been happening at Te Ahumatā, it would be expected that there would be hundreds, if not thousands of primary flakes present around the Te Ahumatā source, whereas no more than a dozen or so pieces of worked obsidian were identified during a field survey in the vicinity of these deposits (Cruickshank 2011). The location of these primary flakes is unknown and could point to a significant reduction area outside the extent of this excavation.

Temporal and spatial distribution of flaked stone

There are no clear patterns in the distribution of flaked stone across the site in any Phase. Recent research in the Tamaki Region has demonstrated a shift from assemblages dominated by Tūhua obsidian to assemblages dominated by Te Ahumatā obsidian, dated to around AD 1500

AD (Cruickshank 2011). The Bayesian analysis of the radiocarbon dates (Chapter 3) provides a very tight dating sequence for the six Phases of occupation, while a comparison of the percentages of each obsidian source present in each Phase (Figure 5.3) shows that the change from Tūhua to Te Ahumatā occurred in the interval between Phase 5 and Phase 7, and is complete by the commencement of Phase 10. The shift in procurement strategies in Tamaki can, on the basis of the Long Bay Restaurant site evidence, be dated to the mid-15th century, though it may have been a process extending over several years, in which case the process extends into the late 15th century (but see discussion of the chronology in Chapter 3 for interpretation of the Bayesian analysis).

Tool manufacture

Several formal stone tools were recovered from the excavation (Chapter 4). No evidence of adze manufacture was found and, while sandstone files were recovered, these are small tools most likely to have been used to shape small objects. The lack of identifiable drill points (with chert only making up 3% of the flaked stone assemblage) or shell tabs indicates that tools like fishhooks were not being made on site, even though they were commonly recovered. As with the lack of primary obsidian flakes in the assemblage, it is likely that if tool manufacture was being undertaken at the Long Bay Restaurant site, it was outside of the excavation area.

Conclusion

There were 484 flaked stone artefacts recovered from this site, represented by at least nine sources, probably largely obtained through direct procurement. This can be seen in the obsidian assemblage, where the small number of flakes with use-wear, high number of flakes with cortex (although no primary flakes were found) and distance to source indicates direct procurement of Tūhua obsidian from Mayor Island with minor sources piggybacking on procurement voyages. From Phase 7 (mid-15th century) Tūhua is replaced by Te Ahumatā as the dominant obsidian, a pattern has been observed elsewhere in the Tamaki Region (Cruickshank 2011).

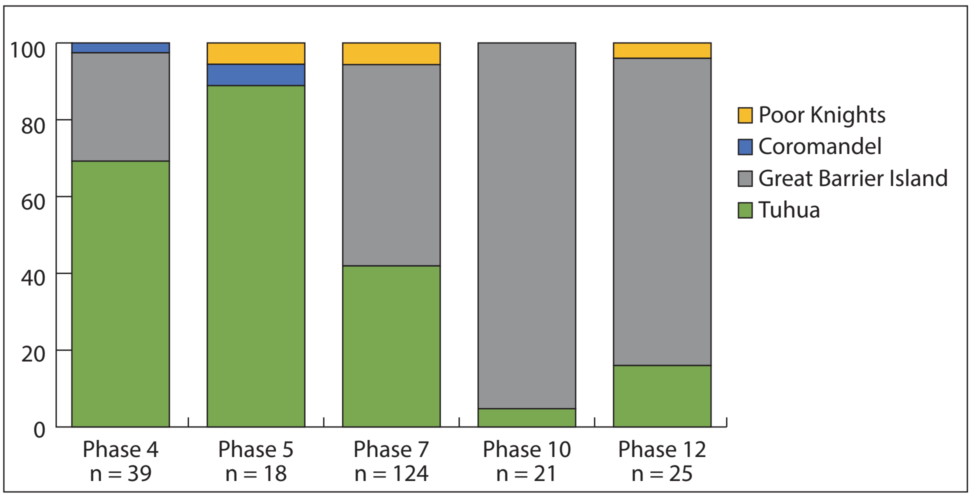

Figure 5.3. Percentage of obsidian identified by pXRF from each occupation Phase, showing change over time from Mayor Island to Great Barrier Island sources (Phase 1, with only a single flake, is omitted).

The presence of macroscopically observable use-wear was low, and likely a result of the ease of procuring raw material reducing the need to use tools to the point of exhaustion. Microscopic and residue analysis of the assemblage may provide further insights into tool use within this site.

The lack of evidence of formal tool manufacture indicates that this part of the site does not represent a full range of pre-European Māori activities. This coupled with the lack of primary cortical flakes from Te Ahumatā shows that there were likely other tasks that were separated from this area and future investigation along Long Bay would likely provide a better understanding of what was happening in the wider area.

6 Faunal analysis

Animal remains are generally better preserved in archaeological sites than plant remains. Shell and bone are hard, are easily excavated and recovered, and there is a long history of analysing these materials in New Zealand and elsewhere. The majority of foods eaten by pre-European Māori, as for most peoples, would have been plant based, but evidence of this is circumstantial: gardened soils, which are often ploughed out by European agricultural practices; or storage pits, which may have had uses other than kumara storage. Plants can leave behind microfossil remains like pollen or starch grains, but this type of analysis has not been undertaken for the Long Bay Restaurant site. Patterns of tooth wear on the kōiwi (Chapter 7 of this volume, and Volume 2) indicate that the diet included bracken fern (*Pteridium esculentum*). The faunal remains analysed in this chapter formed an important part of the diet but would not have been the main part of it. Even so, this analysis shows how people interacted with their environment and gives some important clues to what that environment was like.

Sampling

The necessity of recovering all kōiwi meant that all deposits were sieved through 6 mm or smaller screens. This allowed a 100% sampling strategy to be adopted in the field but it soon became apparent that it was inefficient to attempt to sort faunal, stone and other classes in the sieve. It was decided to separate out all kōiwi or possible kōiwi, and to bag all the sieved material and return it to the lab. In addition, numerous unsieved bulk samples were also returned to the lab, resulting in around 5 m^3 of material remaining to be sorted and analysed. Material had been bagged by square and feature number, and for many of these contexts there were multiple bags. For the purposes of this report, and due to budget and time constraints, a subsample of these bags was sorted and analysed, consisting of: all bags, including bulk samples, from a minimum of two squares from each layer; and a minimum of one bag, a bulk sample if one was available, otherwise a field-sieved sample, from many but not all discrete features other than grave cuts. This sampling strategy applies primarily to fish and shell fish (Figure 6.1). Samples analysed for other faunal classes were maximised as much as practical: moa and sea mammal bone were handpicked during excavation when it was observed, as was much of the kurī (Polynesian dog, *Canis familiaris*) and bird bone. Because of this, samples from these classes were analysed from the clean windblown sand layers separating cultural Phases, as well as from burial contexts, where they were located in the grave fill and had been disturbed out of their original context by the grave cut. Shell and fish were also recovered from these contexts but have not yet been analysed. Identified specimens from these contexts are listed in Table 6.1 and in the relevant tables for each faunal class, but are considered to be out of context and are not generally discussed further.

Method

The bagged material was wet sieved though a 3 mm screen in the lab and air dried. Bulk samples were air dried and weighed prior to wet sieving. The dried material was sorted by hand to faunal class, as well as sorting stone (both fire cracked rock and worked stone), worked bone and shell, and charcoal, and each class was weighed. The LBR number in the project database for the bag was retained for the shell while all other classes were rebagged and given a new LBR number, retaining the context information of the original bag. Each bag was then passed on to the relevant specialist for analysis.

Table 6.1. Total NISPs of identified faunal classes by Phase

	Phase												
	1	3*	4	5	6†	7	8†	9*	10	11†	12	13*	14‡
Shell (MNI)	1298		19212	1777		273			670		30		
Fish	1314		4346	419		724			583		659		1
Mammal	3	1	87	21		153	2	14	27	6	6		36
Bird	20		71	5		113		1	50	2	2	1	11
Sea mammal	1		9		1	4		1	3				10
Reptile	1		6			7			3				
Moa		1	7										

* burial Phase
† clean sand separating cultural Phases
‡ disturbed upper demolition layer, includes sheep (*Ovis aries*), rabbit (*Oryctogalus cuniculus*) and chicken (*Gallus gallus*)

In addition to moa and sea mammal bone, kurī and bird bone were also handpicked when they were observed but significant quantities of kurī and bird, along with rat and reptile, were separated out during sorting and all available mammal, bird and reptile bone was analysed. Very little moa or sea mammal is likely to remain in the unanalysed material, but considerable quantities of other classes have yet to be sorted and analysed.

The counts used in the analysis are based on NISP, the Number of Identified Specimens, which is the total count of all identified elements for each species. For all classes, conventional MNIs (Minimum Number of Individuals) are also provided to allow for comparison with other published datasets. MNI is calculated on the most common element, in the case of paired bones, either left or right. In the case of kurī and sea mammal, age estimates based on the degree of epiphyseal fusion were also taken into account when calculating MNI. The exception is shell which is reported by MNI; bivalves were not identified to left or right, so MNI is NISP divided by two, while the MNI for gastropods is equivalent to the NISP.

Biodiversity statistics

One useful way to examine faunal counts is to employ statistical tests used to measure biodiversity, which analyse the assemblage as a whole (Magurran 2004; Campbell 2016). The statistics used here to discuss the shellfish, fish and bird assemblages are taken from Magurran (2004); although developed for the environmental sciences these statistics translate easily to archaeology. All biodiversity statistics are dependent on how the environment is sampled. This is particularly problematic in archaeology as the analyst has no control over the initial 'sampling methodology', i.e., how species were captured and which species were targeted. Subsequent 'sampling' occurs when bone can be destroyed by burning or being eaten by kurī before it can be deposited in a midden, and once deposited it can be further destroyed by chemical and mechanical factors – this problem is particularly acute for fishbone, which is generally more fragile than bird or mammal bone or shell. The archaeological assemblage is quite different to a natural assemblage and so biodiversity statistics can inform on the structure of the archaeological assemblage but not so readily on the environment it came from. Nonetheless, they can be very useful in archaeology. The simplest of statistics used here are NISP, the total number of identified bones in each

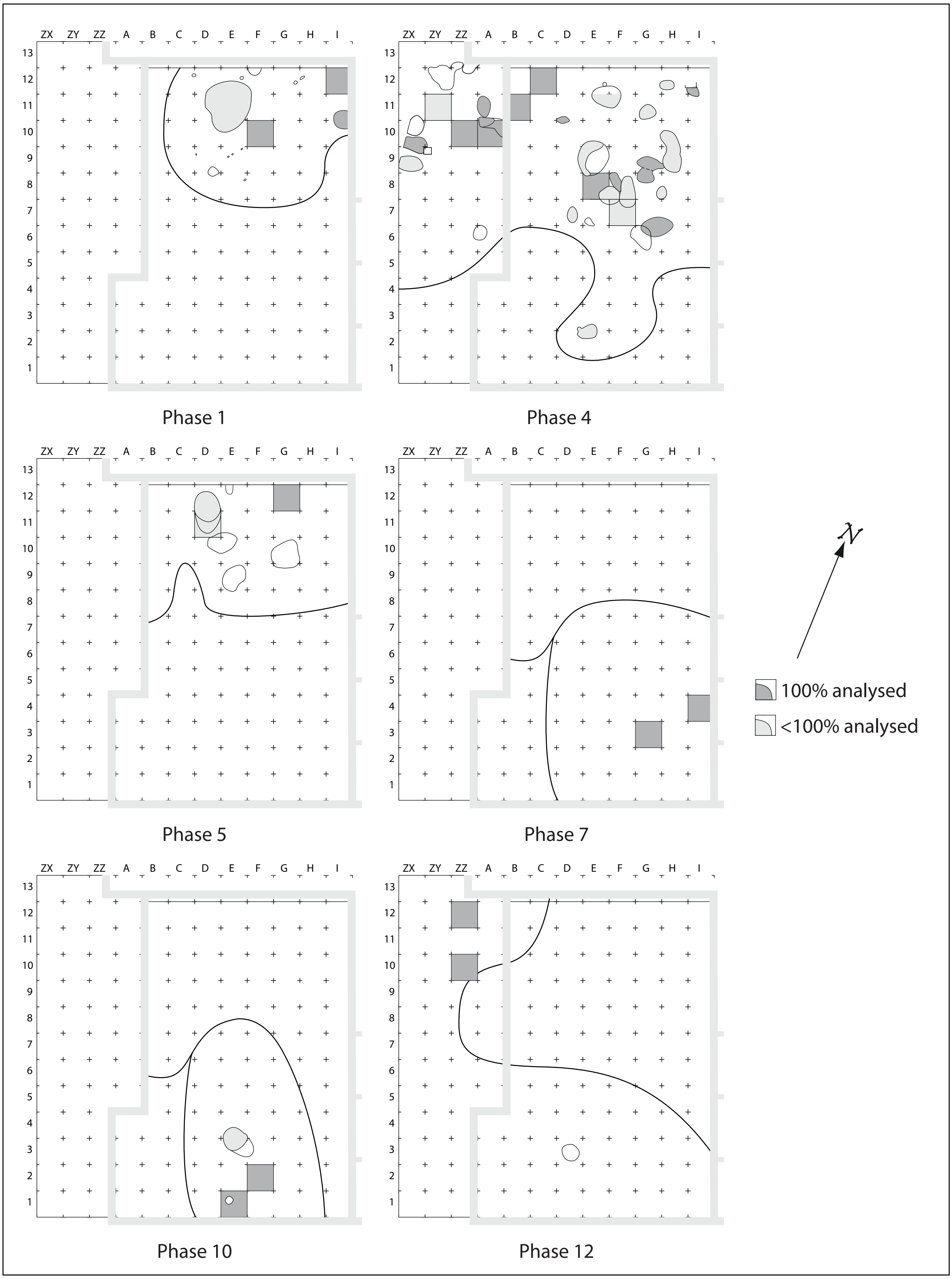

Figure 6.1. Squares and features for which shellfish and fish were analysed for each Phase.

assemblage obtained by adding together the NISPs for each taxon; and S, the number of taxa in the assemblage, often referred to by archaeologists as N-Taxa.

S is a simple measure of assemblage richness. However, since S is affected by sample size (Magurran 2004: 76), i.e., the larger the sample the more likelihood that rare species will be identified, two alternative measures can be used that partly correct for this: Maraglev's index D_{Mg}, which divides S by the log of NISP; and Menhinick's index D_{Mn}, which divides S by the square root of NISP.

In addition to measures of richness – the number of species in the assemblage – it is also useful to measure diversity and evenness – how the species are distributed in the assemblage. The simplest diversity index is the Berger–Parker index d, which measures the proportional abundance of the most abundant species in the assemblage (Magurran 2004: 117). This is usually expressed as 1/d, so that diversity increases as 1/d increases. Another statistic that measures diversity is Simpson's index, D. There are a number of variations on this measure and the literature can be confusing. Simpson's index used here is (Magurran 2004: 115):

$$D = \sum_{i=1}^{s} \frac{n_i(n_i-1)}{N(N-1)}$$

where n_i = the NISP of the ith species and N = total NISP. As with the Berger–Parker index, the reciprocal form 1/D is used here. Simpson's index is sensitive to the dominant taxa in the assemblage and is not particularly sensitive to richness; it is measure how the species are concentrated (there are numerous measures of 'diversity' and other statistics may yield different results, Magurran 2004). The final biodiversity statistic employed in our analyses is Simpson's evenness index, $E_{1/D}$, which is calculated by dividing Simpson's diversity index (in its reciprocal form 1/D) by S (Magurran 2004: 115).

These statistical analyses are applied to the shell, fish and small bird assemblages. Numbers of mammal, sea mammal and moa bone (and small bird from most Phases) were too low to result in meaningful biodiversity measures.

The structure of the midden

Direct observation and recording during excavation is the primary method used to examine the midden as a structure, in other words, how it was built up and used during occupation of the site (Ambrose 1963). Another route to understanding the midden as a structure is to analyse attributes of the shell that it is made from. Examining the ratio of matrix (sand in this case) to midden material (principally shell, bone and stone) gives a measure of midden density.

Where possible, bulk samples of 10 litres were taken from each discrete feature and from most, but not all, squares from each Phase. In practice, samples ranged in volume between 8 and 13 litres, while some samples from discrete features were less than 5 litres in volume. The volume of all samples was re-measured in the lab prior to processing.

Bulk samples were weighed before and after wet sieving in the lab to assess the density and structure of the midden – the greater the proportion of material retained in the sieve, the denser[1]

[1] Density here refers to the proportion of shell to matrix in the midden. Generally a dune midden will be composed of shell embedded in a sandy matrix, but some middens contain very little matrix. Examples are found at Omaha, where deep middens of clean shell with little matrix are interpreted as the remains on 'industrial' processing (Bickler et al. 2003). The Long Bay Restaurant site middens are of the former type however.

Table 6.2. Results of bulk sample analysis. The percentages given are the ratios of sieved to unsieved material by weight. Aggregate % refers to all samples from that context combined.

		Phase					
		1	4	5	7	10	12
Layer	n	3	12	8	22	3	1
	range %	1.2–3.82	0.72–80.13	1.25–37.39	0.13–61.91	0.34–0.7	2.2
	aggregate %	2.96	19.3	8.04	10.34	0.58	2.2
Firescoop	n	2	15	5		1	
	range %	1.64–7.27	0.66–8.28	3.7–13.86		1.36	
	aggregate %	4.41	3.53	10.62		1.36	
Rakeout	n		1	1			
	range %		0.76	1.25			
	aggregate %		0.76	1.25			

the midden. Seventy-four bulk samples with a volume greater than 5 litres were analysed. Table 6.2 gives the results of this analysis by Phase and feature type, showing the range of weights of sieved material as a percentage of the unsieved dry weight as well as the aggregate percentage for all bags in each Phase/feature category combined.

The result show considerable variation both between layers and, more importantly, within layers. For instance, in Phase 4 the general midden ranges from 0.72% weight of sieved material to 80.13%, while the aggregate is 19.3%. Interestingly, both range and aggregate percentages for firescoops in Phases 4 and 5 were less than for the general midden matrix. Material in firescoops is generally more burnt (see analysis of fish bone burning, below) and much of it may have been so heavily burnt that it has become fragmented and falls through the 3 mm screen, but this also implies that the material in the general midden matrix is not firescoop rakeout – in fact where rakeout was identified it was generally highly burnt ashy material. The material in firescoops would have burnt after being left in situ or disposed of in the fire while the general midden matrix was more likely built up from material that had been cooked and removed from the heat before it could become too degraded. Firescoops would generally have been used only once.

Shell

Shell was the most common faunal type at the site – shellfish are easily gathered from all coastal environments and the hard shells preserve well in archaeological matrices, particularly clean sand like the matrix at the Long Bay Restaurant site. Depending on the pH of the soil matrix, the calcium carbonate in shell middens potentially stabilises soil pH so that more fragile remains such as fish bone are better preserved, particularly in deeper and denser deposits (Claassen 1998: 88). Some shell species have a relatively high organic content in their shell as well as nacreous ('mother-of-pearl') interiors and less stable microstructures in their exterior shell. These survive less well than taxa with stronger microstructures. Pāua (*Haliotis iris*), mussel (Mytilidae) and Cook's turban (*Cookia sulcata*) are particularly susceptible to degradation even in pH stable midden contexts, while species like pipi (*Paphies australis*), tuatua (*Paphies subtriangulata*) or tuangi (*Austrovenus stutchburyi*) survive very well (Katherine Szabó pers. comm. 26 May 2017). This has implications for the survival of artefacts made from Cook's turban, such as the fishhooks discussed in Chapter 4.

Method

Shell analysis was undertaken by Danielle Trilford and Arden Cruickshank at CFG Heritage, with assistance from student volunteers Zack Smith and Sian Canton. All diagnostic shell portions (hinges for bivalves; aperture or apex for gastropods, with opercula counted separately) were identified to the lowest possible taxonomic level, with identifications from Morley (2004), counted and weighed. In the case of cat's eye (*Turbo smaragdus*) MNI is generally calculated on opercula, but for all other gastropods it is calculated on aperture or apex.

Results

Thirty-one shellfish taxa were identified across all cultural Phases including very small taxa that are considered to be bycatch or non-economic species. The following discussion counts all contexts in each Phase as a single assemblage. Phase 12, which only had a total MNI of only 30, is generally excluded from the discussion. Phases 1, 4, 5 and 7 were dominated by tuatua, accounting for between 48.2% and 84.9% of the assemblages. The next most common taxon was cat's eye accounting for between 8.9% and 39.6% of the assemblages, while tuangi accounted for between 1.1% and 11.9%. In Phase 10 tuatua and cat's eye accounted for 48.1% and 47.5% respectively of the assemblage (Table 6.3). Many taxa in all Phases are only represented by one or two individuals – these are considered to be a bycatch, with tuatua, tuangi and cat's eye the main target species. The high numbers of smooth slipper shell (*Maoricrypta monoxyla*) in Phases 4 and 5 are certainly bycatch – these small shells are usually found attached to larger gastropods and would provide no meaningful quantities of food.

This distribution of shellfish is typical for a site located on an open sandy shore – shellfish are generally gathered from the local environment and tuatua would have been the prevalent local species, easily gathered at low tide. Cat's eye would have been gathered from the rocks at either end of Long Bay.

Biodiversity statistics

Biodiversity statistics for shell are shown in Table 6.4. The statistics are calculated for all taxa including non-economic species. These are included as they demonstrate that, while certain species were preferentially targeted, harvesting methods took in other species. In other words, non-economic species can inform us about human-environment interactions and harvesting strategies. An argument could also be made for including only economic species and examining more closely the intentions of the occupants as opposed to outcomes. Of the 30 taxa identified, 28 were found in Phase 4, which also had the highest overall MNI, although many more contexts were analysed from Phase 4 than from other Phases (Figure 6.1). This is emphasised when richness is calculated using Margalev's and Menhinick's indices which partly compensate for lower MNIs, where Phases 5 and 7 become the richest assemblages respectively (discounting Phase 12) – in fact using Menhinick's index Phase 4 is the least rich assemblage (Table 6.4). Phases 1 and 5 have fairly high numbers of taxa, but fairly low MNIs, and Margalev's index is high for them. This seems intuitively more accurate – if these assemblages were sampled until they had MNIs of 27,000, then many more taxa might be expected to be identified

MNIs have been discussed already, where it was noted that tuatua dominated the assemblages, often accounting for more than 50% of the total, with cat's eye and tuangi accounting for most of the rest. The Berger–Parker index 1/d for all Phases, apart from Phases 5 and 10, is less than 2, in other words the most abundant species, in all cases tuatua, accounts for 50% or more

Table 6.3. All identified shell taxa by MNI for each Occupation Phase. Non-economic species are separated out by size.

	Phase					
	1	4	5	7	10	12
Gastropods						
Bluish top shell (*Diloma nigerrima*)		2	1			
Black nerite (*Nerita melanotragus*)	11	7	2		7	
Cat's eye (opercula*) (*Turbo smaragdus*)	201	2435	953	44	320	
Cook's turban (*Cookia sulcata*)	1	40	3			
Limpet (*Cellana* sp.)	16	20	11	1		
Ostrich foot (*Struthiolaria papulosa*)		9	9			
Siphon whelk (*Penion sulcatus*)	4	9		2	1	
Smooth ostrich foot (*Pelicaria vermis*)	11	19	1		1	
Spotted top shell (*Melagraphia aethiops*)	8	117	21	1		
Swollen trumpet (*Argobuccinum pustulosum*)	15	31	6	1	2	
Trumpet (Ranellidae sp.)		14				
White rock shell (*Dicathais orbita*)	3	18	2			1
Bivavles						
Dog cockle (*Tucetona laticostata*)		1	1			
Dog's foot cockle (*Cardita aoteana*)		1				
Dosinia (*Dosinia* sp.)	2	1	2			
Frilled venus (*Bassina yatei*)		1				
Mussel (Mytilidae sp.)	10	63	8		1	
Oblong venus (*Ruditapes largillierti*)					1	
Pipi (*Paphies australis*)	1	419	20		6	
Rock oyster (*Saccostrea glomerata*)	7	100	16	5		1
Scallop (*Pecten novaezealandiae*)		2	1			
Tuangi (*Austrovenus stutchburyi*)	57	302	79	32	3	7
Tuatua (*Paphies subtriangulata*)	1046	23,252	1159	179	324	21
Non-economic gastropods						
Circular slipper shell (*Sigapatella novaezealandiae*)		11	2			
Horn shell (*Zeacumantus subcarinatus*)	1	3				
Lined whelk (*Buccinulum vittatum*)	1	7	2			
Ribbed slipper shell (*Maoricrypta costata*)	1	23			1	
Smooth slipper shell (*Maoricrypta monoxyla*)	33	451	104	3	7	
Turret shell (*Maoricolpus roseus*)	3	41	2			
MNI	1432	27,399	2405	268	674	30

* except in Phase 1

of the assemblage NISP in these Phases. In Phases 5 and 10 tuatua is still the most common species, with significant amounts of cat's eye.

Simpson's 1/D ranges from 1.37 to 2.55, indicating that the assemblages are not particularly diverse, dominated by tuatua with smaller but occasionally significant numbers of secondary species (cat's eye and tuangi). Phase 5 is the most diverse assemblage and is not particularly even by Simpson's measures, indicating that more secondary species were significantly represented in the assemblage, again primarily cat's eye and tuangi.

The structure of the assemblages can also be represented graphically. Figure 6.2 shows rank / abundance or Whittaker plots (Magurran 2004: 22) for shellfish from Phases 1, 4 and 5, the three assemblages where $S \geq 20$. The y axis is plotted on a $\log_{10}$ scale in order to allow taxa with very low numbers to be represented, shown as a percentage of the total. The plot for Phase

Table 6.4. Biodiversity statistics for shell from each cultural Phase.

Phase	MNI	S	Menhinick's D_{Mn}	Margalev's D_{Mg}	Berger-Parker 1/d	Simpson's 1/D	Simpson's $E_{1/D}$
1	1432	20	0.53	6.34	1.37	1.80	0.09
4	27,399	28	0.17	6.31	1.18	1.37	0.05
5	2405	23	0.47	6.8	2.08	2.55	0.11
7	268	9	0.55	3.71	1.5	2.06	0.23
10	674	12	0.46	4.24	2.08	2.19	0.18
12	30	4	0.73	2.71	1.43	1.88	0.47

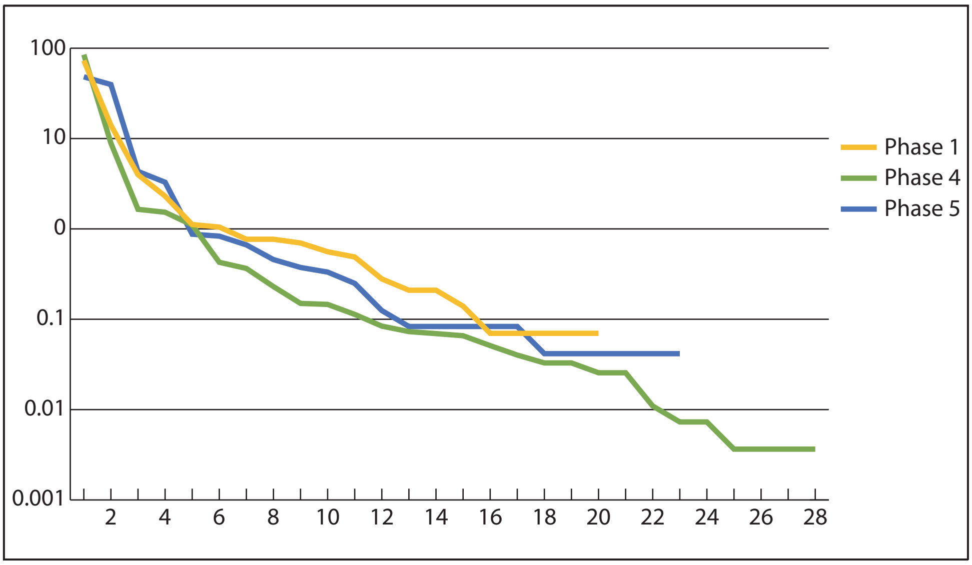

Figure 6.2. Rank / abundance plots (Whittaker plots) for shellfish from Phases 1, 4 and 5. The y axis shows the relative abundance of taxa (plotted on a log_{10} scale) while the x axis ranks the taxa in rank order abundance for each assemblage.

4 in particular begins very steeply before levelling off and then falling away for the least common species; this shape is referred to as log normal (Magurran 2004: 22). It might indicate that the Phase 4 assemblage contains a representative sample of the local environment despite the 'sampling methodology' used to gather the sample, i.e., pre-European Māori food gathering, probably being quite different to the sampling methods employed by ecologists. It also indicates that the Phase 4 shell assemblage has been sampled to redundancy, i.e., that all species present have been identified, or close to it.

Environment

The shellfish were collected from a variety of environments which can be classified along two axes: substrate and tidal depth. Substrate was classified into four simple zones, following Morley (2004) and Powell (1976): rocky, sandy, soft, and soft/sandy. Seven tidal depth zones

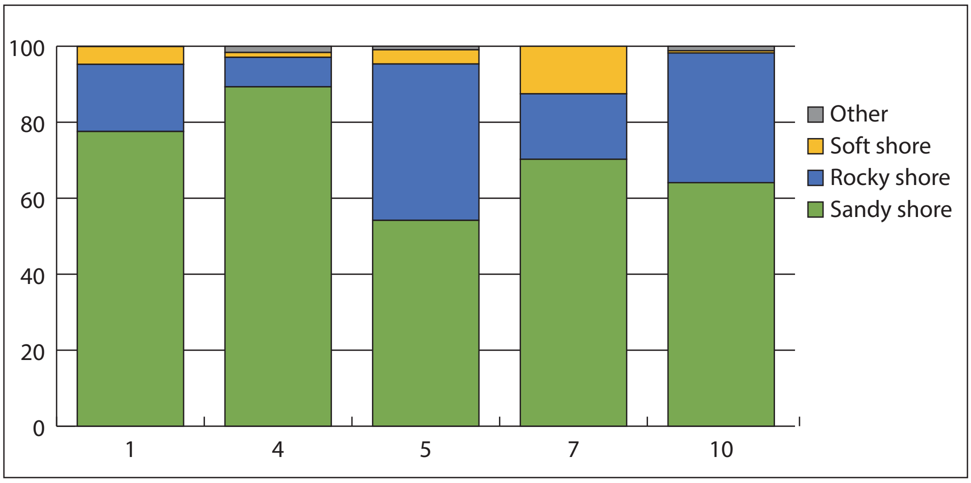

Figure 6.3. Proportions of rocky shore and soft shore shellfish (MNI) by Phase.

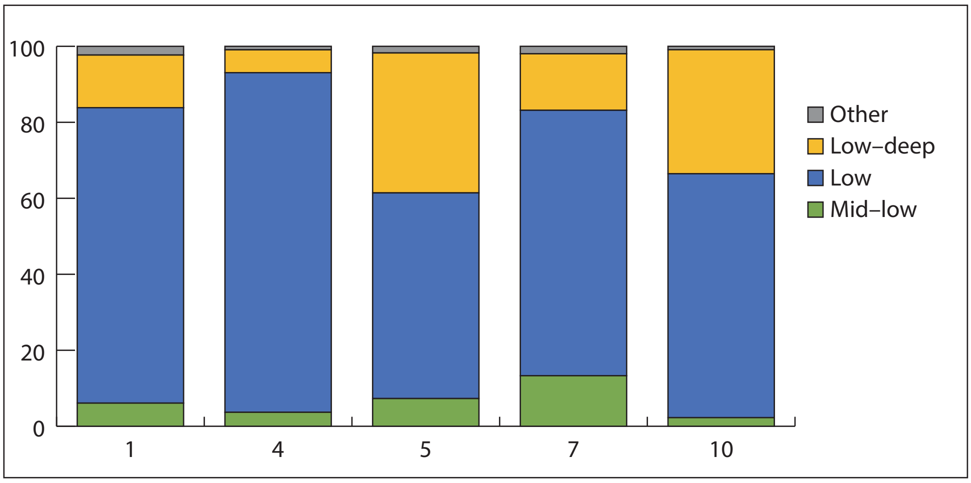

Figure 6.4. Proportions of tidal depth of shellfish (MNI) by Phase.

were also recognised, again following Morley (2004) and Powell (1976): deep, low to deep, low, mid to low, mid, mid to high, and high. All these zones, apart from deep, are intertidal zones.

The results are dominated by sandy shore and low tide species because of the dominance of tuatua in all phases. However, in Phases 5 and 10 there is an increased rocky shore, low to deep tide species, mostly cats' eye, with a significant fraction of soft shore mid to low tide species in Phase 7, mostly tuangi. People were focussed primarily but not exclusively on the sandy shore, while collecting was carried out at low tide.

Gastropod opercula

Several species of gastropod identified on site have opercula, but only three of these were identified during analysis: cat's eye, black nerita (*Nerita atramentosa*), and Cook's turban (Table 6.5). Only two Cook's turban opercula were identified but shell was present in all Phases except Phase 12 (though only as undiagnostic residue in Phases 7 and 10) with an MNI of 40 in Phase 4. On the other hand, cat's eye opercula were more common than shells in all Phases except Phase 1. There are two possible primary explanations for these patterns: taphonomic factors such

Table 6.5. MNI of shell and opercula of three gastropod taxa by Phase.

	Cat's eye		Cook's turban			Black nerita	
Phase	shell	opercula	shell	opercula	fishhook points	shell	opercula
1	201	145	1		1	11	8
4	548	2435	40	1	11	7	4
5	614	953	3	1	2	2	2
7	29	44	*			3	
10	6	320	*		4	7	

* undiagnostic residue only

as trampling, chemical weathering or burning, that can differentially destroy shell or opercula; or human factors that result in differential transport of shell or opercula.

Cook's turban is made up of a nacreous (mother-of-pearl) interior and a prismatic exterior with a relatively high organic content. As this organic content decays, for instance due to burning, or over time in a midden, the shell loses strength and as a result is often found fragmented and delaminating in archaeological assemblages, if it is identified at all. In that case more opercula would be expected than shells for this species, but this is not the case. Cook's turban shell may have been bought on site to manufacture fishhooks – 21 hook points were identified in the assemblage (these are also listed in Table 6.5), although no shell was identified as partly made hooks or manufacturing waste and the only possible manufacturing tool found was a small sandstone file from Phase 4.

In the case of cat's eye, it was noted that many opercula were burnt, though this was not quantified during analysis. It may be that shells were also burnt and so did not survive well, but it is also possible that cat's eye were processed off site and the flesh was removed and bought on site with the opercula still attached.

Summary

Shellfish were the most common faunal class by number – this analysis has not undertaken meat weight studies but it is probable that they contributed as much to the diet as fish, though they do not provide a full range of dietary requirements on their own. The most common taxon in all Phases was tuatua, although cat's eye was nearly as common in Phases 5 and 10, with tuangi also common, particularly in Phase 7. Shellfish were mostly collected from the adjacent beach (tuatua) but other environments were also exploited.

A comparison of the counts of gastropod opercula to bodies indicated that cat's eye may have been brought on to the site already processed, while Cook's turban may have been bought on site as industrial material.

Landsnails

Large numbers of landsnails were collected from several contexts, mostly from Phase 7. These were analysed by Bruce Marshall of Te Papa Tongarewa Museum of New Zealand and Jacqui Craig of CFG Heritage for environmental reconstruction. This analysis is discussed in Chapter 3.

Kina

The remains of kina (*Evechinus chloroticus*), including spines, shell fragments and teeth, were found in small numbers in several samples from Phases 1 and 4 in particular, with one sample each from Phases 7 and 10. These are not analysed any further.

Fish

Fish are generally the second most common faunal class found in New Zealand middens. They were an important component of pre-European Māori diets, providing several dietary components such as amino acids and Omega 3 oils that are not as readily available, or in the right proportions, in plants and shellfish (Leach 2006: 235). Māori developed sophisticated techniques to capture and preserve fish (Best 1977 [1929]).

Method

Fishbone analysis was undertaken by Matthew Campbell at CFG Heritage. Analysis followed the methodology outlined in Campbell (2016), adapted from the methodology developed by Anderson (1973) and Leach (1986). Each specimen was identified to the lowest possible taxonomic level. Bones identified were: for branchiocranial bones, the dentary, articular, quadrate, maxilla, premaxilla (the five mouthparts used by Anderson and Leach), palatine, hyomandibular, opercular, preopercular, ceratohyal and epihyal; for appendicular bones (that articulate the pectoral and pelvic fins) the supracleithrum, cleithrum and scapula; and for neurocranial bones the posttemporal, vomer and parasphenoid. In addition, the lachrymal was analysed for red gurnard (*Chelidonichthys kumu*), where it is highly diagnostic. Vertebrae were also identified, with the vertebral column divide into atlas (first vertebra), thoracic vertebrae, caudal vertebrae and urostyle (last vertebra). With the exception of the vomer, parasphenoid and vertebrae, which are unpaired bones, all bones were identified to side. For the Carangidae, scutes, bony scales along the lateral line of the fish, were also identified. Burning of bones was recorded.

Identifications were primarily undertaken using the comparative collection at CFG Heritage, with some additional identification using the collection at the Anthropology Department, University of Auckland. NISPs for each taxon by Phase, and total NISP by Phase, are given in Table 6.6, although conventional MNIs are also reported (Table 6.7) to allow comparison with other reported fishbone assemblages. MNIs are not discussed any further, except to note that only 12 taxa are recorded by MNI by the conventional method of Anderson and Leach, as opposed to 20 recorded following Campbell's (2016) methodology.

Results

Eighteen bony fish and two cartilaginous fish taxa were identified (Table 6.6); three stingray (whai, *Dasyatis* sp.) barbs were also found with Burial 2 and there are at least two and probably more bony fish taxa that remain unidentified, though these only occurred in low numbers. The following discussion counts all contexts in each Phase as a single assemblage. The most common taxon in all Phases by NISP was snapper (tāmure, *Chrysophrys auratus*)[2], account-

[2] formerly *Pagrus auratus*; following mitochondrial DNA analysis *Pagrus* is now restricted to the Mediterranean and Atlantic and *Chrysophrys* to Australasia and the northwest Pacific (Chiba et al. 2009; Roberts et al. 2015: 1288). Fish binomials in this report follow Roberts et al. (2015).

ing for 50% or more of NISP in most assemblages (Table 6.6), followed by gurnard (kumu, *Chelidonichthys kumu*) in Phases 1, 4, 5 and 7, and yellow-eyed mullet (aua, *Aldrichetta forsteri*) in Phases 10 and 12. Kahawai (*Arripis trutta*) was generally the next (fourth) most common species with the exception of Phase 7 where mackerel (hāture, *Trachurus* sp.), shark/ray (mango/whai, Chondrichthyes) and pilchard (mohimohi, *Sardinops sagax*) were more common. Only five taxa were found in all Phases, while other taxa were generally represented in low numbers.

Table 6.6. All identified fish taxa by NISP for each cultural Phase (3 stingray barbs were also found associated with Burial 2, from Phase 13).

	Phase					
	1	4	5	7	10	12
Barracouta (*Thyrsites atun*)	1	3		5		
Blue cod (*Parapercis colias*)	3	4	1		4	
Blue mackerel (*Scomber australasicus*)		31		2		
Blue maomao (*Scorpis violaceus*)		1				
Eagle ray (*Myliobatis tenuicaudatus*)		8				
Flounder (*Rhombosolea* sp.)			5			
Grey mullet (*Mugil cephalus*)		17				
Hāpuku (*Polyprion oxygeneios*)		2				
Kahawai (*Arripis trutta*)	22	151	29	2	10	10
Mackerel (*Trachurus* sp.)	3	42	6	136	5	6
Morwong (Cheilodactylidae)		3				
New Zealand sole (*Peltorhamphus novaezeelandiae*)		2				
Pilchard (*Sardinops sagax*)	1	2		38		6
Pink maomao (*Caprodon longimanus*)		1	1	1		
Red gurnard (*Chelidonichthys kumu*)	427	1061	67	166	111	82
Shark/ray (Chondrichthyes)		4		17	1	2
Snapper (*Chrysophrys auratus*)	686	2367	255	289	322	416
Trevally (*Pseudocaranx georgianus*)	1	52	1	2		
Wrasse (Labridae)		7	2	1	1	
Yellow-eyed mullet (*Aldrichetta forsteri*)	170	588	52	65	129	137
NISP	1314	4346	419	724	583	659

Table 6.7. All fish taxa by conventional MNI (Leach 1986; Campbell 2016) for each cultural Phase.

	Phase					
	1	4	5	7	10	12
Barracouta (*Thyrsites atun*)	1	1		1		
Blue cod (*Parapercis colias*)		1			1	
Blue mackerel (*Scomber australasicus*)		3		1		
Grey mullet (*Mugil cephalus*)		1				
Kahawai (*Arripis trutta*)	1	39	1			2
Mackerel (*Trachurus* sp.)	1	2		3	1	
Pink maomao (*Caprodon longimanus*)	1	7	1			1
Red gurnard (*Chelidonichthys kumu*)	5	18	3	3	2	4
Snapper (*Chrysophrys auratus*)	33	149	20	24	23	15
Trevally (*Pseudocaranx georgianus*)		2				
Wrasse (Labridae)		3	1	1	1	
Yellow-eyed mullet (*Aldrichetta forsteri*)						1
MNI	43	230	31	40	38	35

This distribution of taxa is fairly typical of New Zealand archaeological fishbone analyses; in the North Island assemblages are dominated by snapper in sites on embayments and by mackerel on more open coasts, while further south barracouta (mangā, *Thyrsites atun*) or red cod (hoka, *Pseudophycis bachus*) are dominant (Leach 2006; Campbell et al. 2009). The dominance of snapper at the Long Bay Restaurant site is typical, and the presence of gurnard and kahawai as the next most common species is also fairly typical. These species, along with many of the other taxa identified, are open water fish that could all have been caught with the types of hooks found during the excavation (Chapter 4). Some of the taxa identified, particularly yellow-eyed mullet and pilchard, are small fish with small mouths, and would not have been able to take a baited hook, which implies that they were netted although no net floats or sinkers were recovered from the excavation. Two flatfish taxa were identified in very low numbers from vertebrae: flounder (pātiki, *Rhombosolea* sp.) and New Zealand sole (pātikirori, *Peltorhamphus novaezeelandiae*). Flatfish are often caught with spears but it is likely that these few specimens were caught in nets. One artefact found in the excavation was identified as a bird spear (Chapter 4) and, while this may have been used for fishing, this seems unlikely. Eagle ray (whai repo, *Myliobatis tenuicaudatus*) and stingray may also have been speared but are equally likely to have been taken with baited hook. While some species will not take a baited hook, all the taxa represented can potentially be netted.

While the majority of taxa in the assemblages, and all the most common, are open sea fish, some are more usually restricted to reefs, particularly wrasses (pāwaiwhakarua / tāngāngā, Labridae sp.) while others such as pink maomao (mātā, *Caprodon longimanus*) and morwongs (Cheilodactylidae) commonly inhabit reefs.

In summary, the fish represented in the assemblages, in all Phases, were taken with baited hooks in open water, perhaps from canoes in the calm waters of the Hauraki Gulf but also from the beach, and with nets from the beach, while a few were taken with baited hooks on reefs, probably from the rocks at either end of the beach.

Element choice and sieve size

The numbers of fish that can be identified in any assemblage are dependent on the excavation and analysis methodologies chosen. As the Long Bay Restaurant site data shows, the apparent character of an assemblage can change when a fuller range of bones, including vertebrae, are analysed and reported as NISPs (Table 6.6) (Campbell 2016) compared to the restricted set of bones reported as MNIs of the conventional methodology (Table 6.7) (Anderson 1973; Leach 1986).

Although only a sample of the excavated material has been analysed, one advantage of the Long Bay Restaurant site excavations was the requirement of a 100% clearance strategy in order to recover all kōiwi. This meant all midden was sieved and all material caught in the screens, other than shell, was bagged. Mostly the midden was dry sieved though a 3 mm screen on site, and all bulk samples analysed were wet sieved through a 3 mm screen in the lab. However, a shortage of sieves meant that some material on site was sieved through 6 mm screen. All Phase 1 material was sieved though a 3 mm screen, but some Phase 4 material was sieved through 6 mm. While the material was not put through nested sieves (6 mm on top with 3 mm below) it is still possible to see how this sieving methodology affected the recovery of different species. Figure 6.5 shows the proportions of the main fish taxa in Phase 4. Most bones were recovered from the 3 mm screen, but roughly 20–35% for most taxa were retained in the 6 mm screen, except for yellow-eyed mullet. For this species, with small, fragile bones, only 4% of the bones were retained in the 6 mm screen.

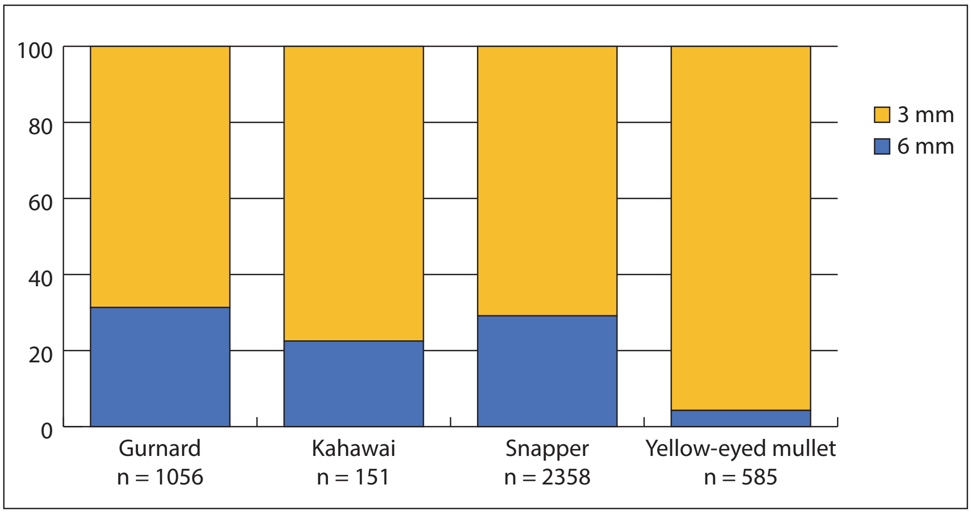

Figure 6.5. Proportions of bone recovered in 3 mm and 6 mm screens, Phase 4, for taxa where NISP > 100.

Yellow-eyed mullet has not regularly been recorded in New Zealand archaeological sites. Kupenga data supplied by Foss Leach lists two sites (Foxton S24/3 and Shag River Mouth J43/2) with a NISP of one each for yellow-eyed mullet. At the N.H.B. site (Q07/58) Nichol (1988: 139) recorded a NISP of 47 yellow-eyed mullet, and from the Sunde site (R10/25) he identified a NISP of 4031 yellow-eyed mullet, 4027 of them from vertebrae (R. Nichol 1988: 238). The N.H.B. site is located on the Whangarei Harbour while the Sunde site is located on Motutapu Island in the Hauraki Gulf, visible from Long Bay 16 km away. Interestingly, Allen (2014) did not record any yellow-eyed mullet at Harataonga Beach (T08/4 and T08/5) on the eastern, ocean side of Aotea / Great Barrier Island in the northern Hauraki Gulf, despite careful use of small screens. While there are few identifications of this species to date, the data so far indicates that they were caught in relatively calm and sheltered waters as opposed to high energy open coast, although this characterisation does not apply to Foxton or Shag River Mouth.

At the Long Bay Restaurant site a NISP of 1141 yellow-eyed mullet was identified, of which all but 19 were vertebrae. While small, these vertebrae are very distinctive, with the thoracic vertebrae having elaborate processes (neural spines and haemapophyses) and the caudal vertebrae having clearly rounded margins on the haemal canal posterior to the haemal spine. Vertebrae are clearly the most robust element of yellow-eyed mullet, as Nichol's data from the Sunde site also indicate.

A NISP of 47 pilchards was identified in all Phases, of which 14 were operculars and 4 preoperculars (Table 6.8). Pilchard operculars, though small, are relatively dense and have highly distinctive radiating striae (Figure 6.6). All but two of these bones were recovered from the 3 mm sieve. The herrings (Clupeiformes), the order to which pilchards belong, is the most commonly caught commercial fish by weight, and presumably by number, in the world (FAO 2016: 10). Figures published by the FAO show that between 2008 and 2014 herrings accounted for 20–26% of the world catch by weight. In some fisheries in 1982 herrings accounted for two thirds of the catch by weight (Whitehead 1985: 3). While this is unlikely to have been the case for pre-European Māori, pilchards may have been considerably more important than the archaeological record suggests. This may also be the case for other clupeids like sprats (kūpae, *Sprattus antipodum*) and anchovies (korowhāwhā, *Engraulis australis*) which, while they have not been identified in any New Zealand archaeological assemblages, have Māori names, indicating that

Table 6.8. Numbers of pilchard elements identified by Phase.

	Phase			
	1	4	7	12
Opercular		1	11	2
Preopercular			3	1
Cleithrum			1	
Vertebra	1	1	23	3
NISP	1	2	38	6

Figure 6.6. Pilchard opercular (left, medial and lateral view) and preopercular (right, medial and lateral view) from the Long Bay Restaurant site. The distinctive striae on the opercular are clearly visible.

Māori were familiar with them. The same is true for yellow-eyed mullet, and other small species that are both vulnerable to taphonomic processes and not regularly recorded when large screens are used or a limited range of bones is analysed.

A smaller screen will catch smaller bone. For snapper, which has large, robust bones, this is unlikely to make any substantial difference unless the site is located adjacent to a snapper nursery and juveniles are being caught, which isn't the case at the Long Bay Restaurant site. For smaller taxa, however, with smaller bones, this makes the difference between being recorded in often high numbers and not being recorded at all. Additionally, smaller bones are less likely to survive in archaeological contexts so that a combination of differential bone destruction through taphonomic processes and screen size has biased the archaeological record in favour of snapper dominating many northern assemblages (see also Allen 2014: 34). This is not to deny the importance of snapper; snapper are still the most common species in the Long Bay Restaurant site assemblages and they are a larger fish by far than yellow-eyed mullet or pilchards, so they would have provided much more food, but species such as yellow-eyed mullet and pilchards may have been much more important in pre-European Māori economies than simple counts of NISP suggest.

Some samples were also sieved though a 2 mm screen. While there didn't seem to be any noticeable difference in the numbers of cranial bones recovered, there were noticeably more very small vertebrae in the 2 mm screen samples. Many of these bones were from unidentified taxa, but there were also very small vertebrae from identified taxa such as yellow-eyed mullet, mackerel and particularly pilchard. Bone from the 2 mm fraction took much longer to sort and it is questionable whether the extra effort provides a proportionate return – it would certainly not be economic to put all samples though such a fine screen but it is instructive to do so with a small subsample.

Biodiversity statistics

The biodiversity statistics discussed above are shown in Table 6.9. Of the 20 taxa identified, 19 were found in Phase 4, which also had the highest overall NISP, although many more contexts were analysed from Phase 4 than from other Phases (Figure 6.1).

Using Margalev's index, Phase 4 remains the richest assemblage (Table 6.6) but it is interesting to note that using Menhinick's index the richest assemblages are Phases 5 and 7, which have fairly high numbers of taxa, but fairly low NISPs. This seems intuitively more accurate – if these assemblages were sampled until they had NISPs of 4000, then many more taxa might be expected to be identified, and they may not yet have been sampled to redundancy. When an attempt is made to correct for sample size, in general it seems that Phases 4, 5 and 7 could be regarded as containing the richest assemblages.

NISPs have been discussed already, where it was noted that snapper dominated the assemblages, usually accounting for more than 50% of the total, with gurnard, yellow-eyed mullet and kahawai accounting for much of the rest. The Berger–Parker index 1/d for all Phases, apart from Phase 7, is less than 2, in other words the most abundant species (in all cases, snapper) accounts for 50% or more of the assemblage NISP.

Apart from Phase 7, Simpson's 1/D ranges from 2.19 to 2.66, indicating that most of the assemblages are equally, though not very, diverse, dominated by snapper with smaller but significant numbers of secondary species (gurnard, yellow-eyed mullet and kahawai). In Phase 7, 1/D is 3.88, indicating a greater diversity in this assemblage, with mackerel, pilchard and shark / ray (vertebrae) also important taxa. This confirms that the Phase 7 assemblage stands out as having different taxa from other assemblages, in different proportional abundances. Because secondary species are present in higher proportional abundances, it is also the most even, measured as Simpson's $E_{1/D}$ – although Phases 10 and 12 are roughly as even, $S < 10$ for these assemblages, and it seems probable that Simpsons' $E_{1/D}$ is sensitive to S when S is low.

Table 6.9. Biodiversity statistics for fish from each cultural Phase.

Phase	MNI	S	Menhinick's D_{Mn}	Margalev's D_{Mg}	Berger-Parker 1/d	Simpson's 1/D	Simpson's $E_{1/D}$
1	1314	9	2.89	0.25	1.92	2.53	0.28
4	4346	19	5.22	0.29	1.84	2.66	0.14
5	419	10	3.81	0.49	1.64	2.41	0.24
7	724	12	4.2	0.45	2.51	3.88	0.32
10	583	8	2.89	0.33	1.81	2.57	0.32
12	659	7	2.48	0.27	1.58	2.19	0.31

The structure of the assemblages can also be represented graphically. Figure 6.7 shows rank / abundance or Whittaker plots (Magurran 2004: 22) for Phases 4, 5 and 7, the three assemblages where S ≥ 10. The y axis is plotted on a $\log_{10}$ scale in order to allow taxa with very low numbers to be represented, shown as a percentage of the total. The plot for Phase 4 has a

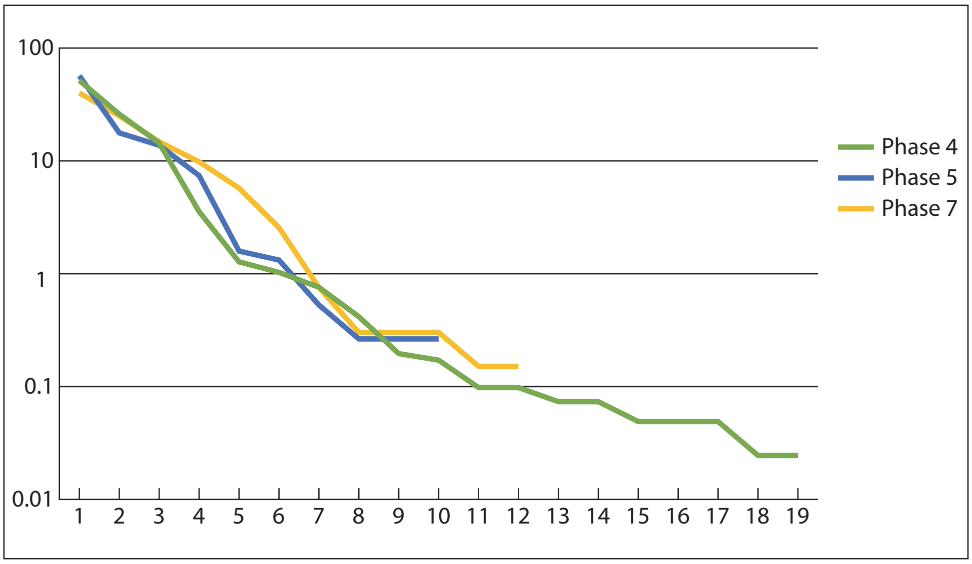

Figure 6.7. Rank / abundance plots (Whittaker plot) for fish from Phases 4, 5 and 7. The y axis shows the relative abundance of taxa (plotted on a $\log_{10}$ scale) while the x axis charts the taxa in rank order abundance for each assemblage.

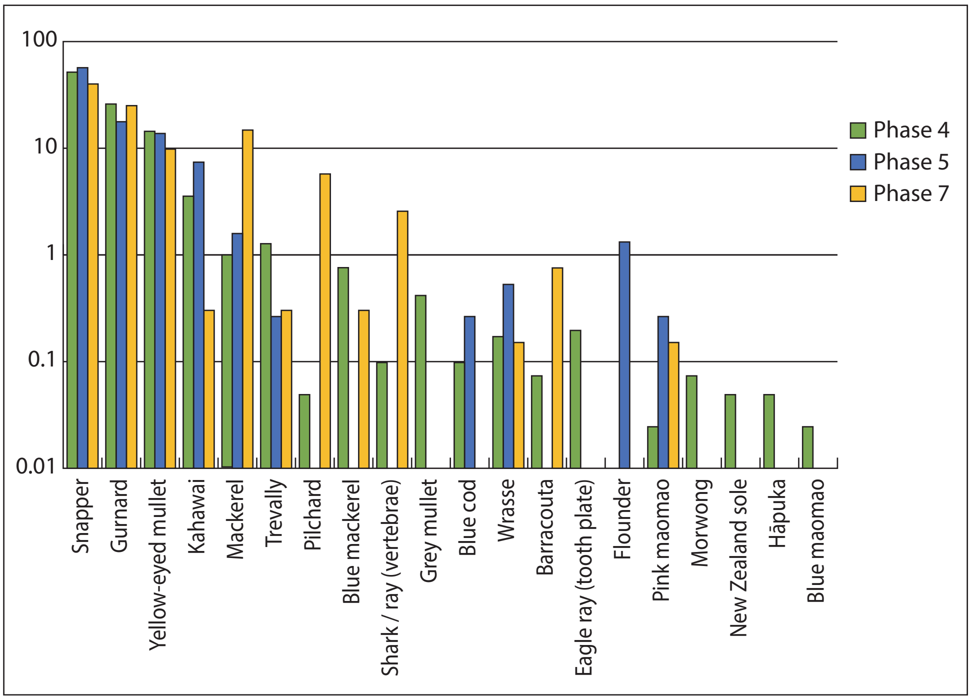

Figure 6.8. Rank / abundance chart for fish from Phases 4, 5 and 7. The y axis shows the relative abundance of taxa (plotted on a $\log_{10}$ scale) while the x axis charts the taxa in rank order abundance for all assemblages combined.

steeper slope, which indicates the dominance of the most common taxon (snapper). For Phase 7 the slope is shallower, indicating the higher proportional abundances of other taxa. This is also shown in Figure 6.8, which charts the abundances of each taxon. The higher proportional abundance of mackerel, pilchard and shark / ray in Phase 7 is made clear, while the presence of flounder in Phase 5 is highlighted (in the case of pink maomao, the NISP for each assemblage is 1 (Table 6.6), but their proportional contribution to the total NISP for each assemblage is different).

In general, the assemblages are equally rich and diverse, particularly when assemblage size is accounted for. The main exception is Phase 7 where snapper counts are, relative to the other Phases, low, accounting for 40% of the assemblage (1/d = 2.50) and the assemblage is the most diverse and, where S > 10, the most even (1/D = 3.88; $E_{1/D}$ = 0.32). As has been noted, the main species, except for kahawai, are all abundant in Phase 7 and mackerel, pilchard and shark / ray (vertebrae) are also more common than in other Phases. Phase 1, though it has a high NISP, has low richness and low diversity – snapper and gurnard between them account for 83.4% of the NISP. Almost all the fish in Phase 1 could be caught by baited hook and netting seems to have been a minor component, resulting in a not very rich or diverse, but quite even assemblage. In Phase 4 a much larger proportion of the assemblage was probably caught in nets so that more minor species are represented resulting in a rich, somewhat diverse but uneven assemblage. It is notable, however, that only one shell fishhook was found in Phase 1, while 11 shell hooks were found in Phase 4, and no net floats or sinkers were found in any Phase.

Taphonomy

Taphonomy is the study of the factors that affect the survival of bones into the archaeological record. These can include capture and processing techniques that will determine what bones will be brought to the site in the first place; butchery, cooking, consumption and disposal practices on site; factors such as exposure on the surface or chemical destruction in the ground that affect the bone once it is deposited; and the choices of archaeologists on how to sample and record the assemblages (see discussion of sieve sizes, above).

A simple way to examine taphonomic processes such as surface weathering, chemical or microbiological dissolution, abrasion or trampling, generally referred to as weathering, is to look at the survivorship profiles of fishbone (Campbell 2005). The seven most common bones of snapper, the most common fish species and the most robust, were selected: premaxilla, quadrate, articular, palatine, dentary, maxilla and scapula. It is a reasonable assumption that the bones that survive best will be the most robust. These were then charted for each Phase by %MAU, which takes the number of each bone and recalculates numbers as percentages, with the most common being assigned a score of 100%. The results are shown in Figure 6.9. Some elements, in this case premaxilla and quadrate, survive better than others, in this case maxilla and scapula (the relevant bones will be different for other species). The more premaxillas that have survived compared to scapulas, shown as the steepness of the change from left to right of the chart, the more weathering can be assumed to have affected the bone (on the reasonable assumption that premaxillas and scapulas were deposited in roughly the same numbers in the first place). Figure 6.9 shows the greatest difference in Phases 5 and 7, with least common bone surviving at only 10–14% of the rate of the most common – scapulas have been destroyed at a much greater rate than premaxillas. Conversely, Phases 1, 4 and 12 are much less weathered. Despite the indication that more bone has been destroyed by weathering in Phase 7, Phase 7 was the most diverse assemblage and contained most of the fine pilchard bones. This further reinforces the argument that pilchard may have been more important than raw numbers suggest, particularly in Phase 7.

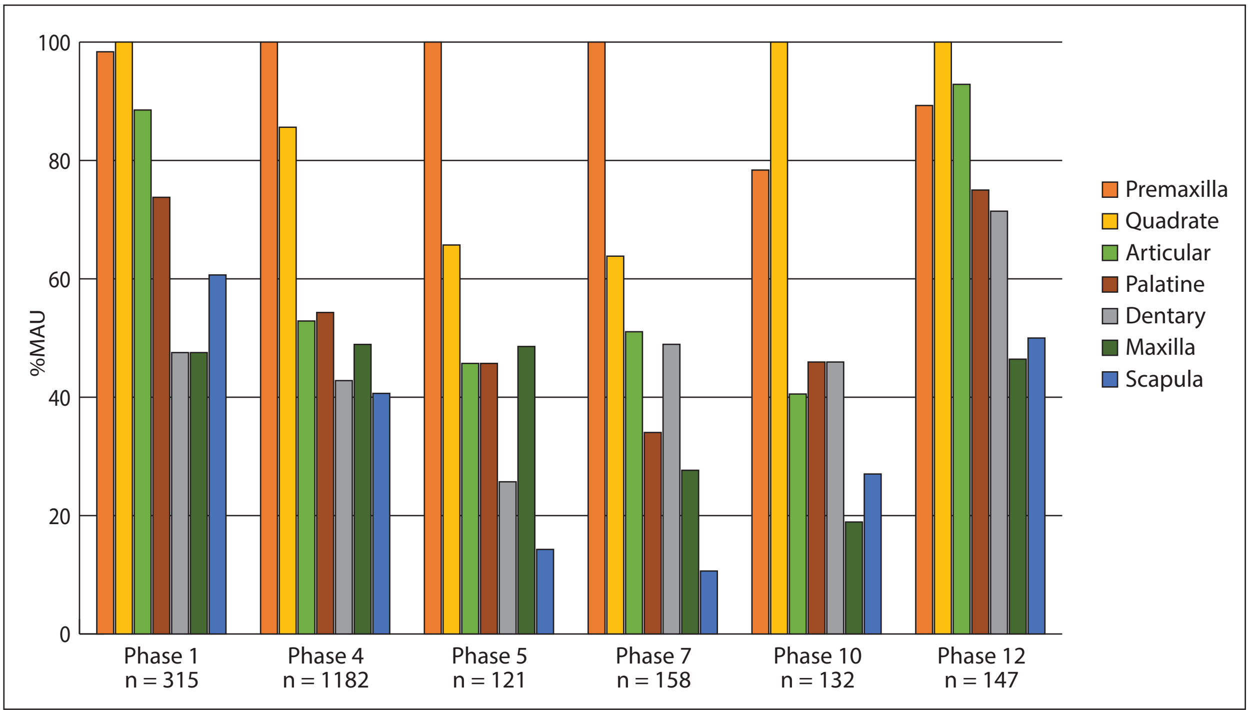

Figure 6.9. Survivorship profiles for snapper from each phase (%MAU).

Qualitative burning classes were recorded for all identified bones, based on colour changes that could reasonably be ascribed to burning – very light burning may result in yellowing of bone that is indistinguishable from natural staining from the soil matrix, and bone that has been cooked will also have been subject to heat without necessarily changing its colour. Bone burning here is assumed to be the result of direct contact with flames or embers. Bones were classified as: 'calcined' where they had been burnt blue-white, which indicates either high heat or a long duration of heating, or both, and complete destruction of organic materials; 'burnt' when they were black, indicating relatively high heat but incomplete combustion of organic materials; or 'scorched' where they were only lightly burnt to a light brown or grey-brown colour, indicating exposure to low heat (Lyman 1994). In practice, these classes are subjective categories that tend to blend into one another.

Table 6.10 shows burning classes for all contexts for which fishbone was analysed; %burnt is a simple burning score for the bone, calculated by adding the NISPs from all three burning categories together and calculating the percentage of bone burnt for each assemblage. In general, there was more burnt fishbone in firescoops (8.2–54.8%, where NISP > 30) than in undifferentiated midden layers (0.5–10.4%). While this might be expected, it supports the conclusions drawn from the analysis of the bulk samples, that the material excavated from the firescoops was not raked out but left in situ, while the general midden is not composed of burnt, raked out material. Middens result from a buildup of waste from another, not necessarily unrelated, activity, probably the consumption and dumping of food cooked on the fires, while waste may have been disposed of in firescoops as the fires burnt down at the end of the day.

Burning was more commonly recorded on generally larger species with more robust bone, i.e., kahawai, snapper, gurnard and trevally (Table 6.11). In the case of mackerel and yellow-eyed mullet only a few bones were burnt while none were burnt at all for blue mackerel and pilchard. In general, large robust bones (of moa, seal or kurī, for instance) would be expected to survive

Table 6.10. Burning of fishbone by context.

Phase	Context	Type	Unburnt	Calcined	Burnt	Scorched	NISP	%burnt
1	55	Layer	456	3	20	4	483	5.6
1	98	Fire scoop	605	59	74	56	794	23.8
1	103	Fire scoop	31		10	2	43	27.9
4	7	Layer	3008	29	107	57	3201	6
4	44	Fire scoop		4	3		7	100
4	54	Fire scoop	1				1	
4	61	Fire scoop	11				11	
4	62	Fire scoop	91	1	8		100	9
4	63	Fire scoop	2				2	
4	91	Fire scoop	67	3	2	1	73	8.2
4	92	Fire scoop	14			1	15	6.7
4	94	Fire scoop	72	3	5	1	81	11.1
4	95	Fire scoop	10	2	3	4	19	47.4
4	96	Fire scoop	204	16	30	12	262	22.1
4	97	Fire scoop	160	3	13	30	206	22.3
4	99	Fire scoop	28	18	7	9	62	54.8
4	104	Fire scoop	62	16	22	8	108	42.6
4	105	Fire scoop	41	5	8	5	59	30.5
4	109	Fire scoop	43	1	3		47	8.5
4	110	Fire scoop	98	47	33	12	190	48.4
4	121	Fire scoop	13		2		15	13.3
4	122	Fire scoop	1				1	
4	123	Fire scoop	63	12	13	10	98	35.7
5	50	Layer	199	1	14	8	222	10.4
5	52	Fire scoop	130	40	22	10	202	35.6
7	17	Layer	899	15	9	3	926	2.9
10	16	Layer	141	1			142	0.7
10	40	Fire scoop	297	80	46	27	450	34
12	20	Layer	658		3		661	0.5

Table 6.11. Burning by taxon, all Phases combined for all taxa where NISP > 30.

Taxon	Unburnt	Calcined	Burnt	Scorched	NISP	%burnt
Gurnard	1567	120	126	101	1914	18.1
Snapper	3659	230	313	136	4338	15.7
Kahawai	210	3	4	7	224	6.3
Trevally	53		3		56	5.4
Yellow-eyed mullet	1119	2	5	15	1141	1.9
Mackerel	195		3		198	1.5
Blue mackerel	33				33	0
Pilchard	47				47	0

taphonomic processes better than small bones of fish. Within fish, snapper has the most robust bones of any of the taxa analysed, while yellow-eyed mullet and pilchard bones are small and thin, and are more easily destroyed by taphonomic factors such as trampling, chemical weathering or burning. For these reason, smaller taxa are underrepresented in the assemblages and the actual numbers in which they were exploited by pre-European Māori was probably much higher.

Fifty-seven coprolite (fossilised faeces) samples were found ranging across all Phases. Although these have not been analysed, it is assumed that they are kurī coprolites. Kurī, and to some degree kiore, are another taphonomic factor that affects fishbone assemblages, since kurī scavenge on middens and will eat fish remains. Byrne (1973) analysed kurī coprolites from several sites in the North Island and found small quantities of bird bone, and larger quantities of fish teeth, vertebrae (often quite whole), jaw bones, spines and scales. Many of the fragments could be identified as snapper. Where size reconstructions could be undertaken, snapper sizes were small, indicating that if the kurī were scavenging middens, they were avoiding larger fish. He suggested they may also have been fed fish that were too small for humans to bother with, but given the numbers of small taxa identified at the Long Bay Restaurant site this seems unlikely to be the case here. The Long Bay Restaurant site coprolites are also likely to be full of partly crushed and partly digested fishbone. Phase 7 contained 36 of the 57 coprolite samples as well as a sizeable assemblage of kurī bone (see below), further reinforcing the exceptional survival of pilchard bone.

Summary

In all Phases at the Long Bay Restaurant site snapper was the most common fish, accounting for between 40 and 60% of the assemblages by number, while kahawai and gurnard were also common in most Phases. This is very much in line with expectations – snapper dominate most analysed fishbone assemblages in the upper North Island, particularly from sites with early dates like the Long Bay Restaurant site (Leach 2006). Somewhat more unusual is the high numbers of yellow-eyed mullet, present in all Phases and the second most common taxon in Phases 10 and 12 and the fourth most common in the other Phases. Other taxa (20 taxa were identified in total, with at least another two taxa not identified) were generally less common but there were reasonable numbers of mackerel in most Phases; blue mackerel, grey mullet and trevally in Phase 4; and pilchard in Phase 7. The identification of yellow-eyed mullet and pilchard is due to the use of 3 mm screens – yellow-eyed mullet are occasionally identified in New Zealand sites but the Long Bay Restaurant site is the first site at which pilchard have been identified (they have since been identified at R10/289, nearby, Trilford and Campbell 2018: 13).

Biodiversity statistics reinforce the impressions gained from looking at the raw NISPs. Most Phases are not very diverse, apart from Phase 7 which is also the most even assemblage where S > 10. Phases, 4, 5 and 7 were generally also the richest assemblages when NISP is taken into account.

Taphonomic factors will affect the richness and diversity of the identified assemblages. Burning was analysed for the Long Bay Restaurant site fish for two reasons. The first was to examine the differences between contexts, where it was concluded that the general midden was not derived from firescoop rakeout. The second was to look at the differential survival of fish taxa. Robust bones, particularly of snapper but also other large species, will survive burning, and other taphonomic processes, better than small, thin bones such as those from yellow-eyed mullet and pilchard. It is probable that these taxa were more important in pre-European Māori economics than raw NISPs suggest.

While fishhooks are common in the assemblages (Chapter 4), and the main taxa could all be taken with baited hook, taxa like grey and yellow-eyed mullet and pilchards would have been taken with nets.

Small bird

Small bird refers to all birds other than the extinct flightless moa (Dinornithiformes). Small bird remains are generally more common in early sites than late sites although 18th and 19th century European accounts emphasise bird in the Māori diet (Davidson 1984: 131). Small birds were probably never as important as fish and shellfish, but made an important contribution to the diet and represent exploitation of a wider variety of environments. Small birds may also have been caught as a source of decorative feathers.

Method

Analysis of small bird bone was undertaken by Tristan Russell and Karen Greig of Southern Pacific Archaeological Research, using the Otago Archaeological Laboratories reference collection. Each specimen was identified to the lowest possible taxonomic level, also recording element, side and portion. Taphonomic factors such as burning, cut marks, gnawing and weathering, were also recorded.

Results

A total of 19 species of bird were identified (Table 6.12) across all Phases. The following discussion counts all contexts in each phase as a single assemblage. Numbers are low in all Phases with the highest totals from Phase 7, and many taxa are represented by a single bone in each Phase. The most common species is the fluttering shearwater (pakaha, *Puffinus gavia*) with a NISP of 17 in Phase 7, though it is not found in other Phases. Tūī (*Prosthemadera novaeseelandiae*) is found in Phases 1, 5, 7 and 10, the only taxon that occurs in more than 2 Phases. Australasian shoveler (kuruwhengi, *Anas rhynchotis*) was only recovered from the matrix of a burial (Burial 15) and so is considered to have been disturbed out of context, while brown kiwi (*Apteryx australis*) only occurs in the disturbed upper demolition layer (Phase 14) and is also probably disturbed out of context. This layer contained the only non-native taxon – chicken (*Gallus gallus*).

Biodiversity statistics

The majority of bird bone, 219 of a total of 271 pieces, could not be identified to species level, though a few could be identified to genus – parakeet (*Cyanoramphus* sp.) and stilt (*Himantopus* sp.) – or family level – shag (Phalacrocoracidae). Bird not identified to species level is excluded from the discussion of biodiversity statistics. Of the 19 that were identified, 11 were found in Phase 7, which also had the highest total NISP at 34 (Table 6.14). In all other Phases numbers are small, often with only one instance of each species found. No meaningful biodiversity statistics can be calculated except for Phase 7 and so it is not possible to use these measures to compare Phases. The statistics show that bird exploitation in all Phases of occupation at the site was opportunistic rather than a deliberate hunting strategy. Given that many taxa are represented by a single bone, some of the material may have been collected as industrial bone, for instance, from beach wracks.

Table 6.12. All bird taxa by NISP for each Phase.

	Phase								
	1	4	5	7	9*	10	12	13*	14†
Australasian gannet (*Morus serrator*)		1							
Australasian shoveler (*Anas rhynchotis*)								1	
Broad-billed prion (*Pachyptila vittata*)	1								
Brown kiwi (*Apteryx australis*)									1
Cape petrel (*Daption capense*)		1							
Chicken (*Gallus gallus*)									1
Common diving petrel (*Pelecanoides urinatrix*)				1		1			
Fluttering shearwater (*Puffinus gavia*)				17					
Grey teal (*Anas gracilis*)				1					
Little shag (*Phalacrocorax melanoleucos*)				2					
Morepork (*Ninox novaeseelandiae*)		1		2					
Pied shag (*Phalacrocorax varius*)				2					
Pied stilt (*Himantopus himantopus*)		1		1					
Red-billed gull (*Larus novaehollandiae*)		1							
Red-crowned parakeet (*Cyanoramphus novaezelandiae*)				4					
Spotted shag (*Stictocarbo punctatus*)				1		1			
Tūī (*Prosthemadera novaeseelandiae*)	2		1	2		1			
Variable oystercatcher (*Haematopus unicolor*)	3								
Yellow-crowned parakeet (*Cyanoramphus auriceps*)				1					
Parakeet sp.				4		1			
Shag sp.		2		3					
Stilt sp.				1					
Bird sp.	14	64	4	71	1	46	2		9
NISP	20	71	5	113	1	50	2	1	11

* burial Phase
† disturbed upper demolition layer

Table 6.13. All bird taxa by MNI for each Phase.

	Phase						
	1	4	5	7	10	13*	14†
Australasian gannet (*Morus serrator*)		1					
Australasian shoveler (*Anas rhynchotis*)						1	
Broad-billed prion (*Pachyptila vittata)*	1						
Brown kiwi (*Apteryx australis*)							1
Cape petrel (*Daption capense*)		1					
Chicken (*Gallus gallus*)							1
Common diving petrel (*Pelecanoides urinatrix*)				1	1		
Fluttering shearwater (*Puffinus gavia*)				2			
Grey teal (*Anas gracilis*)				1			
Little shag (*Phalacrocorax melanoleucos)*				2			
Morepork (*Ninox novaeseelandiae*)		1		1			
Pied shag (*Phalacrocorax varius)*				1			
Pied stilt (*Himantopus himantopus)*		1		1			
Red-billed gull (*Larus novaehollandiae*)		1					
Red-crowned parakeet (*Cyanoramphus novaezelandiae*)				1			
Spotted shag (*Stictocarbo punctatus*)				1	1		
Tūī (*Prosthemadera novaeseelandiae*)	1		1	1	1		
Variable oystercatcher (*Haematopus unicolor*)	1						
Yellow-crowned parakeet (*Cyanoramphus auriceps*)				1			
MNI	3	5	1	13	3	1	2

* burial Phase
† disturbed upper demolition layer

Table 6.9. Biodiversity statistics for bird from each cultural Phase.

Phase	MNI	S	Menhinick's D_{Mn}	Margalev's D_{Mg}	Berger-Parker 1/d	Simpson's 1/D	Simpson's $E_{1/D}$
1	6	3	3.86	1.22	2	3.75	1.25
4	5	5	7.15	2.24	5		
5	1	1		1	1		
7	34	11	7.18	1.89	2	3.84	0.35
10	3	3	6.29	1.73	3		

Environment

The majority of identified small bird remains come from coastal (NISP = 40) and forest (NISP = 19) environments, with only one duck species from a general lowland environment (and another from Burial Phase 13), which could also be on the margins of coast or forest (Table 6.15) (Scofield and Stephenson 2013; Robertson et al. 2015). Given the coastal location of the site this is not surprising, but it also demonstrates the exploitation of a wider catchment.

Table 6.15. Primary environments from which small birds would have been taken for each cultural Phase.

	Phase				
	1	4	5	7	10
Coast	4	6		28	2
Forest	2	1	1	13	2
Lowland				1	
NISP	6	7	1	42	4

* burial Phase
† disturbed upper demolition layer

Taphonomy

The most commonly recorded taphonomic factor on bird bone was burning, recorded on 45 bones (Table 6.16). The majority of these were from bones that could not be identified to any lower taxonomic level (Bird sp.). Burnt bone from identified taxa was restricted to a single element from each of six species. Most of the bunt bone was from Phase 4. Bone was equally distributed through firescoops (25) and general midden matrix (20) in contrast to the observed pattern for fish bone, where most of the burnt bone was from firescoops (Table 6.10).

Table 6.16. Burning on bird bone from each cultural Phase.

	Phase				
	1	4	5	7	10
Broad-billed prion	1				
Fluttering shearwater				1	
Morepork		1			
Pied stilt		1			
Red-billed gull		1			
Tūī	1				
Bird sp.	2	28	1	3	5

Weathering was only seen on two unidentified bird bones from the general matrix of Phase 4 in square A10. These bones were probably exposed to the elements on the dune surface prior to incorporation into the midden matrix. It is probable therefore that they represent a lag deposit from Phase 1 that has blown out in this part of the site (Figure 3.2), but it is also possible that they were present naturally on the dune surface prior to the Phase 4 occupation.

Summary

While total numbers of small bird bones were relatively low (NISP = 274) and only 63 of the bones could be identified to any lower taxonomic level, the number of taxa identified was high, with 19 identified at species level. Many species were represented by a single bone. Phase 7 contained both the highest number of bone (NISP = 113, with 34 identified to family, genus or species) and the highest number of species at 11, but even here nine of these taxa were only represented by one or two bones. Birds were primarily taken from coastal environments but a significant proportion came from forest environments. Overall, the results suggest that birds were taken occasionally and opportunistically throughout the sequence of occupation, in contrast to the shellfish and fish remains which demonstrate a strategy of targeted resource exploitation.

Reptile

The only reptile found at the site was tuatara (*Sphenodon punctatus*). Tuatara is often found in small numbers in early sites but its role in subsistence economics has not been explored by archaeologists.

Method

Analysis of reptile bone was undertaken by Tristan Russell and Karen Greig of Southern Pacific Archaeological Research, using the Otago Archaeological Laboratories reference collection. Each specimen was identified to the lowest possible taxonomic level, also recording element, side and portion. Due to the low numbers of identified taxa, no biodiversity statistical analysis was undertaken.

Results

Of the 17 tuatara specimens, six were jaw bones (five dentaries and one maxilla), nine were vertebrae and two were limb bone shafts. The Phase 10 remains were found in a firescoop, (Feature 40) but the bones from Phases 1, 4 and 7 were found in the general midden matrix. No burning or other taphonomic factors were observed on any of the bones. The limited presence of tuatara across four Phases of occupation suggests that they were, like the small bird, exploited opportunistically. Alternatively, they may have been present naturally and incorporated into the midden through taphonomic processes.

Table 6.17. Identified reptile species by NISP for each cultural Phase.

	Phase			
	1	4	7	10
Tuatara (*Sphenodon punctatus*)	1	6	7	3

Mammal

Mammal in this context refers to land mammals, which in New Zealand archaeology are analysed separately from sea mammals (seals and whales). New Zealand's only native land mammals are two species of bat, so that mammals in pre-contact Māori archaeological contexts (other than human) are the kurī and kiore (Polynesian rat, *Rattus exulans*) that arrived with the first settlers around AD 1280–1320. The osteology of kurī and their role in economy and society has been well studied by archaeologists (Allo 1970; Clark 1995; Greig et al. 2018), the kiore less so though it has received some attention in the tropical Pacific (e.g., White et al. 2000) and ancient DNA (aDNA) studies have used the timing of kiore dispersal as a proxy for human settlement (Matisoo-Smith and Robbins 2009).

Method

Analysis of mammal bone was undertaken by Tristan Russell and Karen Greig of Southern Pacific Archaeological Research, using the Otago Archaeological Laboratories reference collection. Each specimen was identified to the lowest possible taxonomic level, also recording element, side and portion. When recording portion, landmark features on the bone were used where available. When no landmark features were present, general morphological zones were used to describe the portion of bone present. This method allows for accurate identification, and provides a conservative estimate of species abundance without over-estimating the presence of taxa (Lombacher et al. 2016). Taphonomic factors such as burning, cut marks, gnawing and weathering, were also recorded. Butchery cuts were described in relation to standard anatomical planes. Due to the low numbers of identified taxa, no biodiversity statistical analysis was undertaken.

Results

A total NISP of 467 mammal bones was recorded but several of these are from insecure contexts and are not discussed here. The NISP from secure contexts was 435, although 115 of these are from the disturbed upper layer Phase 14, including one rabbit (*Oryctolagus cuniculus*) and one sheep (*Ovis aries*) bone, and it is possible that the rat identified as kiore in Phase 14 may include some introduced European rats – ship rat (*R. rattus*) and Norway rat (*R. norvegicus*) – which are very difficult to distinguish from each other and from kiore. The following discussion counts all contexts in each Phase as a single assemblage. Kiore was the most common mammal taxon recovered, followed by kurī. Numerous mammal bones could not be identified to taxon due to their fragmentary nature, but these are almost certainly kurī – they are too large to be rat.

Two of the identified kurī bones from Phase 7 suggest the presence of a sub-adult; some cranial sutures are not fused and an axis vertebra is missing its epiphyseal plate.

Table 6.18. Identified mammal taxa by NISP for each Phase.

	Phase										
	1	3*	4	5	7	8†	9*	10	11†	12	14‡
Kurī (*Canis familiaris*)		1	48	14	20				6	2	8
Kiore (*Rattus exulans*)	1		13	1	108		1	15		2	88
Rabbit (*Oryctolagus cuniculus*)											1
Sheep (*Ovis aries*)											1
Mammal sp.	2		26	6	25	2	13	12		2	17
NISP	3	1	87	21	153	2	14	27	6	6	115

* burial Phase
† clean sand separating cultural Phases
‡ disturbed upper demolition layer

Table 6.19. Identified mammal species by MNI for each Phase.

	Phase									
	1	3*	4	5	7	9*	10	11†	12	14‡
Kurī (*Canis familiaris*)		1	1	1	1			1	1	1
Kiore (*Rattus exulans*)	1		2	1	5	1	2		1	2
Rabbit (*Oryctolagus cuniculus*)										1
Sheep (*Ovis aries*)										1
MNI	1	1	3	2	6	1	2	1	2	5

* burial Phase
† clean sand separating cultural Phases
‡ disturbed upper demolition layer

Taphonomy

Burning was not recorded on any kurī bone and on only five kiore bones from firescoop Feature 96 in Phase 4. Several unidentified mammal bones were burnt, including 3 from firescoop Feature 52 in Phase 5 and 6 from firescoop Feature 40 in Phase 10. Like the burnt fishbone, most burnt mammal bone was from firescoops, while burnt bird bone was roughly equally found in firescoops and midden matrices.

Weathering was observed on 27 mammal bones, of which 15 were fragments of unidentified mammal bone while the remaining 12 were kurī. Four bones were found in clean sand layers and many of the others were from squares and features in Phase 4 and 7 where the underlining cultural Phase, Phases 1 and 5 respectively, was not present, suggesting that they represent lag deposits incorporated into subsequent occupations (Figure 3.2).

Thirteen weathered mammal bone fragments were found in the grave cut of Burial 7 in Phase 9. The nature of the weathering suggested they had been digested rather than weathered on the exposed dune surface.

Table 6.20. Weathering on mammal bone from each Phase in which it was found.

	Phase				
	4	5	7	8*	11*
Kurī	2	1	7		2
Mammal sp.	13			2	
NISP	15	1	7	2	2

* clean sand separating cultural Phases

Body part representation

From Phase 4 and 5, the kurī elements identified were primarily cranial portions, vertebrae, ribs, and foot bones, with long bones completely absent. This may have implications for butchery patterns or waste disposal but the sample is quite small. Body part representation in Phase 7 was similar, but three long bones were also present (a right humerus, a left tibia and a left fibula). These three bones were all weathered suggesting that if they were a lag deposit from a previous Phase, in this case probably Phase 5, the proposed pattern of body part representation does not hold, and in fact it may be a result of the small sample size.

Summary

Kurī were the only domesticated animal successfully introduced to New Zealand by Polynesian colonists in the late 13th or early 14th century AD. Kurī bones are found throughout New Zealand in archaeological contexts, often as food refuse but also as an industrial material used to manufacture fish hooks and other items. Deliberate kurī burials have also been reported. Early European explorers noted the presence of free-ranging kurī in settlements, and kurī travelling with people overland and in waka. Kurī appear to have had a complex and variable relationship with people, as pets, village dogs and watch dogs, but also as a source of food and raw materials for the manufacture of clothing and other items. The kurī bones from the Long Bay Restaurant site are likely to represent the culling of village dogs for use as food.

Sea mammal

It is usual in New Zealand zooarchaeological analyses to separate sea mammal (seals and whales) from other mammals. Exploitation of native wild sea mammals represents different economic and social relationships than exploitation of introduced domestic dogs, and hunting pressures resulted in progressively shrinking distributions of seals in the pre-European period (Smith 2002).

Method

Analysis of sea mammal bone was undertaken by Tristan Russell and Karen Greig of Southern Pacific Archaeological Research, using the Otago Archaeological Laboratories reference collection. Each specimen was identified to the lowest possible taxonomic level, also recording element, side and portion. When recording portion for sea mammal, landmark features on the bone were used where available. When no landmark features were present, general morphological zones were used to describe the portion of bone present. This method allows for accurate identification, and provides a conservative estimate of species abundance without over-estimating the presence of taxa (Lombacher et al. 2016). Taphonomic factors such as burning, cut marks, gnawing and weathering, were also recorded. Butchery cuts were described in relation to standard anatomical planes. Due to the low numbers of identified taxa, no biodiversity statistical analysis was undertaken.

Results

In total, 16 sea mammal bones were recovered (Table 6.21). The following discussion counts all contexts in each Phase as a single assemblage. The only sea mammal species identified was fur seal (*Arctocephalus forsteri*), but two highly fragmented sterna were recovered, one from Phase 4 and one from the disturbed upper layer, Phase 14. This fragmented bone is also probably fur seal but the morphological similarities between fur seal and New Zealand sea lion (*Phocarctos* sp.)[3], particularly the sternum, made species-level identification impossible.

[3] Recent DNA and osteological analysis has shown that the sea lion endemic to mainland New Zealand (*Phocarctos* sp.) became extinct soon after human arrival and was replaced by subantarctic populations of genetically distinct *P. hookeri* (Collins et al. 2014). Reference to sea lion in this chapter is to this extinct lineage (Collins et al. do not refer to 'species').

Table 6.21. Identified sea mammal species by NISP for each Phase.

	Phase						
	1	4	6†	7	9*	10	14‡
Fur seal (*Arctocephalus forsteri*)	1	5	1	4	1	2	
Sea Mammal sp.		1					1
NISP	1	8	1	4	1	3	1

* burial Phase
† clean sand separating cultural Phases
‡ disturbed upper demolition layer

Table 6.22. Identified sea mammal species by MNI for each Phase.

	Phase					
	1	4	6†	7	9*	10
Fur seal (*Arctocephalus forsteri*)	1	1	1	1	1	1

* burial Phase
† clean sand separating cultural Phases

One right fur seal rib was recovered from the clean, windblown sand layer of Phase 6. No weathering or burning was recorded so it appears not to belong to a lag deposit from a previous occupation (see discussion below). It may have been deposited between periods of occupation or it may be disturbed out of its original context. One fur seal rib shaft fragment was found within the grave cut of Burial 13 (Burial Phase 9) and is assumed to have been disturbed out of its original context. Other than a single broken vertebra recovered from a Phase 4 firescoop, Feature 62, all other sea mammal bone was recovered from the midden matrix.

The size and robustness of an atlas vertebra from Phase 4 suggest this individual was a large adult male, while the epiphysis of a left metatarsal from Phase 7 was unfused, suggesting that this individual was a juvenile, or more probably, a sub-adult. The pre-human breeding ranges of fur seals and sea lions included all of the North Island but by AD 1500 the evidence suggests fur seals at least no longer bred north of about Marlborough (Smith 2002; Collins et al. 2013). The fur seal at the Long Bay Restaurant site would not therefore have come from breeding colonies but non-breeding colonies would probably have continued to be present, and exploited, in northern New Zealand during the period of the Long Bay Restaurant site occupation.

Taphonomy

Burning was recorded on the broken, unidentified sea mammal sternum from Phase 4. This may have contributed to its broken condition. Weathering was recorded on three bones: the fragmented, unidentified sea mammal sternum from the disturbed context of Phase 14; the broken vertebra from firescoop Feature 72 in Phase 4; and a rib from Square D3 in Phase 10. These bones probably represent lag deposits from previous phases (Figure 3.2), but it is also possible that these bones were present on the dune surface naturally.

One left femur from Phase 4 had clear transverse cut marks on the shaft, particularly the anterior and medial faces (Figure 6.10). These clearly indicate butchery of fur seal, so that while some seal may have been present on the dune naturally, others are evidence of the economic exploitation of seal. It does not necessarily indicate hunting; seal could as easily have been scavenged as hunted.

Palaeopathology

The two fur seal sternum portions from Phase 4 had visible lesions on them (Figure 6.11). It isn't clear what the origin of these lesions is, but they appear to indicate disease. They have been sampled for future aDNA analysis to test whether the lesions relate to tuberculosis. Fur seal sterna are made of several bones essentially similar in size and shape and it is likely that the two portions from Phase 4 are from a single individual.

Figure 6.10. Cut marks on the anterior face of fur seal femur from Phase 4.

Figure 6.11. Fur seal sternal fragment from Phase 4 with visible lesions.

Moa

Bones of the extinct moa (Dinornithiformes) are an important marker of early sites – moa were probably extinct by AD 1450 (Holdaway and Jacomb 2000). With the development of aDNA analysis there has been some doubt on the accuracy of moa species identification to low taxonomic levels on bone morphology alone (Bunce et al. 2003), but none of the moa bone recovered from the excavation could be identified to species or genus level.

Method

Analysis of moa bone was undertaken by Tristan Russell and Karen Greig of Southern Pacific Archaeological Research, using the Otago Archaeological Laboratories reference collection. Each specimen was identified to the lowest possible taxonomic level, also recording element, side and portion. Taphonomic factors such as burning, cut marks, gnawing and weathering, were also recorded. Due to the low numbers of identified taxa, no biodiversity statistical analysis was undertaken.

Results

Eight moa bones were identified, all fragments except a single complete phalanx. Due to the condition of the bone, as well as the elements and portions recovered, further identification to species level was not possible. Moa was recovered from two cultural phases (Table 6.23) with seven of the bones recovered from the general matrix of Phase 4, while the other was recovered from the matrix of a burial (Burial 15) and so is considered to have been disturbed out of context. All were weathered, suggesting exposure to the elements on the dune surface prior to incorporation into the midden matrix. It is probable therefore that they represent a lag deposit from either the underlying layers or from Phases of occupation that have not survived. The bones not from the burial were recovered from squares D7 (the single phalanx) and E3 (six fragments) and so may have originated in the Phase 1 occupation (Figure 3.2).

Any moa bone recovered from the site dates from very close to the period of its extinction proposed by Holdaway and Jacomb (2000). Given that moa was never as common in the North Island as in the South Island and was extirpated in the north earlier than in the south, the moa bone found may be natural in origin or, if cultural, may have been imported onto the site as sub fossil bone from an older kill, butchery or occupation site. The fragmentary and small scale nature of the remains provide no evidence regarding whether moa was bought on site as food or industrial material, but the latter seems most likely. Several moa bone artefacts were recovered from the site (Chapter 4), including three fishhooks and a trolling lure shank, but there was no evidence of moa bone working on site and the only abrader was recovered from Phase 7.

Table 6.23. Identified moa by NISP for each cultural Phase.

	Phase	
	3*	4
Moa (Dinornithiformes)	1	7

* burial phase

Discussion

Each Phase is briefly summarised here. While the six Phases were all occupied within a short timespan and probably by the same family group, no real trends are evident. The general pattern of animal exploitation fits within wider patterns of pre-European Māori occupation of the Hauraki Gulf and upper North Island generally, and this is discussed in greater detail in Chapter 8.

Phase 1

The Phase 1 layer was probably originally more extensive but had mostly blown out (at least, within the excavated area of the restaurant foundation) before the subsequent Phase 4 occupation (Figure 3.2). One large and three small firescoops were cut into the midden matrix, which was not particularly dense. Total shell MNI was not particularly high but 20 taxa were identified and Margalev's or Menhinnick's indices show that the assemblage was quite rich, though it was not very diverse or even, being dominated by tuatua (73%). The fishbone assemblage was not so rich but was more diverse with snapper dominating (48%) but significant numbers of gurnard (35%). Numbers for all other faunal classes were low.

Phase 4

Phase 4 was the most complex phase archaeologically, with numerous firescoops cut into the midden matrix. Phase 4 also contained the densest midden deposits, though density varied across the site. Consequently, more samples were analysed from Phase 4 and numbers of identified shellfish and fish are significantly higher, though interestingly bird and mammal numbers are both higher in Phase 7 than in other Phases. For shellfish and fish more taxa were identified in in Phase 4 than in any other Phase indicating a higher species richness but in each case when the high NISPs are controlled for, using Margalev's or Menhinnick's indices, other assemblages appear to be richer and if they were as heavily sampled as the Phase 4 assemblage the number of taxa is likely to be higher. Phase 4, on the other hand, has quite likely been sampled to redundancy.

Shellfish and fish diversity and evenness in Phase 4 were low because in each case the assemblages were dominated by a single taxon – tuatua (85%) for shellfish and snapper (52%) for fish. Numbers of other faunal classes (both NISP and S) were too low for any taxon to stand out as dominant – single examples of a few bird taxa, six tuatara bones and several kurī and kiore bones.

While fur seal is found throughout the sequence, numbers are higher in Phase 4, but overall numbers are low and it isn't feasible to propose that hunting pressures are responsible for the drop off in numbers – in fact hunting pressure on fur seals would have been most intense in the 14th century and seal numbers would have been low in the mid to late 15th century, and they would no longer have bred this far north (Smith 2002; Collins et al. 2013). Moa is found only in Phase 4, other than a single example in Burial Phase 3, but all moa bone is weathered indicating that it was exposed on the dune surface (Figure 33.2) and so probably originates in Phase 1. Given the dates of the site and the paucity of moa bone it isn't clear that these represent a cultural deposit, but if they do they are almost certainly sub-fossil bone.

Phase 5

Like Phase 1, the Phase 5 layer was probably originally more extensive but had mostly blown out before the subsequent Phase 7 occupation (Figure 3.2). Three large and one small firescoops were cut into the midden matrix, which was moderately dense. 10% of fishbone from the midden matrix was burnt. Total shell MNI was not particularly high but 23 taxa were identified, while total fish NISP was significantly lower than for Phases 1 and 4, and 10 taxa were identified. Margalev's and Menhinnick's indices show that both assemblages were quite rich, though not very diverse or even, being dominated by tuatua (48%) and snapper (57%). Few bones from other classes were identified with no reptile, mammal, sea mammal or moa.

Phase 7

The Phase 7 matrix was moderately dense and varied across the site and contained no firescoops, and notably few fishbones were burnt (Table 6.10). Total shell MNI was low and only 9 taxa were identified, although fish NISP was relatively high and 12 taxa were identified. Margalev's and Menhinnick's indices show that shell richness was low while fish richness was high. Tuatua (66%) dominated the shell assemblage while snapper (39%) was the most common fish with gurnard (24%) and mackerel (19%) contributing to the high diversity scores. Phase 7, along with Phase 5, was also the most weathered assemblage (Figure 6.9) but had 38 of the 47 pilchard bones identified from the site. It is certain that there were many more pilchards caught during the Phase 7 occupation than were identified. Phase 7 contained the most bird bone, with an identified NISP of 34 and S of 11. The bird assemblage was both rich and diverse but overall does not alter the interpretation that in all phases bird exploitation was opportunistic. Phase 7 also contained the highest reptile and mammal bone counts, though Phase 4 had more kurī, a few seals and no moa. Phase 7 stands out from the other assemblages as being the most diverse but at the same time, the most weathered by taphonomic processes.

Phase 10

The Phase 10 matrix was the least dense and contained two firescoops. Shell numbers, both MNI and S, were low and the assemblage was not rich, but cat's eye (47%) was almost as common as tuatua (48%) so the assemblage was relatively diverse and even. Fish numbers, both NISP and S, were also relatively low and the assemblage was dominated by snapper (53%) with low diversity and evenness. Numbers for other taxa were also low, with few bird and no kurī or moa.

Phase 12

The Phase 12 matrix was not dense and contained two firescoops. Only one sample was analysed so unsurprisingly shell numbers are low, but fish numbers are high, with a NISP of 627 and S of 7. The fish assemblage is neither rich nor diverse, being dominated by snapper (62%) to a greater extent than any other Phase. Numbers for other classes were low, with two unidentified bird bones and two each of kurī and kiore.

Summary

While shellfish and fish were consistently the most common taxa across all Phases – given the coastal location of the site this is to be expected – there were notable differences between Phases. The six occupations were all different even though they were so close in time. The excavation measured only 12 x 13 m and it is clear that much of the occupation evidence, for Phases 1 and 5 certainly, and probably for other Phases, has been destroyed by blow outs of the dune. Activities evident in one Phase of the excavation and not another, therefore, may have taken place in an unexcavated part of the site or in a part of the site that has not survived, but some general patterns are evident and would not be likely to change markedly if the excavation were extended.

Tuatua dominates all the shellfish assemblages, often with a significant proportion of cat's eye, indicating exploitation of both the adjacent sandy beach and the rocky headlands at either end of Long Bay. However, in some Phases, notably Phases 1, 10 and 12, the midden was quite sparse and shellfish numbers were consequently low. In other Phases the midden was denser, though variably across the site and never very dense, and in Phase 4 firescoops were numerous. In these Phases shellfish numbers are higher (though more samples were analysed from Phase 4), and consequently the assemblages are richer though not necessarily more diverse.

Snapper is the most common taxon in the fish assemblages, with other species such as kahawai, gurnard, mackerel and yellow-eyed mullet also common. Yellow-eyed mullet and pilchard are small species with fragile bones and are not often found in archaeological sites. Pilchard is particularly common in Phase 7, although this assemblage also appeared to be the most weathered. The fish in all Phases would have been caught with both baited hooks and nets, and fishing was undertaken deliberately and carefully.

In contrast, bird exploitation seems have been an opportunistic activity throughout the occupation of the site, with numerous taxa from both coastal and forest environments found but only ever in small numbers. If birds were only exploited opportunistically, the occupants were probably visiting the forest to collect other resources rather than specifically to hunt birds, though there is no good evidence of what these were from the archaeology of the site. Charcoal from forest conifers is present throughout the sequence, and forest broadleaves are found in Phase 1–7 (Chapter 3), but it is unlikely that people were visiting the forest solely to collect firewood. Landsnail analysis (Chapter 3) indicates that, in Phase 7 at least, they were bringing forest leaf litter back to the site (it is unclear why), which is also the Phase with the most bird bone, from both forest and coastal environments. Extended forest visits may result in more birds being captured, but exploitation is still opportunistic.

Other classes are only found in low numbers – kurī are the most common of these and both kurī and fur seal would have provided proportionally greater quantities of meat than fish and small birds, despite their low numbers. Similarly, although shellfish are by far the most common class by number, their contribution to the diet would not have been a high as their numbers suggest. On the other hand, fishbone, especially of cartilaginous fish (sharks and rays) and small species such as yellow-eyed mullet and pilchard, is differentially destroyed by taphonomic processes, such as being consumed by kurī, burning or weathering, and so fish would have made a greater contribution to the diet than their numbers suggest. However, there is no way to correct for the biases of taphonomy other than to note its influence on the assemblages.

As was noted at the start of this chapter, while animal protein was an important part of the diet, plant foods would probably have been a more significant component but very little evidence of this survives. The evidence of eating tough plant matter like bracken fern root is evident in the teeth of the kōiwi but no garden soils or kumara storage pits were excavated.

7 Kōiwi community report

This chapter presents a plain-language 'Community Report' describing the kōiwi that were uncovered at the site, the process of excavating them and the results of their analysis. It is intended that it is readily readable to a non-archaeological audience. Due to the sensitive nature of highly culturally significant kōiwi, this Community Report does not include photographs of the kōiwi, but instead provides drawings and diagrams (prepared by Andrew McAlister). The Community Report is a summary of the full technical osteological report (Volume 2). That volume will contain further detail and analysis that is intended to be comparable to other kōiwi reports, so that a broader understanding of these past people may be built. Volume 1 is made available on the web and may be freely distributed. Volume 2, which will contain photographs of the kōiwi, will not be made available on the web and will only be available on request, with the agreement of mana whenua.

The 25 burials at the Long Bay Restaurant site included men, women and children of all ages. Their skeletons showed examples of accidental and violent injury, a probable case of gout, an unusual case of calcified nodules in the throat and one case of widespread chronic infection, in addition to many of the common health problems that affected pre-industrial people, such as severe wear and tear of the teeth and joints. Their manner of burial indicates that burial was an ongoing process that could have multiple stages, but not everyone received the same treatment in death.

The kōiwi have been reburied in Long Bay Regional Park, not far from the site of discovery. All the remains were placed together in one large grave (with the exception of Kōiwi 1, who was reburied prior to the rest of the kōiwi being uncovered). The reburial was conducted with appropriate tikanga, as determined by representatives from Ngāti Manuhiri, Ngāti Whātua o Kaipara, Ngāti Maru, Ngāi Tai ki Tāmaki, Te Kawerau ā Maki, Ngāti Pāoa; and Ngāti Whātua o Ōrākei.

Excavating kōiwi

Burials and skeletal remains provide a direct, personal connection to the people of the past. They hold information about basic aspects of a person's identity and some of the things that affected their bodies during their lives. Through the process of 'reading' a skeleton we can gain some insight into who that person was – male or female, old or young, what individual traits they had and what activities, illnesses or injuries left their mark on the bones or teeth. Patterns across the group can give an understanding of what kind of life that population had, especially when considered with the archaeology of the wider site. By comparing some of these things between sites we can build up our understanding of pre-European Māori and changes they underwent over time.

Although this report often discusses the kōiwi as bones or skeletons in anatomical terms, it is not forgotten that these are the remains of people – individuals who deserve respectful consideration and treatment, and whose remains carry considerable significance for their descendants, the tangata whenua. Efforts were made to treat the bones gently and respectfully during excavation and recording.

Method

The general method of excavation of the site is outlined in Chapter 3 but the methods specific to kōiwi excavation and the examination and analysis of the burials are outlined here.

Excavation of the kōiwi

Excavation aimed to identify the original grave and to carefully remove all the soil filling it, while leaving the skeleton and grave edge intact. The nature of the loose, mobile sand made finding and following the grave edges somewhat difficult. All of the soil from the grave was sieved through a 3 mm screen so that all fine remains of bones, shell or any other items in the grave could be retained. Small wooden hand tools and brushes were used to uncover the skeletons. Once fully exposed, the position of the skeleton was recorded on paper recording sheets. The burial was photographed extensively during excavation and its location was recorded on a map of the site. When the kōiwi were ready for removal, they were lifted, placed in heavy paper bags – for cushioning and to allow slow drying – and were packed into woven baskets, pīkau kōiwi, that were provided by Ngāti Whātua o Ōrākei.

In addition to burials, there were also scattered fragments of human bone at the site. For this reason, all of the soil from the excavation was sieved. The excavation area was gridded into 1 m squares (Chapter 3) and all material was excavated and sieved by square, or by discrete feature, separating different layers within that square.

Once lifted from the ground, kōiwi were removed to a dedicated room in the park buildings, the wharemate, which was locked with access restricted. Here the kōiwi were further recorded and stored until the reburial took place. Nick Hawke of Ngāti Whātua o Ōrākei, mandated cultural monitor, conducted opening and closing karakia over this room and established tikanga for removing shoes before entry and washing hands on exit.

Examination of the kōiwi

Surfaces of the bones and bone fragments were gently brushed clean of sand so that features and any abnormal bone changes could be noted. All bone was catalogued in a digital datasheet, with each piece of bone given an individual identifying (HR) number. The remains were examined for indicators of age, sex, stature, ancestry and injury or ill-health. These features were described, measured, photographed and scored according to established standards (e.g., Buikstra and Ubelaker 1994) so that the information is comparable to other kōiwi analyses. Further detail regarding the methods and standards used is given in Volume 2.

Examination was limited to visual observation. At the end of the analysis, with the approval of the cultural monitor, some bones were taken to be radiographed at a facility in town, and returned to the wharemate that same day. The calcified nodules found with Kōiwi 2 were also taken in to the University of Auckland for micro CT scanning and XRF analysis. At the end of the excavation six were reburied but, with approval of mana whenua, four were retained for further chemical testing to aid diagnosis. This analysis is a separate project which is not yet complete and so is not reported here. All such analyses were only conducted after seeking approval from the cultural monitor.

Summary of burials

Twenty-three grave were discovered at the site, but two of these contained the remains of more than one person, so there were in fact 25 individuals represented in formal burials. The location within the site of each burial is shown in Figure 7.1. The burials included: 15 adults (6 female, 4 male or 'probable male' and 5 of unknown sex), 2 adolescents (both male), 3 children and 5 infants. Basic details of these individuals and their burial are summarised in Table 1.

In addition to these, there were also a number of scattered bones recovered from the excavation that were not in burials, although many of them would have originated from burials. Some of this bone had been disturbed by the construction of the restaurant building, but some of it had been disturbed during the pre-European Māori occupation of the site. When all the scattered bone is taken into account, the minimum number of individuals (MNI) represented at the site is 27 (15 adults, 3 adolescents, 3 children and 6 infants). The excavated bone could have come from more people than this, but it would take a minimum of 27 people to account for all the bone recovered.

The kōiwi were interred in at least three phases, as outlined in Chapter 3: Phase 3, where the burials were clearly overlain by Phase 4 features; Phase 9 where they were either overlain by Phase 10 midden or were at the same level and the graves contained the same fill as other Phase 9 burials; and Phase 13, which were located at a higher level and may represent more than one Phase of activity but the construction of the restaurants has obscured the stratigraphy at this level.

Individual Descriptions

This report begins by describing each individual burial. More detail of individuals, such as non-pathological skeletal traits, is given in Volume 2. Aspects of the group as a whole are then outlined at the end of the chapter.

Kōiwi 1
Phase 13

This was the first burial discovered at the site, in May 2013, when trenches were cut through the concrete foundation slab of the restaurant building. The bones were directly below the black polythene plastic sheeting that the concrete had been poured onto (Figure 7.2). The trench uncovered the skull and neck vertebrae of the child.

The development of the teeth and bones indicates that the child was about 5–7 years old. The sex is unknown, since you cannot reliably tell the sex of a skeleton before the age of puberty. The child had been buried lying on its back, with the knees folded up over the chest. The hands were laid across the chest and the ankles were crossed and had probably been tied together – otherwise they would have fallen apart from each other. The toes were pulled up towards the body, which suggests the toes either sat against the grave or were restrained by some encasing material such as cords or a mat.

There were black scorch marks on some of the lower leg and foot bones, which – judging by their position – appear to have occurred after burial and so were probably the result of a later fire over part of the grave and not necessarily connected to the burial practice.

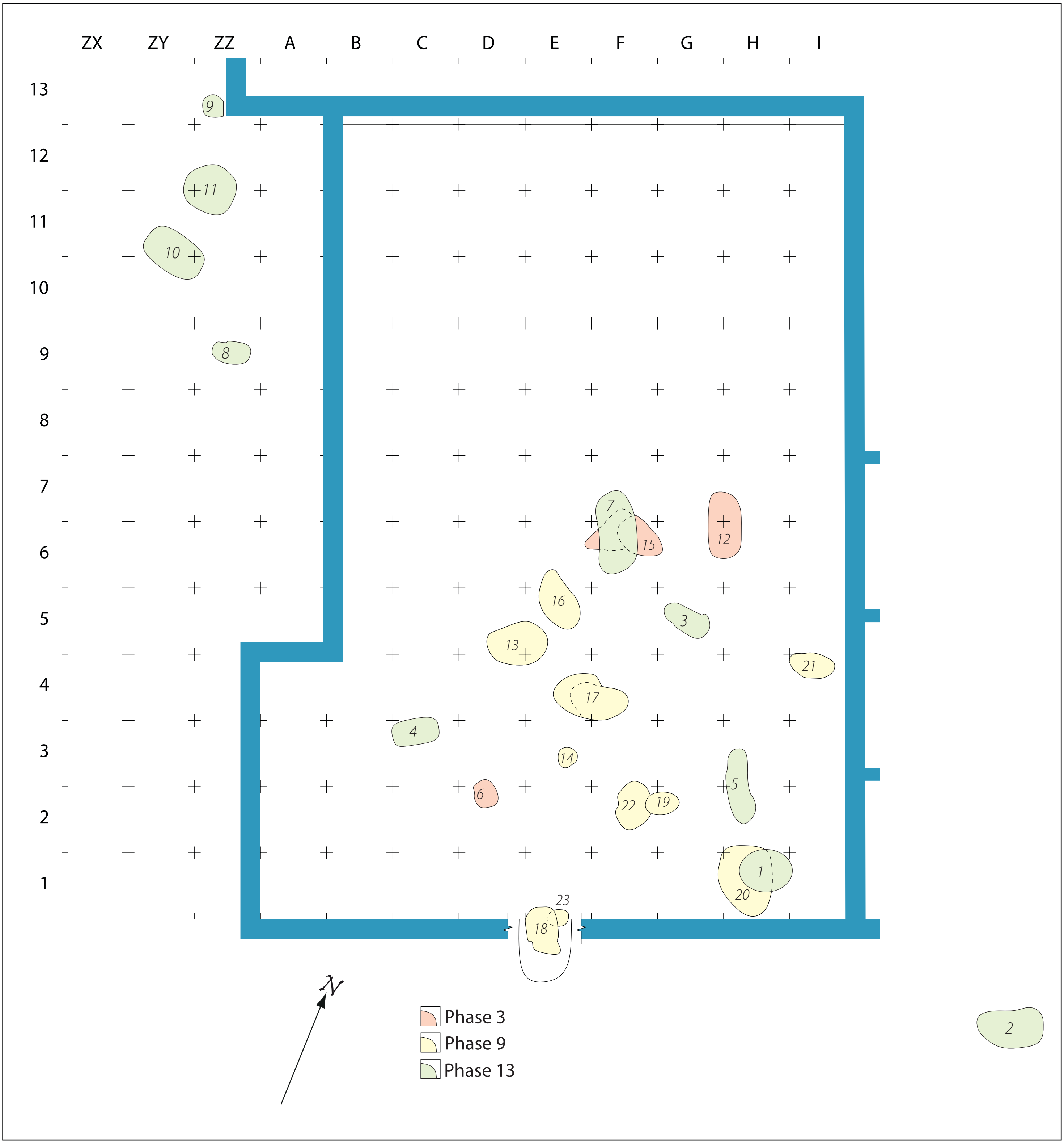

Figure 7.1. Plan of all burials by Phase. The location of Burial 1 is approximate only.

Table 7.1. Summary of burials and individuals at the Long Bay site.

Number	Context	Phase	Completeness (approx.)	Age	Sex	Burial Type	Articulation	Orientation Head	Orientation Face	Stature estimate (cm) [Bone, max. length (mm)]	Position	Artefacts	Notes
1	-	13	100%	Child (5–7 yrs)	U	Primary	articulated	SE	–	n/a	Flexed, on back	–	
2	1	13	100%	Mid Adult	F	Primary	articulated	W	N	165 ± 2 [Fem., 435]	Flexed, on left side	–	Sting ray spines found in torso – unworked. Ossified nodules by neck.
3	18	13	50%	Infant (11–16 months)	U	Disturbed	partially articulated	n/a	n/a	n/a	Disturbed	*Antalis* beads	
4	33	13	100%	Mid Adult (30–45)	F	Primary	articulated	SW	N	156 ± 2 [Fem., 392]	Flexed, on left side	–	Single unworked bird bone on the base of the grave
5	27	13	100%	Young Adult (18–25)	F	Primary	articulated	SSW	NE	157 ± 2 [Fem., 395]	Part flexed, on right side	Bird bone awls	
6	31	3	100%	Infant (18 mo–2.5 yrs)	U	Primary	articulated	NW	E	n/a	Loosely flexed, on left, head propped up	–	One obsidian flake in grave fill
7	34	13	25%	Adult	U	Revisited	disar-ticulated	n/a	n/a	n/a	n/a	–	One obsidian flake in grave fill
8	35	13	25%	Child (4-5)	U	Disturbed	partially articulated	n/a	n/a	n/a	n/a	–	
9	45	13	<25%	Infant (ca. 18 mo–4 yrs)	U	Disturbed		n/a	n/a	n/a	n/a	–	
10	56	13	100%	Adolescent (17–22)	M?	Primary	articulated	SE	N	171 ± 2 [Fem., 441]	Flexed, on back	–	Vertebra of another individual on base of grave
11	67	13	100%	Adolescent (15–18)	M	Primary	articulated	E	SE		Flexed, on back	–	
12	84	3	100%	Young Adult (25-35)	M	Primary	articulated	NW	SSE	178 ± 2 [Fem., 472]	Flexed, on right side	–	

Table 7.1. continued.

Number	Context	Phase	Completeness (approx.)	Age	Sex	Burial Type	Articulation	Orientation Head	Orientation Face	Stature estimate (cm) [Bone, max. length (mm)]	Position	Artefacts	Notes
13	73	9	100%	Older adult (50-60)	F	Primary	articulated	NW	n/a	166 ± 2 [Fem., 436]	Flexed, upright, on right side	–	
14	74	9	100%	Infant (6–9 mo)	U	Primary	articulated	E	W	n/a	Flexed, upright, on left side	–	
15A	83	3	25%	Adult	U	Revisited	disar-ticulated, some articulated elements	n/a	n/a	170 ± 1.4 (male) 176 ± 1.4 (female) [Fib., 366.5]	n/a	–	One obsidian flake in grave fill
15B	83	3	<25%	Adult	U	Revisited	disar-ticulated	n/a	n/a	n/a	n/a	–	Potentially related to burial 7
16	75	9	50%	Mid Adult (35–45)	M?	Revisited	partially articulated	n/a	n/a	176 ±2.05 [Rad., 265]	n/a	–	Grave oriented SE–NW
17	74	9	50%	Mid Adult (35–45)	M	Revisited	partially articulated	n/a	n/a	n/a	n/a	–	grave oriented SE-NW
18	86	9	100%	Mid–older Adult (40-60+)	F	Primary	articulated	E	N	157± 2 [Fem., 396]	Flexed, on right side	–	
19	90	9	100%	Infant	U	Primary (birth–2 mo)	articulated	NE	S		partially flexed, on left side	3 chert and 1 obsidian flakes by left leg	
20A	82	9	<25%	Adult	U	Revisited	disar-ticulated, some articulated elements	n/a	n/a	n/a	n/a	–	Grave oriented SE–NW

Table 7.1. continued.

Number	Context	Phase	Completeness (approx.)	Age	Sex	Burial Type	Articulation	Orientation Head	Orientation Face	Stature estimate (cm) [Bone, max. length (mm)]	Position	Artefacts	Notes
20B	82	9	<25%	Adult	U	Revisited	disar-ticulated, some articulated elements	n/a	n/a	n/a	n/a	–	Grave oriented SE–NW
21	93	9	~90%	Mid Adult (30–50)	F	Primary	articulated	SW	N	161 ± 2 [Fem., 414]	flexed, on back	–	
22	124	9	100%	Young Adult (25–35)	M?	Primary	articulated	NW	n/a	171 ± 2 [Fem. 441]	flexed, upright	–	
23	125	n/a	100%	Infant (birth–2 mo)	U	Primary	articulated	NE	SW	n/a	flexed, on back	–	

M = male, M? = probable male, U = sex unknown, F? = probable female, F = female.
Fem. = femur, Fib. = fibula, Rad. = radius.

Figure 7.2. Location of Kōiwi 1 in the south east corner of the base of the restaurant building in July 2013.

The child's teeth had quite heavy wear, which had removed the surface of the enamel of the crown in many places. This suggests a tough diet that was either gritty or fibrous and which had worn down the teeth, as is typically seen in pre-European Māori kōiwi.

The child had suffered a heavy blow to the head, which had left a fracture and an indentation and was probably the cause of death. The fracture was at the top left of the skull, where an oval segment of bone had been broken away. This had occurred when the bone was fresh, that is, either while the child was still alive or very soon after death. Next to this break was a small (11 x 5 mm) oval indentation in the skull. This may have been made by the same force as that which broke the bone, or a separate blow. It cannot be said with certainty whether this blow to the skull was a result of violence or an accident, though the former appears likely, especially in light of finding of similar skull fractures in two other women at the site (Kōiwi 2 and 5).

Kōiwi 1 was discovered and investigated prior to the main 2015–2016 excavation. In 2014 it was reburied at an urupā near Piha and is therefore not reburied with the others.

Kōiwi 2
Phase 13

This burial was uncovered in November 2014, when the refurbishment of the restaurant had resumed after the delay initiated by the discovery of Kōiwi 1. Part of the skull was disturbed by the digger, though the rest of the body was in place and undisturbed.

Features of the skull and pelvis showed that this was the skeleton of a woman who was probably her 40s or 50s. The shallow grave was roughly oval and appeared to have been dug just large enough to contain the flexed body. The woman had been placed in the grave lying on her left side with her lower legs tightly drawn up towards her torso (Figure 7.3). Both arms were bent and the hands rested on either side of the jaw. The shoulders were hunched up tightly, which suggests that they had been restricted – either by binding or encasing with some material or by the confines of a narrow grave. The knees and ankles were together, with one leg stacked on the other. Modern disturbance to the burial had caused disconnection between the ankles and the rest of the foot bones.

The grave included three unmodified stingray (whai, *Dasyatis* sp.) spines in the area of the chest cavity, by the middle ribs on each side (the position of one is shown in Figure 7.3). It is not clear whether these were deliberate or incidental inclusions in the grave.

The woman's skeleton had several abnormalities that resulted from disease or injury. Like Kōiwi 1, there was evidence of suffering a heavy blow to the skull around the time of death, which almost certainly killed her. This left a hole in the left side of the skull and the blow was so forceful that it also fractured the base and back of the skull and the left side of the mandible. There is no sign of any healing on these injuries. Three ribs and one of the shoulder blades also had unhealed fractures, and another two ribs had broken earlier but had time to heal before death. This suggests both an old injury during life and probably violence when she died.

Her teeth were severely worn; many had entirely lost the enamel of the crown, leaving only root stumps to chew on. Some of her molars were worn on steep angles in a manner that is

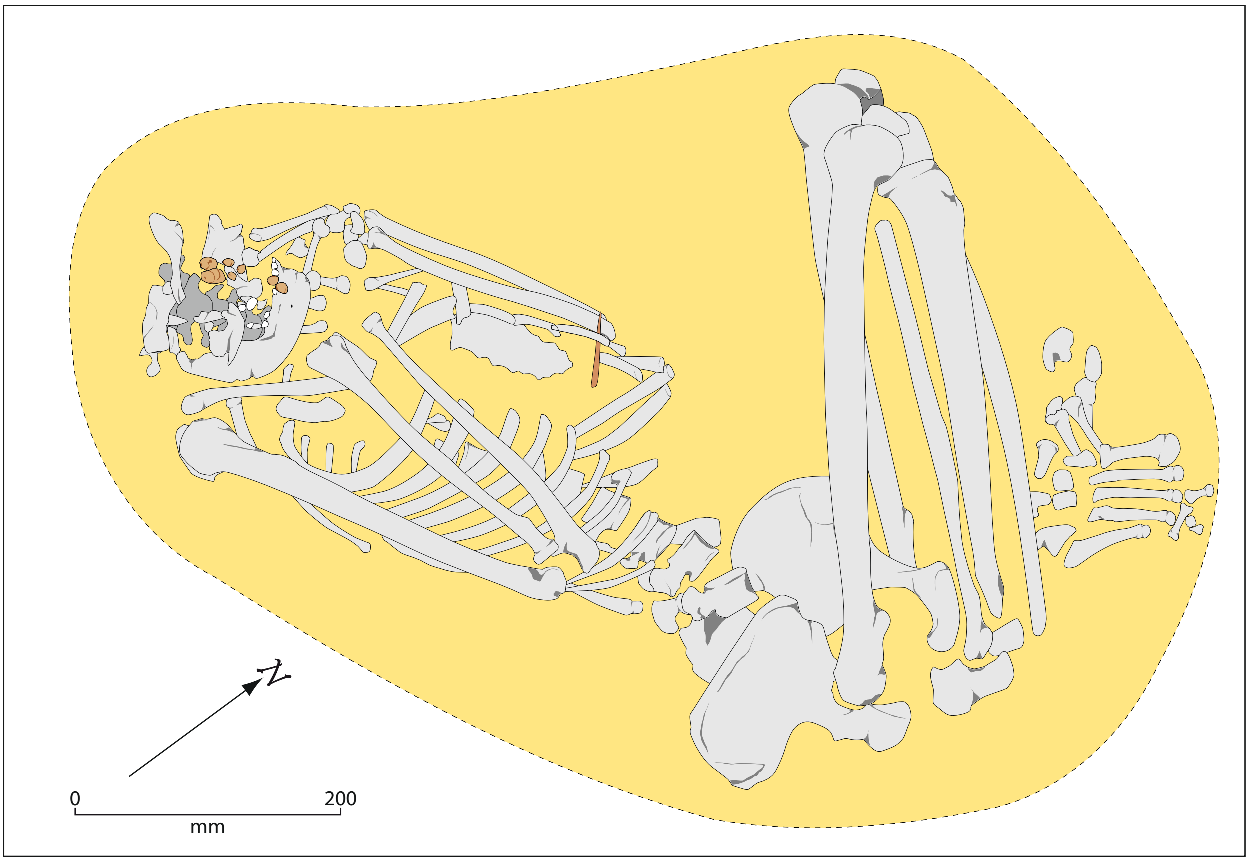

Figure 7.3. Kōiwi 2.

referred to as 'fern root plane', a distinctive wear commonly seen in pre-European Māori that is probably from chewing the fibrous bracken fern root, aruhe (*Pteridium esculentum*) (Taylor 1963). She also had chips in three of her teeth, a result of either hard matter in her diet or use of the teeth as tools. Poor dental health had left her jaw vulnerable to infection and this caused small hollows in the bone beneath the sockets of three molars.

A group of 10 nodules of hard, bone-like matter were found in the front of the throat area where they formed a roughly linear arrangement on the right side of the neck, between the second to sixth neck vertebrae. The largest measured 24.6 x 19.1 x 8.4 mm and the smallest 6 x 3 x 3.4 mm (Figure 7.4). Approval was given by mana whenua representatives to have the nodules taken off site temporarily for X-ray and CT scanning, and for some nodules to be kept aside for radiocarbon dating and destructive testing. Four nodules were selected to be retained for testing and the remaining six nodules were reburied with the kōiwi. X-ray and CT scanning showed that the nodules were a conglomerate of small dense granules within an outer shell. One was radiocarbon dated to cal AD 1520–1670, meaning the woman lived and died during the later phases of the occupation of the site, later than Phase 12, the most recent undisturbed Phase (Chapter 3).

Calcified nodules such as these are a very rare find. The nodules indicate that the woman had chronic disease that had caused the precipitation of granules which had prompted the body to react by encapsulating them into these nodules. Calcifications most commonly result from infection (including dental and respiratory infection), neoplasms (abnormal growths including cancers), tuberculosis and sarcoidosis (an inflammatory disease). There were no signs of tuberculosis in the rest of the skeleton, and sarcoidosis tends to produce calcified nodes in other parts of the skeleton, so these two diseases are unlikely to have been the origin. There was evidence of dental infection, with healing abscesses in the mandible. It is possible that infection was intro-

Figure 7.4. The group of calcified nodules found at the front of the throat of Kōiwi 2.

duced into her blood stream from dental disease, and that this caused inflammation and then calcification of the lymph nodes. While this appears the most likely cause at present, further testing is planned that will allow for other diagnoses to be examined.

The woman had a hollowed-out lesion in the big toe joint of her right foot that was probably a result of gout. Gout is a painful condition of the joints and has been related to a diet that is heavy in certain kinds of proteins, though the genetic factor to its cause is increasingly being recognised. Modern Māori have some of the highest rates of gout worldwide and findings of gout in pre-European Māori are assisting with better understanding the history and causes of this disease among Māori (Pinhasi and Bourbou 2008; Gosling et al. 2014a; 2014b).

It is common to find examples of severe arthritis in pre-European Māori, particularly older individuals, and this woman was no exception. She had severe joint degeneration in some bones in both feet, where the joint cartilage had degraded to the point where bone was rubbing against bone, causing polishing (eburnation). Polishing was also noted in a specific point in the left hand (MC2 and MC3 facing articular facets) and suggests repetitive movement of the hand/fingers that did not affect the wrist or thumb. She also had marked destruction of the bone in her knees. Arthritis and degeneration had been affecting her lower spine, where mechanical strain had caused polishing, and grooving and bone growth around the mobile joints at the back of the lumbar spine. Milder joint degeneration was also noted in her shoulders, ribs, elbow, wrist and hips.

Kōiwi 3
Phase 13

This was probably originally a complete burial of an infant though later activities had disturbed it, leaving only a concentration of bones surrounded by a scatter of *Antalis* (see Footnote 1, Chapter 4) shell beads (Figure 7.5). Once the upper layer of more scattered bones and beads had been removed, groups of articulated remains were revealed: a portion of the articulated spine (lower thoracic and lumbar) and groups of partially articulated bones of the left hand and the left foot sat at the base of a small hollow.

The infant was about one year to 18 months old at death. There is no indication of ill health or injury on any of the bones, which were all in very good condition. Bones from head to foot were present, though the majority of the infant's skeleton was missing. There were no long bones of the limbs present and there was only a small portion of the skull and two teeth. The spine was nearly complete and the sacrum was present. There were portions of the shoulder blades, breastbone, five ribs and part of one side of the pelvis. Parts of both hands and both feet were present (Figure 7.6). This burial was probably disturbed by the building of the restaurant, though the fact that the limbs and majority of the skull were absent does bear some resemblance to other burials at the site that were only disturbed by pre-European activity, so this may also have been the origin of the disturbance.

The *Antalis* beads were found above and below the infant's bones, indicating that the beads had surrounded the body at the time of burial. In one place a small group of beads appeared to have been laid out in parallel rows, which suggests the beads had been an ornament or garment of multiple beaded strands (Figure 4.4). Ornaments made of *Antalis* beads have been found in archaeological sites throughout the pre-European period. Both archaeological finds and early historic accounts document that strings of shell beads were used in necklaces, anklets, bracelets, belts and were woven into garments. The beads have been found as funereal offerings, in a number of cases with infants (Leach 1977). These items are discussed further in Chapter 4.

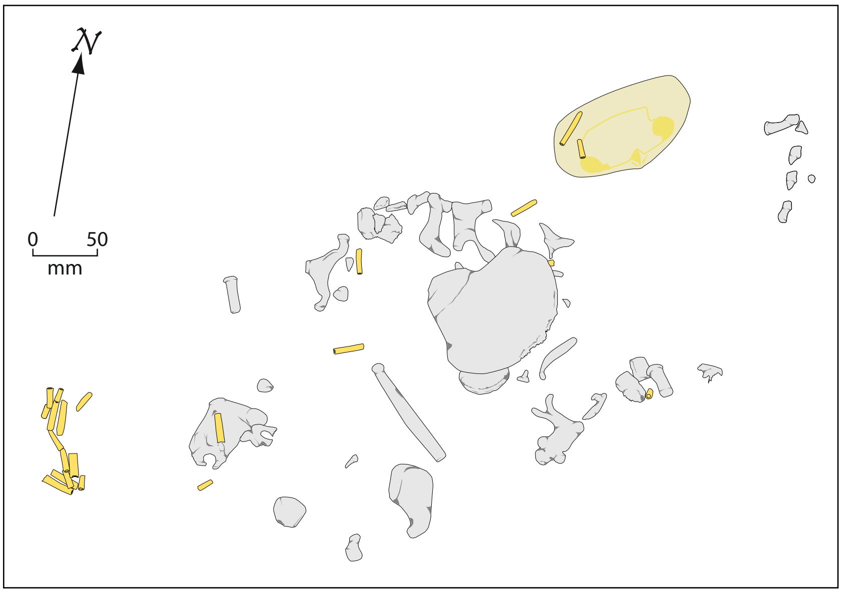

Figure 7.5. Kōiwi 3.

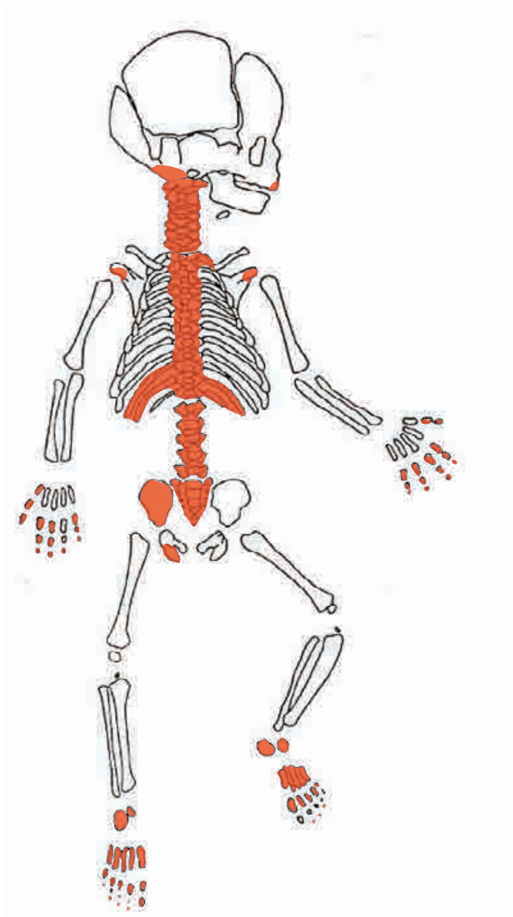

Figure 7.6. Diagram of bones present in Kōiwi 3.

Kōiwi 4
Phase 13

This was a complete primary burial (i.e., buried here as a whole body, rather than already decomposed bones) of a woman in about her early 30s to mid-40s. She had been placed in a tightly flexed position with the legs and arms drawn very tightly up against the body. The bone was in very poor condition, in contrast to most other burials at the site. It is not clear why, but it seems probable that at some stage sand blowouts in the dune meant the bone was exposed to the elements. The skeleton was fully articulated however, so there is no evidence that her skeleton was fully exposed for any length of time.

To be flexed so tightly, the body must have been constrained by either a very narrow grave or by having been tightly bound by some perishable material, such as cordage or matting, when it was placed into the grave. Cordage or matting seems more likely, given that the feet were neither flexed nor extended and so had not been included in this constraint.

The woman's bones were generally small and gracile, and at 156 cm she was estimated to be the shortest adult at the site. She had lost a lot of teeth during her life and the few that remained were very worn. Many had no crowns left and were only stumps or slivers of root. Infection in the gum and bone had caused destruction of the bone around the sockets. In the upper jaw, the right first molar had clear 'fern root plane' wear.

The state of her teeth had left her vulnerable to infection and abscessing in the jaw. One very large abscess had left a crater in the bone between her upper front teeth and the base of the nose (measuring 14.7 mm max. diameter x 8.5 mm deep). The sharp and rough edges to this

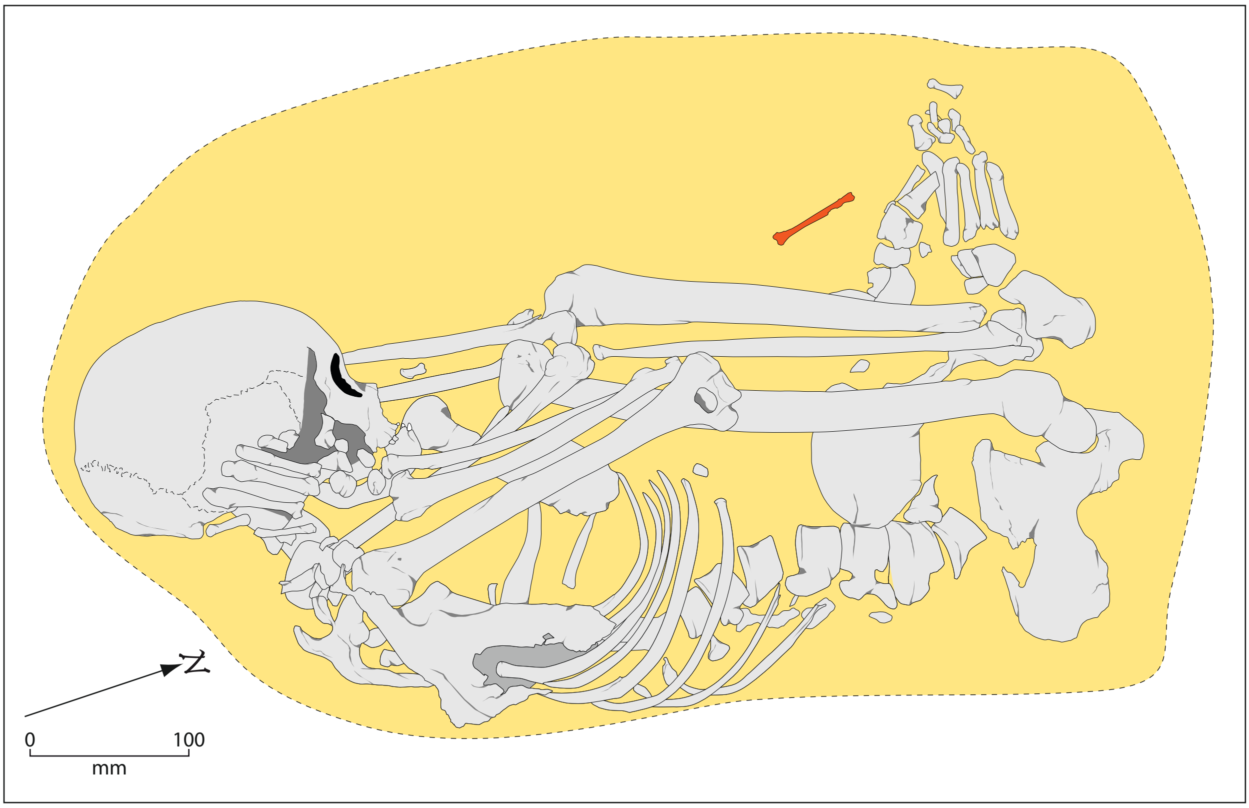

Figure 7.7. Kōiwi 4.

crater indicate that her body was still battling the infection at the time of death. This woman had the dentition of someone who was either very elderly, and/or had an extremely harsh diet or activity that wore down the teeth and led to other dental problems.

In the rest of her skeleton, the evidence of illness was primarily arthritic joint degeneration, mostly in her wrists and spine, particularly in the neck and lower back. She had also suffered from a slipped disc.

Kōiwi 5
Phase 13

Kōiwi 5 was a young woman in her late teens or early 20s who had been laid in a narrow grave on her right side with her legs tightly bent at the knees (Figure 7.8). Although she was young her body showed signs of hardship: wear and tear in the joints suggestive of heavy work; poor dental health; growth disruption as a child; healed injuries and injuries made at the time of death.

She was buried with a group of bone awls that were placed together, possibly tied in a bundle, like a small tool kit, next to her face (Figures 4.1–4.3). It is probable that she was a skilled worker who used awls, perhaps for the working of skins or fibre.

The skull had been broken with what appears to be two different blows and this is probably what killed her since there is no sign of the bone of the skull attempting to heal. There was a large oval hole centred on the back right of her skull (120 mm x 49 mm) but extending all the

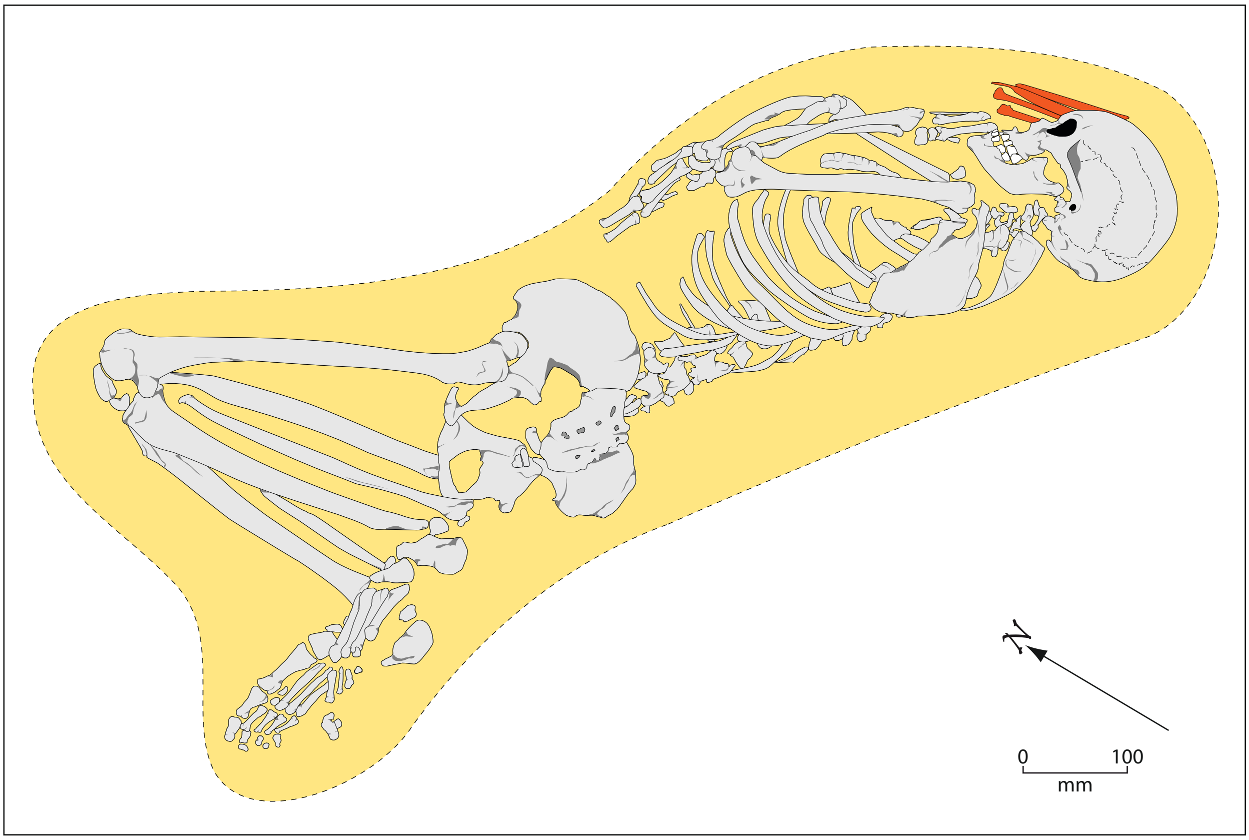

Figure 7.8. Kōiwi 5.

way around the right temple, with fracture lines radiating from it. Connected to this was another linear hole that had straight edges (49 x 9.2 mm). This was at the centre of the back of the skull and also had a fracture radiating which extended all the way across the left side of the skull. These breaks were made with considerable force. The bone had been broken around the time of death. The linear hole appears to have been made with a straight edged or V-shaped implement. Whatever it was had punctured the skull but cannot have been a very sharp blade, since there was no polishing on the edges of the break. While broken bones can of course result from accident, evidence of a heavy blow to the back of the head is usually suspected to be the result of violence.

She also had some evidence of injury to a number of ribs and vertebrae, also made around the time of death. The first vertebra at the very top of the spine had a notch cut into the back of it on the left side, probably caused by the same blows that damaged the skull. Lower in the spine there were some small punctures in two thoracic vertebrae and left ribs.

In addition to all of this, she had had an injury to the skull when she was much younger, one that she recovered from, but which left its mark. This was indicated by an area of abnormal bone on the right side of the skull that could have resulted from a long-healed head injury or possibly an area of healed infection. This bone was roughened, irregular and lumpy with a curved ridge and channel snaking across it. There was also a curved, roughened line that had the appearance of a near-obliterated cranial suture. This area of altered bone could have been caused by a fracture and related inflammation and it would probably have taken place when she was a child or teenager.

Despite her youth, this woman's teeth were already in a poor state of health, showing wear, infection and possibly cavities. She had an abscess around one of the front teeth in her upper jaw. Infection appears to have then spread from this abscess to the surrounding bone, as much of the bone between her front teeth and the base of the nose was finely porous and discoloured grey. She had fewer than the normal number of teeth and it seems that this was due to genetic variation, with all four of her second premolars missing and no evidence that they had ever been present.

Three of her canine teeth bore linear grooves in the enamel (hypoplasia) that are occur when they temporarily stop growing while they are being formed in infancy, in this case, somewhere between the ages of about 2 and 5. This is caused by a period of stress on the body such as illness or injury.

Although this woman was only young, she had one severe point of arthritis in the base of her spine and some of bodies of the lumbar vertebrae had developed slightly collapsed bodies. This indicates mechanical and loading strain on the lower spine.

Kōiwi 6
Phase 3

This was the complete, articulated skeleton of an infant aged about 2 years old (1.5 to 2.5 years). The fragile skeleton sat in a loosely crouched position lying on its left side with the head propped upright against the side of the small grave. The body was in a flexed position with the lower legs tightly flexed but not drawn up to the chest (Figure 7.9).

This young child also had a broken skull, but the condition of the bone made it difficult to be certain whether this happened around the time of death or long after death when the bone was brittle and dry. The skull was broken in a curved, roughly triangular area on the left side

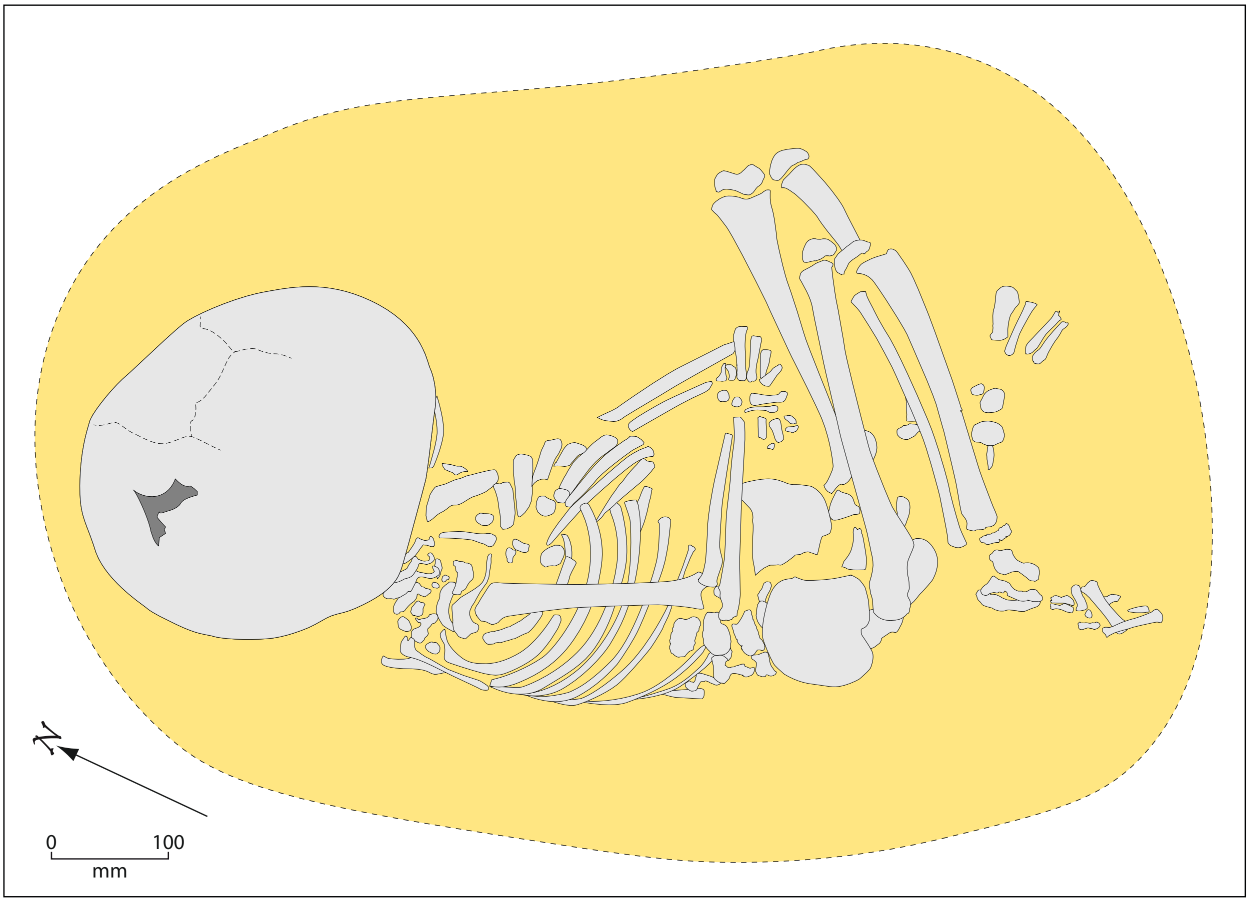

Figure 7.9. Kōiwi 6.

towards the back (left parietal bone) and the broken edges had some points where the break appeared to have been made when the bone was fresh, and others that were more characteristic of bone that has broken when dry and brittle. This infant's broken skull was potentially also due to being broken before or around the time of death, but this cannot be said with complete certainty. It remains possible that the fragile, hollow cranium (which had not entirely filled with sand) broke after death where it lay in the ground.

The child had been ill for a period of time before death. There were bone changes on the skull and femur that indicate some kind of chronic illness. The disease in question may have been a nutritional deficiency or an infectious disease. Bone had become porous in the roof and floor of the eye sockets, around the upper jaw and palate, and on the temples.

Some of these bone changes – porosity and new bone in the eye sockets, upper jaw and sphenoid bone of the skull – are typical of scurvy in infants. This is a disease that results from a deficiency of dietary vitamin C, which leads to a breakdown of connective tissue, bleeding and new bone formation. Porosity in the orbital rooves is also characteristic of another metabolic condition, iron deficiency anaemia (IDA), though there are some subtle differences in the nature of the bone changes. This child had some features of both diseases and it is possible that they had both conditions, due to some process inhibiting their diet or their ability to absorb nutrients from it. It is possible that a large, oval hole in the upper end of the left femur was caused by the same disease, or it could have been an isolated cyst of some kind.

Figure 7.10. Diagram of bones present for Kōiwi 7.

Kōiwi 7
Phase 13

A distinct oval pit contained the disarticulated partial remains of an adult of unknown age and sex. The remains included mostly small bones from throughout the body – bones of the hands, ribs, vertebrae, patellae (kneecaps), the hyoid (a small bone from the front of the throat), the manubrium (top of the breastbone) and the coccyx (tailbone). There was only one whole limb bone – the fibula (lower leg) – and one small fragment of the left distal humerus (elbow). The remains are all compatible with belonging to one adult, as there were no duplicates. Figure 7.10 shows a diagram of the bones present.

This collection of bones gives little insight into the individual. It is unknown how old the individual was other than that the skeleton was mature and older than a teenager. There is no clear indication of sex, though the fibula was quite large (361 mm long) and measured 20 mm longer than the largest female fibula at the site. Its measurement was closer to the site average for males (357 mm) than females (313 mm). This suggests they were male, but is not certain.

The grave measured 1200 x 600 mm and was at least 450 mm deep. It was oriented north west–south east. The bones were deposited haphazardly through the fill of the pit – scattered, disconnected and found at different levels in the fill. None were sitting on the base. It may be that this was once the grave of more complete remains that were subsequently removed, leaving bones scattered through the backfill of the hole. Alternatively, the hole was dug for some other purpose and the bones were incorporated either accidentally or deliberately as it was filled in. But the fact that the bones were in very good condition – with no bleaching, weathering or other indication of exposure to the elements – supports the former rather than the latter. At any rate, this does not appear to be a deliberate secondary burial: if the bones were brought here to be purposefully reburied, we could expect them to be in a bundle at the base of the pit.

There was no clear evidence of disease or injury in the bones present in this burial. The only point of note was that the fibula had a slightly unusual form at its head, which may be related to excess bone being laid down in response to lower leg muscle strain.

Kōiwi 8
Phase 13

This was the disturbed and incomplete burial of a young child aged about 5. The grave appeared to have been disturbed in modern times by works relating to the construction or renovation of the restaurant building, though it is possible that this was also disturbed or revisited prior to that, during pre-European times. They appeared to have been in a scooped oval hollow of a grave, though disturbance to the area made it difficult to be sure of the original nature of the grave.

The bones present were mostly bones of the hands and feet along with parts of the sternum (breast bone), hyoid (small bone from the front of the throat), some upper and lower ribs and the long bones of the left forearm (Figure 7.11). The left hand and forearm were articulated, as was part of the left foot and part of the right hand, but the other bones were disarticulated. They were mostly at the same level and so they appear to have been laid on the base of a grave, that is – not scattered through the fill as Kōiwi 7 was.

This collection of bones bears some resemblance to those found in both Burial 3 and Burial 7: bones of the hands and feet, upper and lower ribs only, no or little cranial remains and missing most long bones of the limbs. Although modern disturbance obscures the original burial practice to some degree, it may be that these burials had been revisited as part of a mortuary practice for the removal of bones, in which case it would show that re-visitation was a practice that could be performed for anyone, not only adults.

There was no indication of illness or injury on the child's bones. The sex of the child is unknown.

Kōiwi 9
Phase 13

The bones of an infant or young child were found in a shallow, round hollow in the north west corner of the excavation area. Only a small number of disconnected bones was present, including some bones of the hands and feet, two vertebrae, part of the sacrum, one tooth and a bone from the base of the skull (the basi-occiput). There were also the epiphyses (the unfused ends of bones that are still growing) of both the left and right femurs (thigh bones) (Figure 7.12).

The development of the single tooth present indicates an age of between 18 months and 4 years at death, while the growth of the sacrum (at the base of the spine) suggests an age of around two years. The sex of the child is unknown. There was no indication of injury or illness in these bones.

Modern disturbance to the grave makes it difficult to say whether this had originally been the complete burial of a child or if there had also been disturbance and retrieval of bones in pre-European times, or indeed whether this was an intentional formal grave or just a redeposited group of bones.

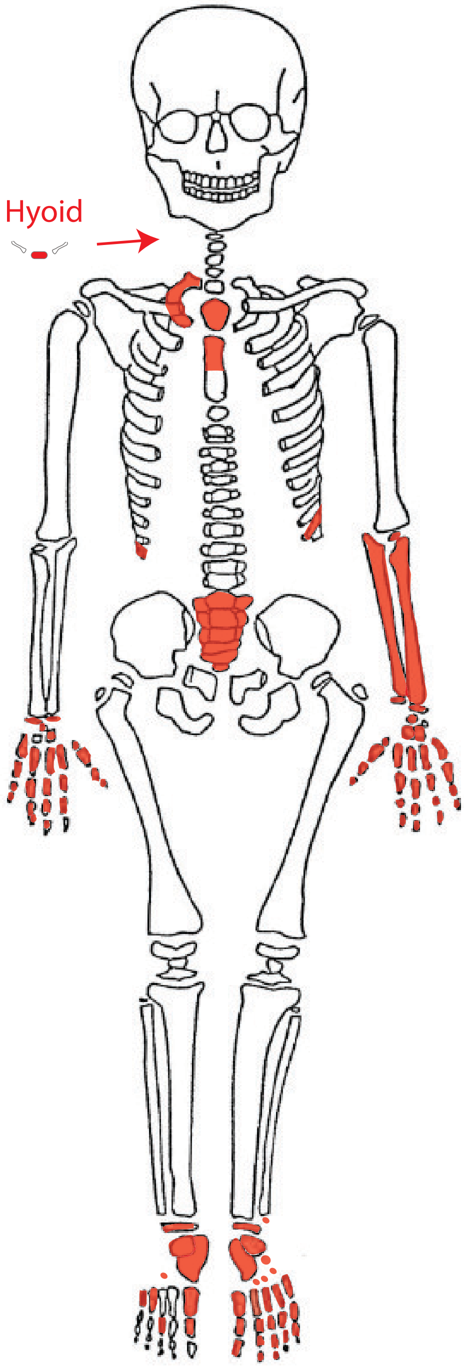

Figure 7.11. Diagram of bones present for Kōiwi 8.

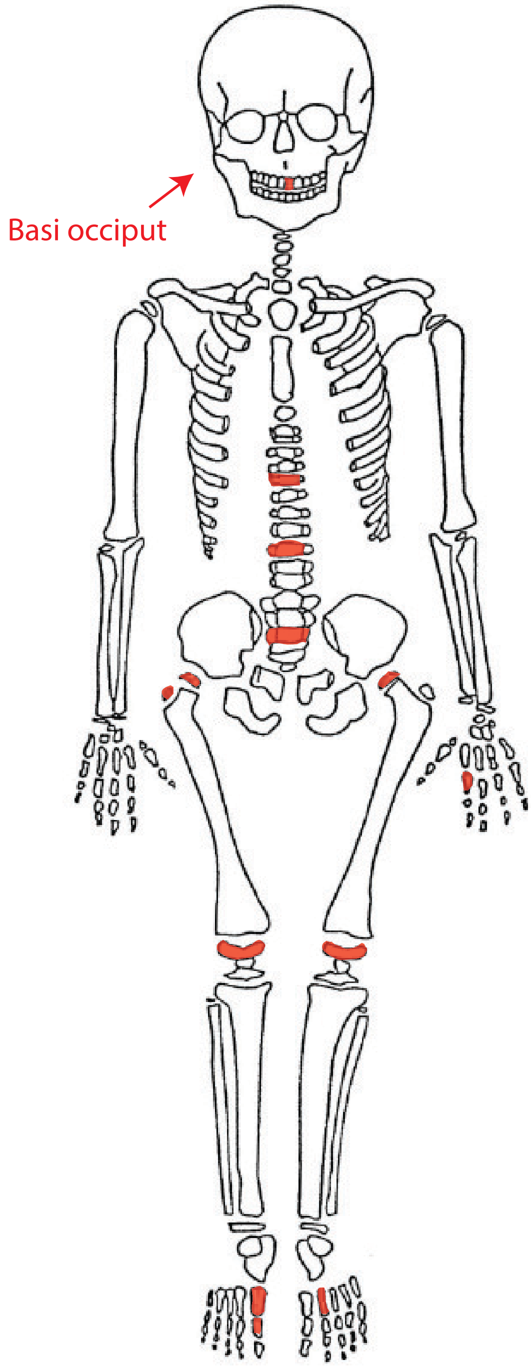

Figure 7.12. Diagram showing bones present for Kōiwi 9.

Kōiwi 10
Phase 13

This was the complete primary burial of a teenager of about 17–22 years of age who had been buried in a deep, rounded grave. The shape of the pelvis and cranium indicate that this was probably a male.

The body had been arranged lying on its back with the legs tightly flexed up over the torso (Figure 7.13). The arms were folded with the hands lying on the upper chest. The head was oriented to the south east. The lower legs were parallel and sat very close together and had probably been bound together.

There was one additional vertebra in the grave that did not belong to this individual. It sat on the base of the grave, by the young man's left hip (indicated with arrow in Figure 7.13). It was a lumbar vertebra of another young person, probably also a teenager, since it was of adult size but had not completed growth. This bone was in poor condition with damaged surfaces, which suggests that it had been exposed to weathering or movement. It is likely that this was an isolated, scattered bone that had been in the surrounding soil and had been incorporated in the grave fill accidentally. This shows that activity that caused scattering of human bone had already taken place by the time this young man was buried.

The young man's teeth were generally in good condition with little wear or dental disease. They did indicate a period of growth disruption during his infancy or childhood though. Many of his teeth had pitted, lumpy enamel on the lower third of the crown. This is another form of enamel hypoplasia, which can result from a period of ill health in childhood, in this case between the ages of about 1.5 to 9 years of age.

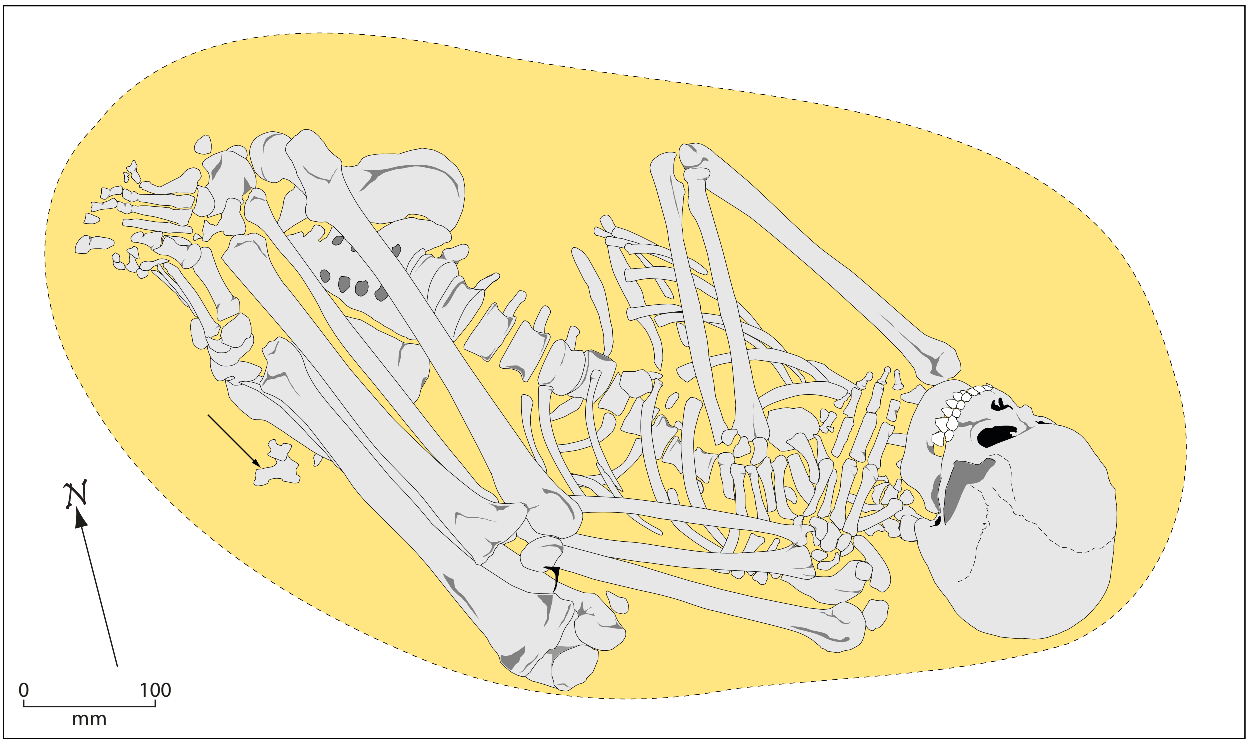

Figure 7.13. Kōiwi 10; the additional vertebra is arrowed.

This young man had a number of developmental anomalies in his skeleton, most of which would not have affected him greatly and are unlikely to have caused him suffering. One of these was spina bifida occulta, a variation in the form of the sacrum. This, along with several other anomalies, is detailed in the technical report.

Notable of these was that this young man had a particularly pronounced version of a defect that is commonly seen in pre-European Māori skeletons – he had a deep, oval hole in the centre of the joint surface of one big toe (left first proximal foot phalanx). This was noted in several other individuals at this site and is a common finding in Māori kōiwi, though its cause is uncertain. It appears to be a developmental defect, perhaps exacerbated by activity.

Kōiwi 11
Phase 13

Kōiwi 11 was the burial of another teenager, also probably male. The deep round grave was larger than needed for the body and afforded a lot of room around the skeleton, which contrasts with others such as Kōiwi 4 and 5, who were either tightly bound or placed in a constrictive grave.

This was also a complete primary burial. The head had been leant against the east wall of the grave and the lower legs were bent, but not drawn up over the torso (Figure 7.14). Neither the ankles nor knees were together, so the legs do not appear to have been bound.

This individual was a similar age to Kōiwi 10 and buried very close to him. Kōiwi 11 was developmentally a little younger than Kōiwi 10 though, closer to the mid-teens, probably around 14 to 19 years old.

Although younger than Kōiwi 10, this young man was already taller – estimated to stand at 176 cm. If he had lived longer, he might have gone on to be taller still.

His teeth were generally in good condition with little wear or dental disease, though there was some evidence that inflammation in the gums had spread to the underlying bone (periostitis).

Although he was estimated to have been in his mid-teens, he still had two of his milk teeth in his upper jaw. These deciduous second molars would usually have fallen out around the age of 10 or 11 years, but had stayed in for longer than usual, even though the roots had almost entirely resorbed in preparation for falling out. The reason they had not fallen out appears to be because there were no adult premolars (P2) coming through beneath them to push them out of the way. This lack of upper P2 teeth is a genetic variation and is reminiscent of Kōiwi 5, who was missing all four P2s.

This young teenager had been ill for some time before he died and this showed in his skeleton. He had suffered a chronic, systemic illness that had caused widespread bone changes and deformation. The most obvious changes were on the limbs, primarily the femora (thigh), humeri (upper arm) and tibiae (lower leg), but the left calcaneus (heel), radii (in the forearm) and fibulae (lower leg) were also affected. In his torso, changes were noted in the thoracic vertebrae (middle of the spine) and one left rib.

The bone changes have the hallmarks of osteomyelitis – pus-producing infection of the bone. The bone changes are described in detail in the technical report. To summarise here, the changes were particularly severe in both upper femurs and upper humeri. These bones were deformed and 'swollen' by large lumps of bone that covered the normal shaft surfaces. Some

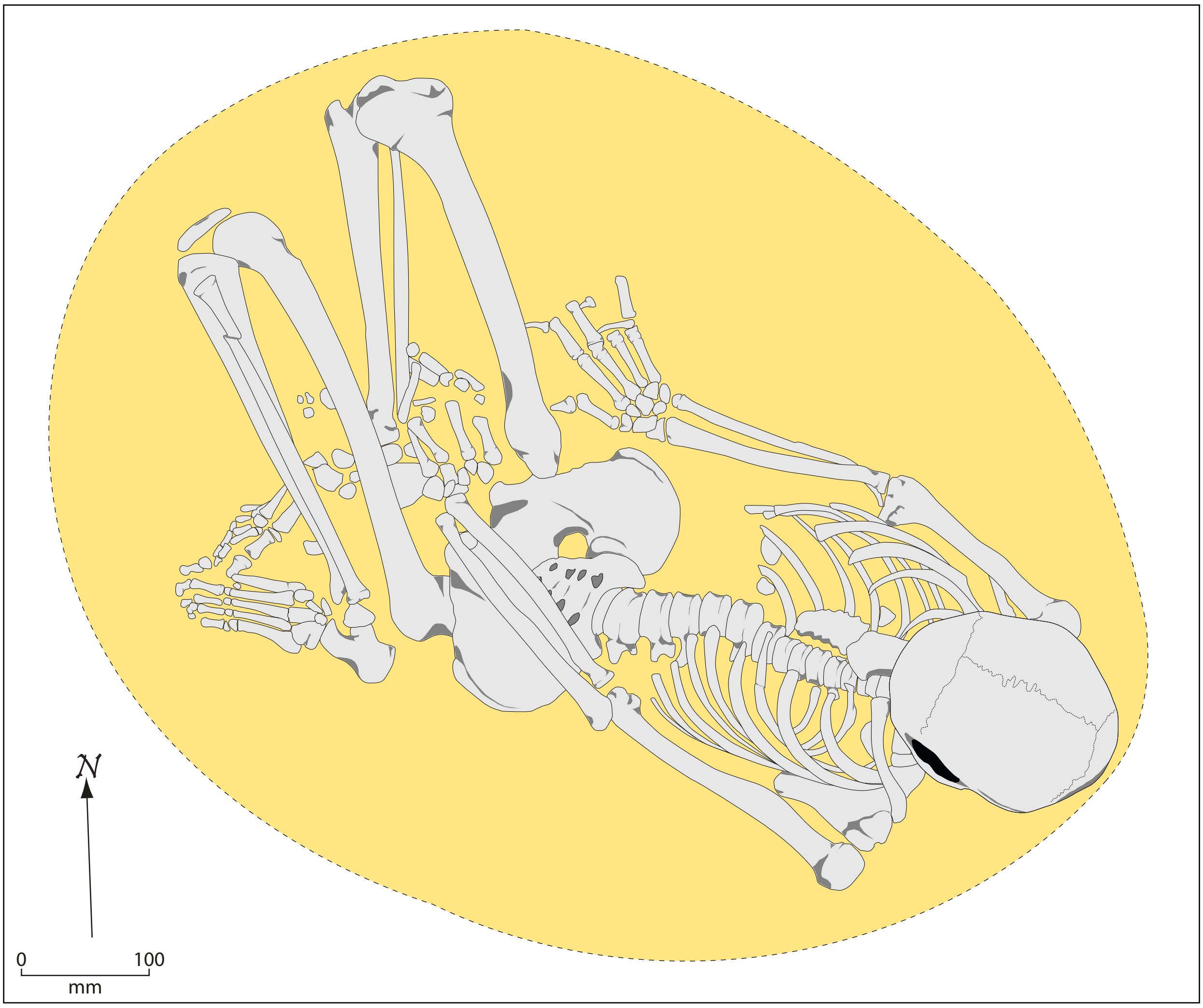

Figure 7.14. Kōiwi 11

of these lumps had smooth-walled holes at the centre. Radiography (x-ray) of the left humerus showed that the swollen area was a layer of bone that had been laid down over the surface of the original shaft of the bone. The holes in this swollen bone were likely cloaca – holes to drain the pus produced by infection within the bone. The bone changes had been ongoing for some time, but there were also areas of new bone that showed that the disease was still active and causing bone reactions at the time of death.

Other defects, that may be related to the osteomyelitis, include a large, smooth hole in the sixth left rib and a round hole in the preauricular sulcus (near where the sacrum joins the pelvis) of the right hip bone. These holes were potentially caused by cysts or were holes (cloaca) for draining pus resulting from infection deeper in the bone.

It is unknown what caused the infection. It could have started with something such as an infection in the throat, ear or sinuses. It evidently entered the blood stream and spread through the body. However he contracted the illness, this young man was sufficiently resilient to with-stand infection long enough for it to cause deformity of the bones.

Kōiwi 12
Phase 3

This was a very tightly flexed burial of a young man who had been placed in an oval grave oriented with the head to the northwest. He lay on his right side with his face looking to the south. The body appeared to have been tightly bound, since the legs were very tightly bent and drawn up against the torso, with the heels against the hips and the knees against the ribs. The spine was very straight – unnaturally so, as its normal curvature had been straightened out. This indicates that the whole body had been bound or constrained in some way, perhaps with cordage or matting, and that this had pulled the spine straight by bracing it against the bound legs.

The joints of the pelvis indicated that he was probably around the age of 25–35. This young man had experienced physical injury and joint degeneration at a young age, similar to Kōiwi 5. His teeth were only moderately worn but he was suffering from infection in the upper jaw where a series of abscesses had formed around the roots of four adjacent teeth. These large holes indicated substantial chronic infection in the jaw. The man also had a number of large cavities in his upper and lower teeth, more cavities than any other person at the site (14 teeth with cavities). Cavities indicate acidic erosion of the teeth, which was also evident where his worn teeth had become cupped by erosion. The cavities suggest a sugary, acidic or sticky starch element to this young man's diet – notably more so than others at the site.

He had experienced some physical injury that fractured a number of bones, but which he survived and mostly healed from. He had healed breaks to bones in his right hand (M1 and M3 shafts), left and right feet (L, MT1; R medial cuneiform). His sacrum had begun to fuse to the left ilium (hip). Fusion at this point can result from strain on the joint or a number of diseases that cause fusion at this specific location. His right shoulder was already showing considerable joint degeneration. The left side was not affected, so it seems he used his right shoulder to perform a strenuous task that his left shoulder did not do.

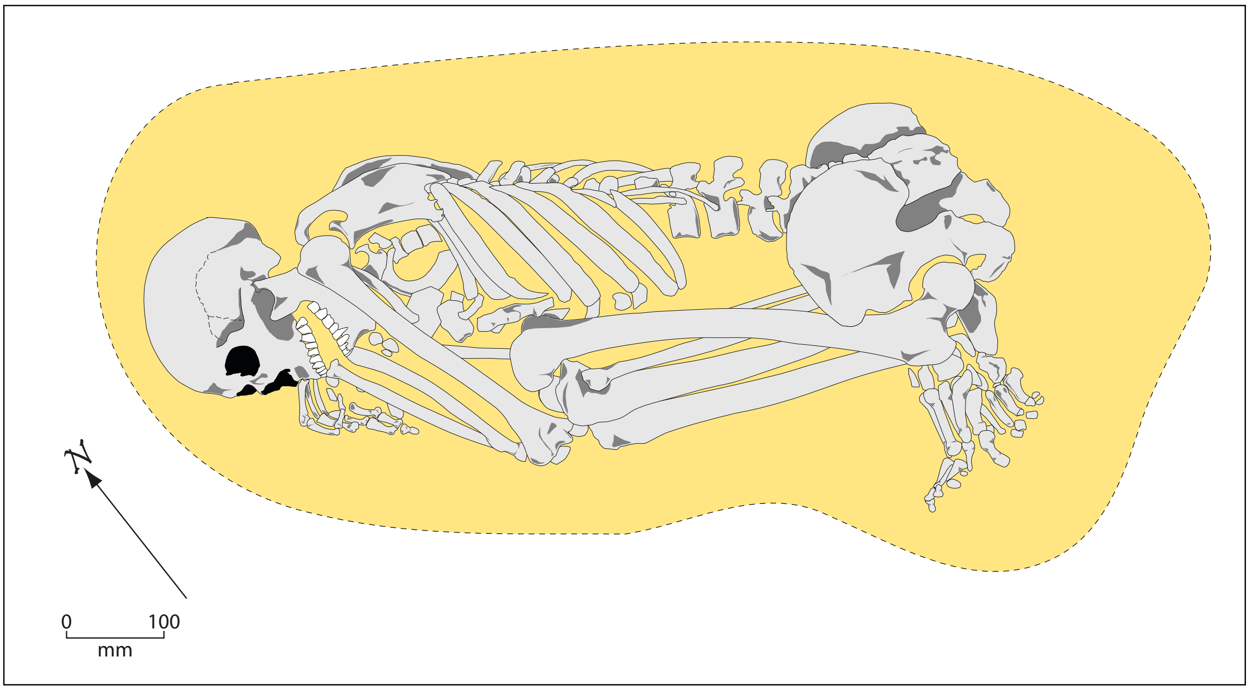

Figure 7.15. Kōiwi 12.

Kōiwi 13
Phase 9

This was the burial of an older woman whose skeleton sat in a deep, roughly oval grave. This was a primary burial and the skeleton was complete and articulated. The woman had been buried in a crouched position and was sitting partly upright and resting against the grave wall.

The joints of the pelvis indicated that she was probably in her 50s or above and the state of her skeleton – riddled with severe joint degeneration and missing a lot of teeth – contributed to giving her the appearance of being the oldest person at the site. Certainly her body had been subject to a lot of wear and tear.

The woman had very deep pits on the back of her pubic bone. Such pits can develop as a result of strain on the ligaments during childbearing (McArthur et al. 2016) so she had probably had children. She had lost a lot of teeth during her life and their sockets had completely healed over. Interestingly, she had lost the back teeth from her lower jaw and the front teeth from her upper jaw, meaning that most teeth did not have opposites to bite against. The teeth that remained were heavily worn, some on steep angles. Some of the left upper molars had cavities and several of the lower front teeth had small build-ups of calculus (tartar). The woman's unusual pattern of tooth loss could perhaps result from using the teeth as tools for some specific activity such as processing food or other materials.

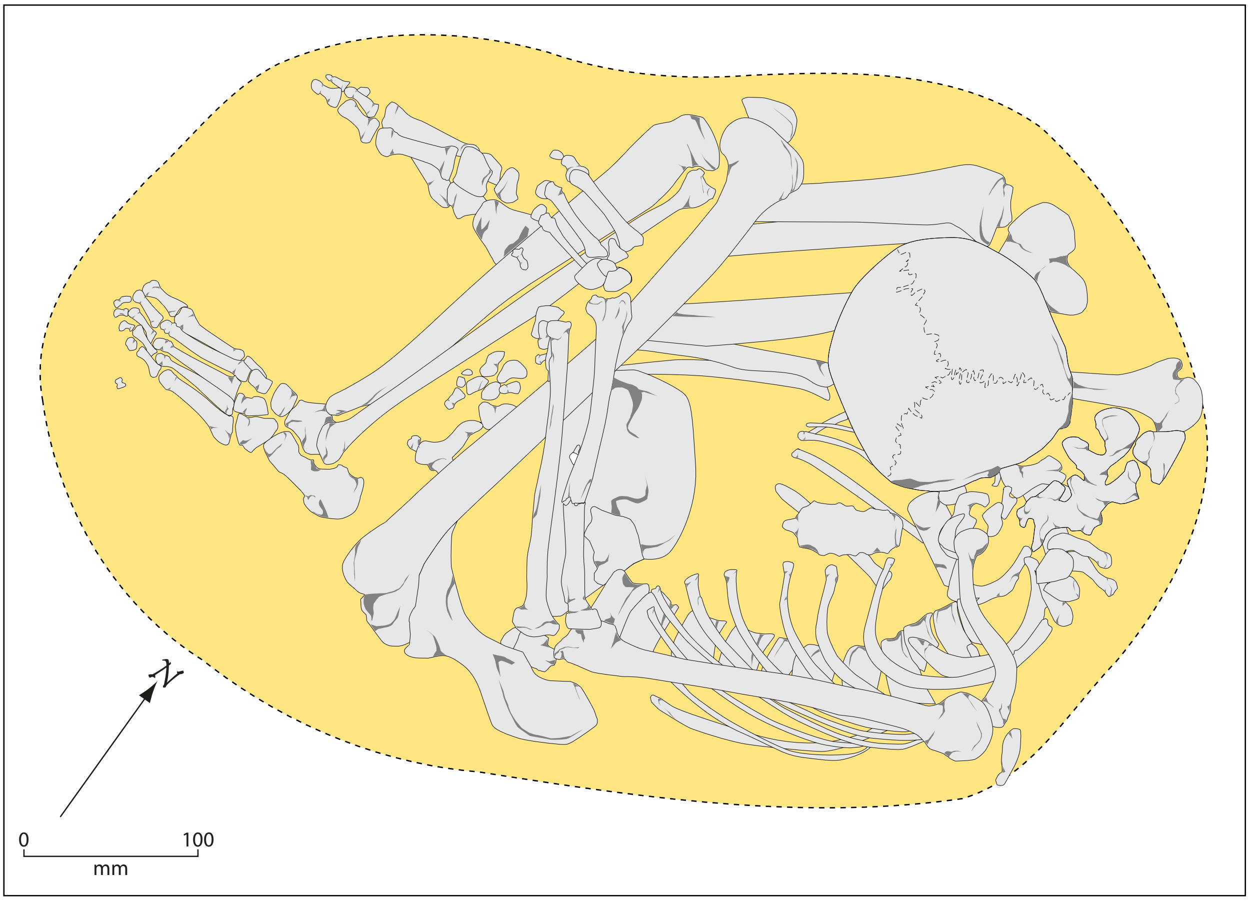

Figure 7.16. Illustration of Kōiwi 13.

She had arthritis and severe degeneration of the joints throughout her skeleton. This had left many of her joint surfaces deformed as the bone reacted to destruction of the joint's soft tissues. In many joints, the joint surfaces had been extended by ragged or bulbous proliferations of bone around the joint borders, or porous destruction of the bone surface. Many joints also had eburnated surfaces at which the joint cartilage had been destroyed to the point where bone had been rubbing on bone, polishing and sometimes scouring grooves in the bone surfaces.

Osteoarthritis affected both of her elbows, wrists, thumb joints, her left hip, her right ankle and foot, the neck and the lumbar spine, her jaw and in her right first rib. The destruction of the joints was most marked in the elbows where joint surfaces were polished and porous and had great profusions of bone around the edges, some of which had developed as separate pieces of bone. The heads of the humerus, at the shoulder, were not affected by arthritis, so some activity seems to have placed great strain on the elbows but not shoulders.

The joint degeneration was also severe in her spine. Degeneration was particularly severe in the upper neck (C1–4) and lower back (T10 to S1), where vertebrae had polished and grooved joint surfaces. One lumbar vertebra (L1) had evidently collapsed under pressure, as the vertebral body had become wedge-shaped with a callus of excess bone on the front of it. The cupped upper and lower surfaces also had large holes in their centres. There seem then to have been two processes taking place in this bone: 1) the bone suffered a compression fracture; 2) herniation of the vertebral discs caused shallow holes in the body surfaces (called Schmorl's nodes).

The woman may have also suffered an injury to her right femur. There was a distinct, raised lump of bone on the front centre of the right femur. Radiography showed that the shaft of the bone had not been interrupted by a break, so the lump appears to be bone formation in reaction to a localised infection or injury to this point on the leg.

Kōiwi 14
Phase 9

The skeleton of this baby was crouched in an upright position in a deep round grave. The body lay slightly to its left side with the legs very tightly drawn against the body. Both arms were also flexed against the body and the right hand rested on the knees.

The skeleton was complete and in good condition. It was mostly articulated, though there had been some movement of bones within the space of the torso, presumably caused by collapse during decay. Even very small details of the skeleton such as the hyoid, distal hand phalanges and auditory ossicles were retrieved.

Dental development indicated an age of 6 months (± 3 months). The degree of development of the cranium and mandible also indicate the bracket of 3 to 9 months. There was no evidence of disease or injury showing on the infant's bones or developing teeth.

Kōiwi 15A and 15B
Phase 3

This collection of partially articulated bones was found in a scooped hollow next to the pit that contained Kōiwi 7. The roughly oval hollow contained an articulated right lower leg (fibula only) and foot along with other disarticulated small bones from throughout the body, such as: hand and foot bones, both patellae, part of the hyoid, ossified thyroid cartilage, the coccyx, the xiphoid process, and two lower ribs and several vertebrae. A number of the bones were dupli-

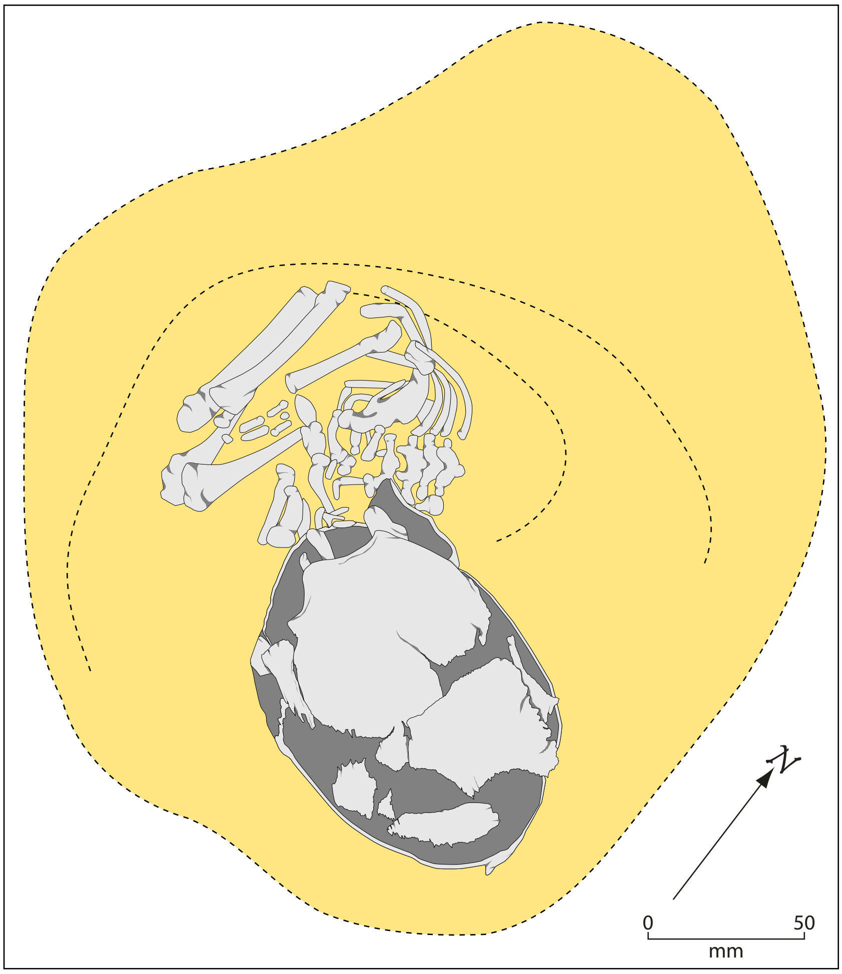

Figure 7.17. Kōiwi 14.

cated, showing that there were remains of two different adults buried here. There was one obsidian flake in the fill of this feature, though whether its inclusion was intentional or incidental is unknown.

Most of the bones from this burial were catalogued as 15A. Duplicate bones or those that clearly did not match the rest of 15A in terms of size and appearance, were assigned to 15B. Figure 7.18 shows a diagram of all the bones present for this burial.

There were no skeletal elements present that could help estimate sex or age beyond the fact that these were both adults. The vertebrae showed that at least one of these individuals was fully mature, probably older than 20. Some of the bones were notably large and robust. The fibula was long (366.5 mm), the fourth longest at the site and longer than the average fibula length for males at the site (357 mm). It suggests they may have been male, but it is possible that this was simply a tall woman of robust build.

When the bones were placed here, most were probably dry bones with no soft tissues attached, but the articulated right foot and fibula must have been at least partially fleshed in order for the bones to hold together. It is possible that the complete lower leg, or indeed the complete burial was once here, since the articulated left first phalanges (i.e. the big toe of the other foot) was in place next to the complete right foot – as it would have been in a burial with the feet placed side by side. All other bones in this feature were disarticulated and jumbled how-

Figure 7.18. Diagram of bones present for Kōiwi 15A and 15B.

ever. If there had once been a complete body here, both the skeleton and the grave had been highly disturbed with the majority of the skeleton removed.

All six vertebrae recovered in this burial showed signs of spinal joint degeneration and on five of them this was severe. There was eburnation on the C1, C2 and C5 and there was porosity and large areas of excess bone on the C3 and C4 articulations. This was the only evidence of disease noted in the bones present, though there were some other anomalies. Both first proximal foot phalanges had hollows in the centres of their proximal articular facets, which have been described before for others at this site. Also there was one rib that had what appeared to be ossifying costal cartilage at its end (the cartilage that connects the ribs to the breastbone). This was rough and finely noduled protrusion of bone that extended 22 mm past the end of the normal rib shaft and tapered to a sharp point.

Kōiwi 16
Phase 9

This burial was of a partial skeleton that lay in a deep oval grave with straight walls. It appears that a complete skeleton was originally buried here, but that the grave was later revisited to remove parts of the skeleton. What remained in the grave was a lower torso – from the 8th thoracic vertebra, down to the pelvis. This section was all articulated; the lower spine, the ribs (from the 8th to 12th on the right side and the 9th to 12th on the left side), the sacrum, coccyx and both hip bones were all connected as they would be in life. On either side of this section of skeleton, were the forearms and hands, which lay on either side of the body in the position they would be in if the whole skeleton was present. These parts of the skeleton had been buried when the flesh was present to hold them all together. But there was no skull, neck or upper spine and ribs, the bones of the shoulders, upper torso and upper arms were also absent.

Of the lower body, the bones of the legs and the kneecaps were also absent, but the majority of bones from both feet were present. These were mostly scattered at different depths in the fill, which suggests that they were disturbed while retrieving the leg bones. Figure 7.19 is an illustration of the burial and Figure 7.20 gives a diagram of all the bones present in this grave.

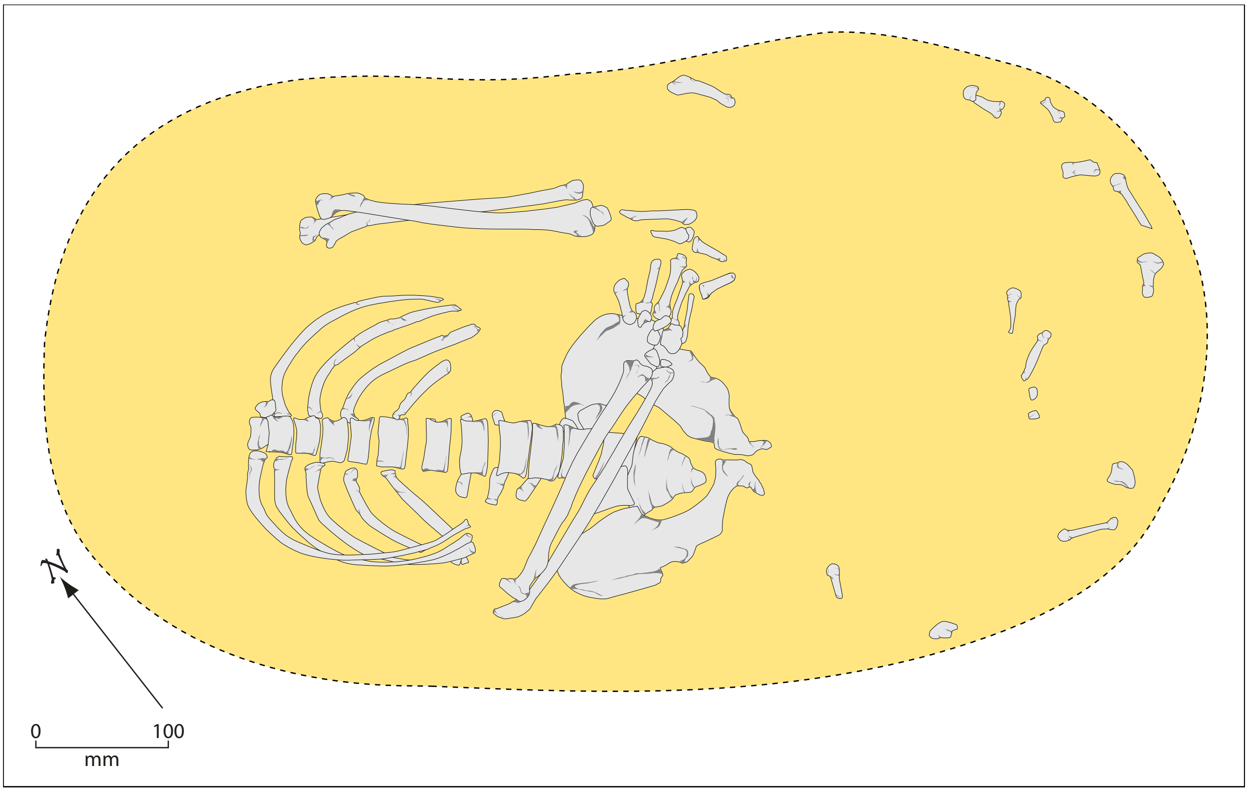

Figure 7.19. Kōiwi 16

Features of the pelvis were generally masculine, so this person was probably male. The joints of the pelvis indicated an age of about 35–45 years of age when he died.

There was little evidence of illness in these bones. The man had osteoarthritis in his left wrist, milder joint degeneration in the heads of both 11th ribs, the right ankle wrists and toes.

He also had several miscellaneous smooth bone nodules or protrusions on some bones of his feet and ankles. These are all minor anomalies of unknown cause which probably had little effect for the man. Finally, he had a small amount of bone erosion on the base of the bone of one big toe, similar to that seen in Burial 20 and Burial 17.

Kōiwi 17
Phase 9

This burial appears to be another interesting example of re-visitation and rearrangement of skeletal remains within a grave. The partial skeleton of a man in about his 30s or 40s was found in a grave made up of two parts: one earlier section and one later section that had been dug into the first. The first was a large, shallow, oval portion of the grave, which contained articulated feet. The second was a deeper oval portion that contained disarticulated bones from throughout the body and an articulated section of spine. The shallower, primary cut had probably originally contained the burial of a complete body, while the deeper portion was the secondary cut, which disturbed the first part and was apparently made when the grave was returned to in order to remove bones. Figure 7.22 gives an illustration of the grave and remains and Figure 7.21 shows a diagram of the bones found in the different parts of the grave.

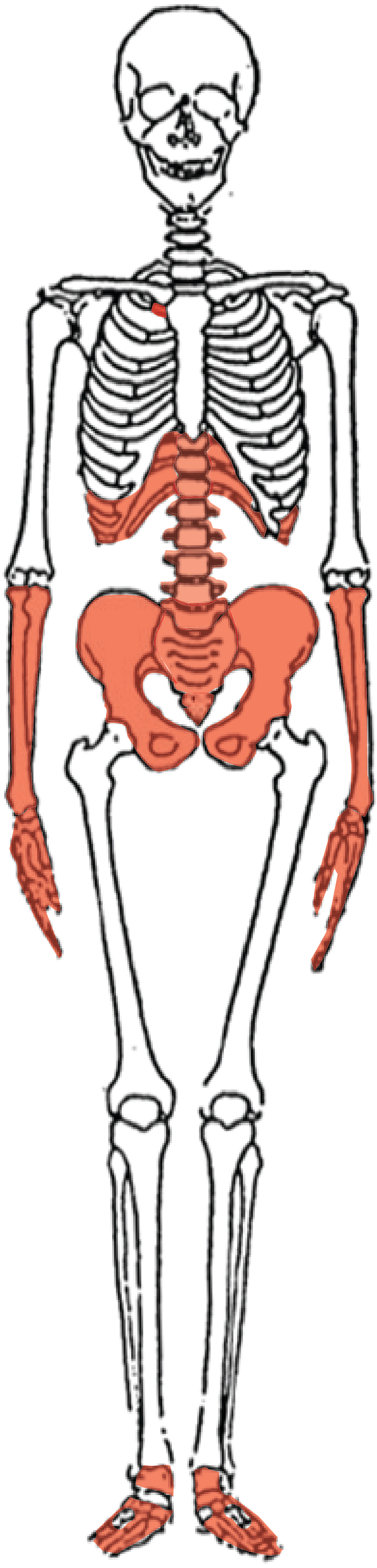

Figure 7.20. Diagram of bones present for Kōiwi 16.

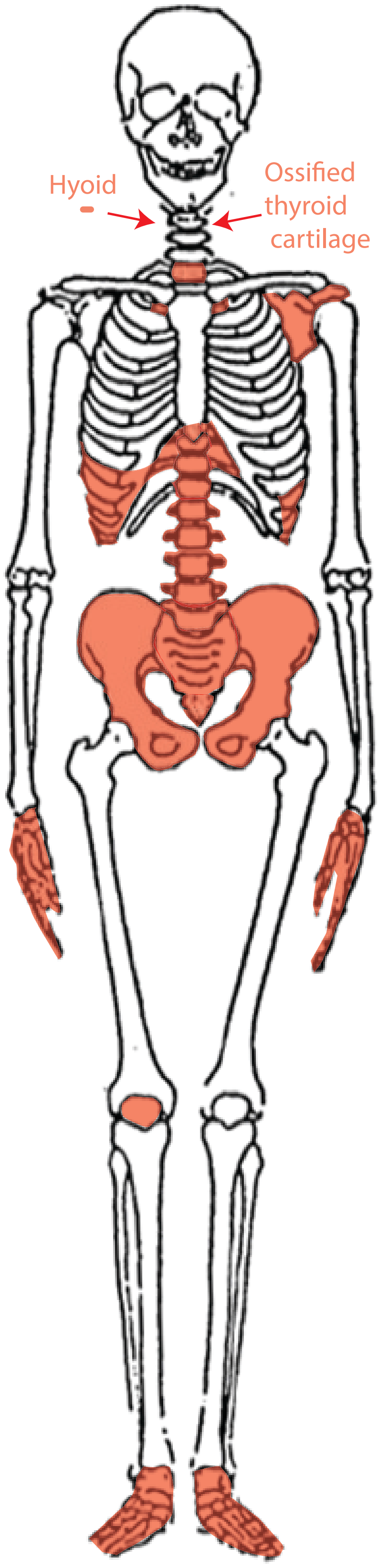

Figure 7.21. Diagram of bones present for Kōiwi 17.

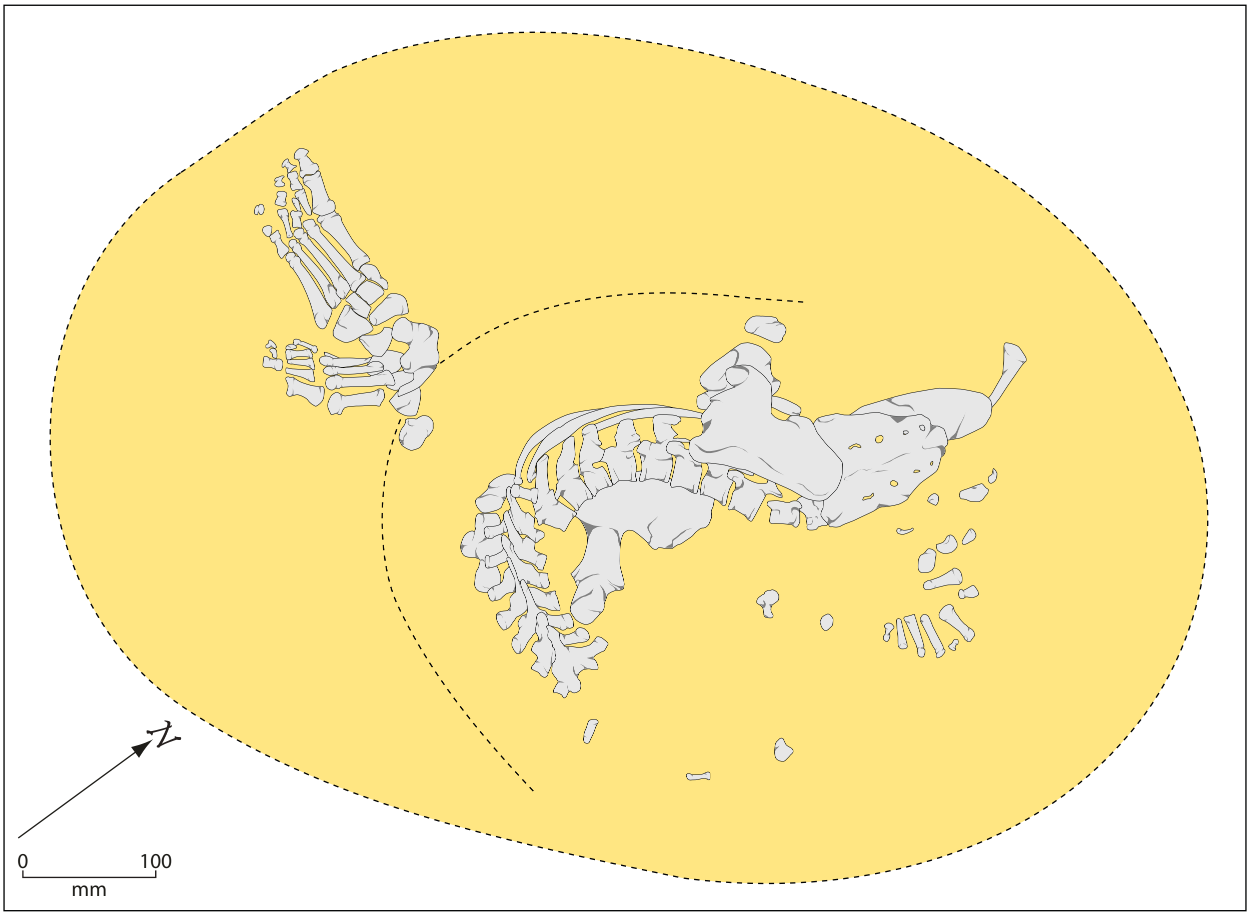

Figure 7.22. Kōiwi 17.

The primary cut contained articulated left and right feet that sat side by side, but with the left foot to the right of the right foot – as they would sit if the complete skeleton had sat with its ankles crossed. The left foot was complete and most of the right foot was there, minus bones of the back of the foot (talus, calcaneus, cuboid and navicular), which were found in the secondary cut.

The secondary portion of the grave contained an articulated partial spine (from T1 to the sacrum), three articulated right ribs, two disarticulated innominates (hip bones), a disarticulated left scapula (shoulder blade), and the disarticulated right clavicle (collar bone). Other disarticulated small bones include bones of both hands, the coccyx (tailbone), two teeth, the hyoid, ossified thyroid and costal cartilage, the right patella (knee bone) and the xiphoid process of the sternum (lowest portion of the breast bone).

The remains were all compatible with being one person and the left calcaneus (heel bone) that was under the spine in later part of the grave matched the right calcaneus that was in the earlier part of the grave.

It appears that this was originally a complete primary burial that was revisited some time later to remove parts – primarily the skull and long bones of all limbs, though other parts of the skeleton were also missing. The presence of two teeth, the hyoid and the ossified thyroid cartilage indicate that the skull and neck was once present in the grave and the fact that the feet sit side by side as if with crossed ankles indicate that the long bones, at least of the lower leg, were once present.

The re-visitation and removal would have taken place at a time when decomposition was only partial; soft tissues clearly held the spine together but they did not hold the pelvis together, which was presumably upended by removal of the femora. Close observation of the bones found no evidence of cut marks to indicate forced disconnection of the bones.

The two teeth found in the grave were both very worn on steep angles. One an upper canine was worn on an angle with greater wear on the side against the tongue. Such wear could have been caused by using the front teeth in a particular manner to bite food or grasp or strip materials.

There were a few points of disease or injury in the skeleton. One vertebra had had its spine broken, which had healed but left the spine out of alignment. No other bones around it showed any unusual bone changes so this looks like a localised injury.

Mild to moderate joint degeneration was noted in a few joints in the toes and fingers (phalanges and sesamoid), right shoulder (lateral clavicle), right knee (patella) and ankle (talus). None of these were particularly severe.

There was an eroded lesion in the big toe (left MT1, adjacent to head) that could be a result of gout. This lesion was rounded and multi-lobed. Radiography (X-ray) showed the opening of the lesion to be overhanging slightly – a feature that is typical of bone lesions caused by gout.

Other pathological bone changes include new bone on both left and right heels (calcaneus). Finely porous 'puffy' looking bone on the instep side of these bones indicates inflammation here that could have been caused by either infection or trauma – possibly even strain on the muscles that attach at this site. Finally, this person also had the eroded inferior borders of the first proximal foot phalanges (in the big toes) and seen in a number of others at the site.

Kōiwi 18
Phase 9

A burial of a middle-aged to older woman was found underneath the concrete foundation wall of the southern side of the restaurant building, approximately 350 mm below the base of the wall. She lay in a tightly flexed position, partly on the right side. Her legs were tucked up against the torso and her shoulders were somewhat hunched. Her ankles had been crossed and the left foot was arched with the toes bent back as if they had pushed up against some restraint such as the edge of the grave (Figure 7.23).

This was a primary burial and the complete skeleton was fully articulated. There was a large hole in the cranium, but the nature of the broken edges of the bone showed that this was a break that had taken place after death and after decomposition. The cranium was probably damaged during compaction of the footing trench for the building foundation. In fact, the condition of the entire skeleton was very poor, notably worse than others at the site. This is probably partly due to the building foundations which lay over it and maybe also by the fact that the water tap and restaurant's fat trap on the outside of the building at this location, which probably affected the soil conditions.

The woman's skeleton gave a mixed reading regarding age, but it was clear that she was not a young woman when she died. She's estimated broadly to have been in about her 40s to 60s.

The woman would have suffered from the pain of poor dental health as heavy wear had caused infection and abscesses in two of her upper teeth (right incisors). Her teeth were heavily

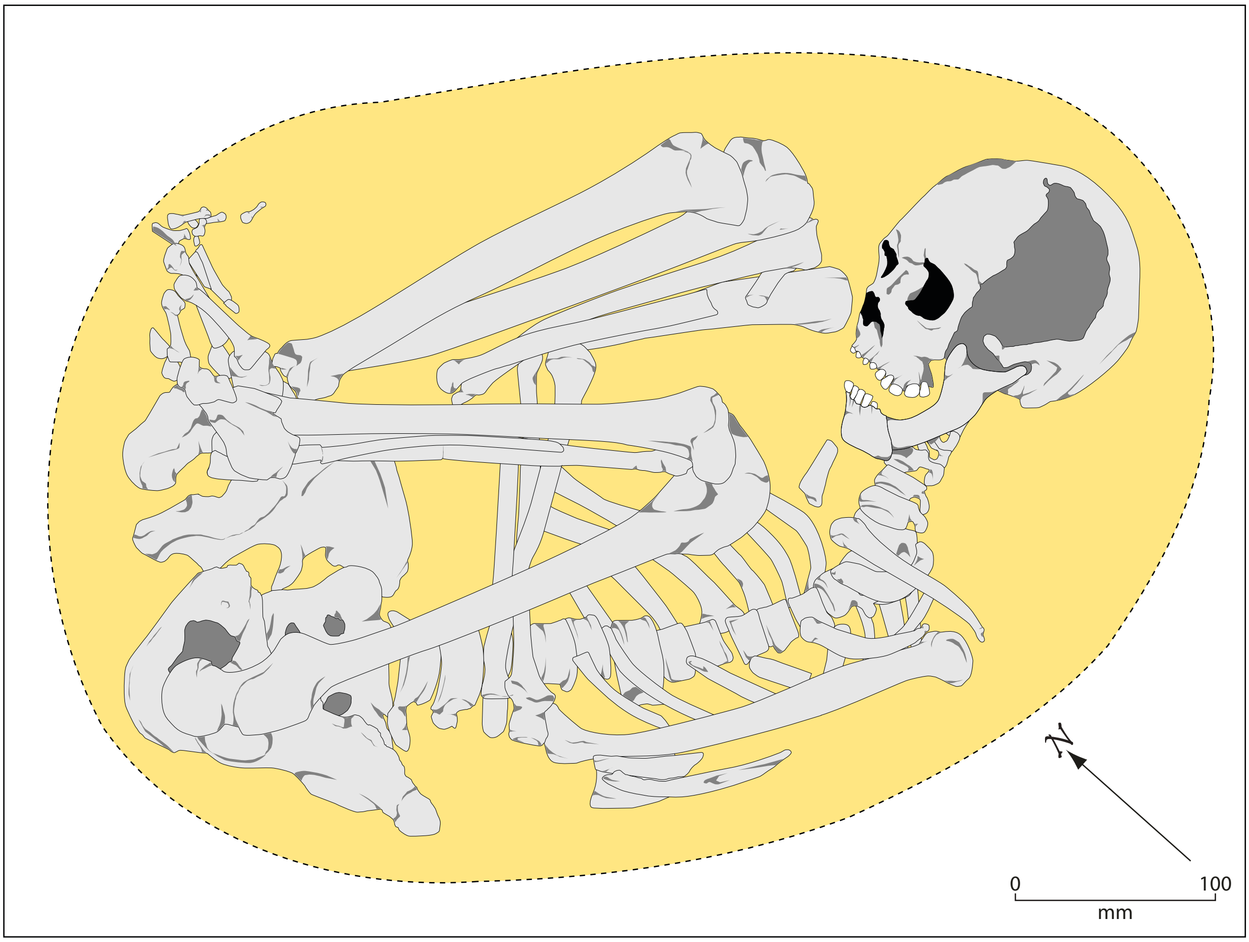

Figure 7.23. Kōiwi 18.

worn but not equally so around the mouth – some teeth had borne more strain than others. The upper front teeth, the lower molars and the upper right molars were very worn, in many cases on steep angles and with some loss of teeth before death. The degree of wear and the angle of wear did not always match the wear on the opposing teeth suggesting use against other objects.

The woman had severe joint degeneration in her knees (femora), toes (one foot phalanx) and spine (L1). Milder degenerative changes were noted in her elbows (humeri and ulnae), left shoulder (scapula), hips (femoral head), left ankle (fibula) and right side of the jaw (mandible).

Although middle aged or older, her spine was generally in good health, except for one lumbar vertebra. This vertebra had a split superior surface with a linear 'tear' or crevice across it. This is a kind of bone injury called a Schmorl's Node, which results from herniation of the intervertebral disc and can be caused by weight-bearing strain, though there is also a genetic factor to their development.

The woman had suffered a broken toe in her right foot and it never entirely healed. A bone from one of the toes, either the second to fourth toes (a proximal foot phalanx, ray 2 to 4), was in two parts where the shaft of the bone had broken during life. The edges of the breaks were surrounded by a proliferation of new, disorganised porous bone. The body had made an attempt at healing but had not bridged the gap to join the two broken bone ends.

Kōiwi 19
Phase 9

The burial of a newborn infant was found in a small oval, scooped grave. The infant lay in a loosely crouched position on its left side (Figure 7.24). This burial, along with Kōiwi 3 and 5, was one of the few at the site to contain grave goods: three chert flakes and one obsidian flake were found under the left leg, sitting on the base of the grave. They had clearly been placed on the base of the grave before placing the body directly on top of them.

The infant's legs were loosely flexed and not drawn in to the body tightly and one arm was extended, so the body does not appear to have been tightly bound or constrained the way some adults at the site were.

Although this baby was very young, either a couple of months old or perhaps even stillborn, its tiny skeleton was riddled with evidence of chronic illness. Bones throughout the skeleton – the upper and lower limbs, the bones of the pelvis, vertebrae, hands, feet, mandible and cranium, all had the same bony reaction to disease. These bones all had finely porous new bone formation on their non-articular surfaces. The bone changes are described in detail in the technical report. Generally, porous bone was raised above the normal bone surface, creating a 'puffy' appearance to the bone.

This kind of widespread porous new bone formation can develop due to inflammation in response to systemic infection. It may be that the mother was ill while the baby was in utero, or perhaps the baby struggled through its first one or two months of life with an illness before succumbing.

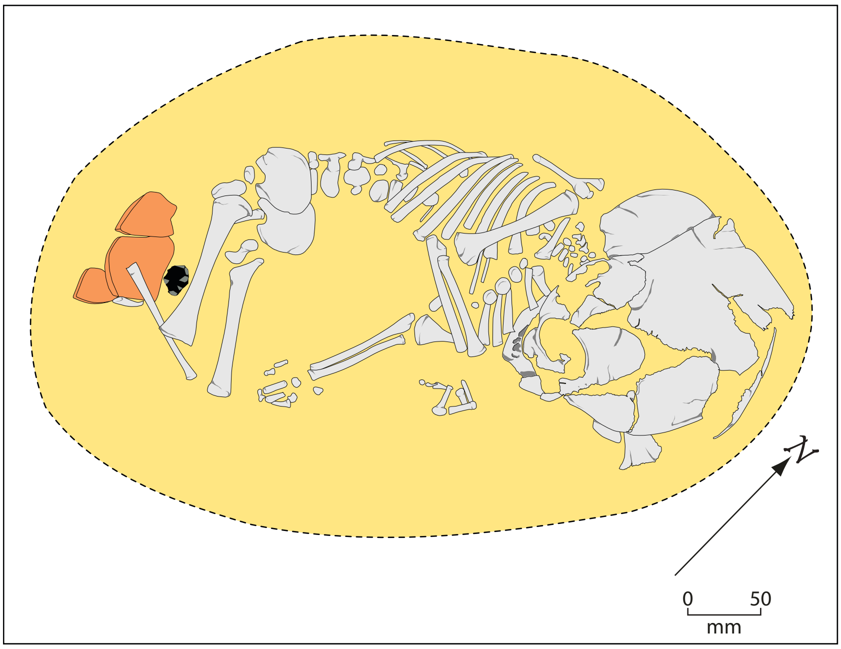

Figure 7.24. Kōiwi 19.

Kōiwi 20A and 20B
Phase 9

This burial bore some resemblance to the burial of Kōiwi 15 as it contained mostly disarticulated remains of the small bones of the skeleton, but with an articulated foot and lower leg and an articulated hand. There were also two groups of ribs in which the ribs lay parallel to each other in anatomical position, as if they had been held together as a section of ribcage by soft tissues when they were placed here.

As with Kōiwi 15, there were remains of two adults in this grave and in this case many could be assigned to an individual based on their size. One very large and robust adult (Kōiwi 20A) and one smaller adult (Kōiwi 20B) were represented. There were no skull fragments, but there were two teeth and the hyoid (upper neck region) was present. Both the left and right fibulae (lower leg) were present, but their length and appearance indicates that they belonged to two different people.

The question with this burial is whether this is a primary grave that had been revisited and disturbed, or whether this was only ever a burial of incomplete, mostly disarticulated remains (a secondary burial, where the body had been buried or exposed elsewhere prior to being buried here). In favour of the former is the fact that the articulated right lower leg that lay on the base of the grave, with the kneecap next to it. The whole, articulated skeleton could have been here once, folded into this oval grave cut with the right lower leg on the base. It could then have been disturbed later by the retrieval of the skull, most limb bones and a number of other bones, and possibly with the (intentional or unintentional) addition of a few bones of a second individual.

Also in favour of this scenario is the fact that most of the bones in this grave were found at different levels throughout. This scattering through the fill could be caused by disturbance of a grave, with the soil within it being turned over as certain bones are retrieved from the complete skeleton at the base. As with Kōiwi 7 and 15, this was not the deliberate burial of a bundle of disconnected bones that were placed together on the base of a pit.

The bones in this grave are predominantly of the hands and feet, but a few other small bones from throughout the body were present and are interesting to note, since they repeat a pattern that has been seen at another site in the Auckland region. Kōiwi 20 also included the coccyx (tailbone), hyoid and ossified thyroid cartilage (both from

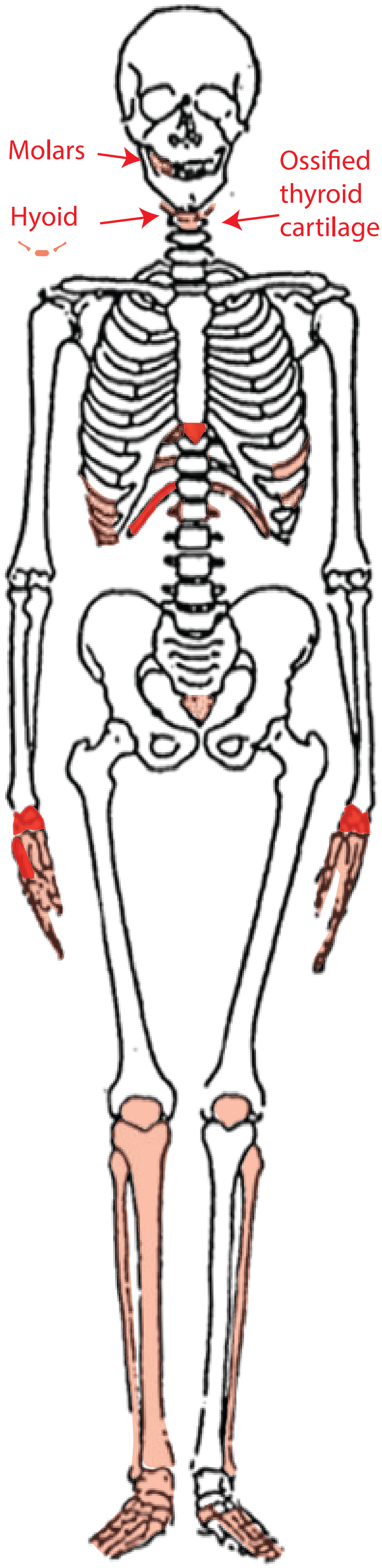

Figure 7.25 Diagram showing the bones present for Kōiwi 20A and B.

the front of the throat), the patellae (kneecaps) and the posterior arch of a vertebra that has split into two parts with a condition called spondylolysis. This is reminiscent of a pattern of elements that were found in a number of secondary burials uncovered at the NRD site on the banks of the Manukau harbour (Hudson and Campbell 2011).

Both individuals 20A and 20B had some degree of arthritis. The more severe osteoarthritis, shown by polished joint surfaces, affected several bones of the right and left wrist of Kōiwi 20A, hand bones from both 20A and 20B and also on two foot sesamoids from either 20A or 20B. Milder arthritic changes were noted in several other bones of the wrists, hands, feet and kneecap (left and right trapezia, left trapezoid and left triquetral of 20A, foot phalanges of 20A or 20B, hand phalanges of 20B, and left patella of 20A).

The tibia (20A) showed some healed injury to the ankle area. On the instep side of the tibia shaft, close to the ankle, the bone had a slightly swollen and misshapen appearance. Radiography showed that this was probably a healed fracture that had taken place a long time before death and had healed well, leaving only subtle changes to the bone.

Kōiwi 21
Phase 9

This was a burial of a woman who had died when she was in her middle adult years. She had been laid on her back in a roughly oval grave with her legs and arms flexed and tucked up over her body (Figure 7.26). The grave was a small and oval (720 x 420 mm x 440 mm deep), just large enough to fit the very tightly crouched body. The feet and cranium had been highest in the grave and there had been some disturbance to the feet.

The body had been very tightly bundled into the grave. The knees were tucked right up to the shoulders to the extent that the patellae (kneecaps) touched to scapulae (shoulder blades) and there was little room between the skeleton and the walls of the grave cut. Her lower legs were stacked directly on top of the femurs, which in turn lay directly on top of the bones of the torso. The clavicles were very steeply angled, showing that the shoulders had been hunched up very high. It is not clear whether this tight bundling would have been caused by binding/wrapping or simply by fitting the body snugly into a small grave. Certainly, she cannot have been a corpulent person at the time of death.

The woman had poor dental health. Although she had not lost as many teeth as some of the other older women at the site had, such as Kōiwi 13 or Kōiwi 18, her teeth showed severe wear, large cavities, evidence of infection and abscessing around the roots, ragged and receded bone around the sockets resulting from infection of the gum and bone, and calculus (tartar) deposits. Many of her teeth had been worn down through use, erosion also contributed to destruction of the teeth and this indicates an acidic aspect to her diet. The right first molar crown had been hollowed out and half destroyed by a massive cavity. The neighbouring tooth (P2) and one molar (right lower M3) also had cavities and several teeth had cupped areas of exposed dentine.

Other than this, there was very little other evidence of injury or disease in her skeleton beyond some minor joint degeneration in her knees and jaw.

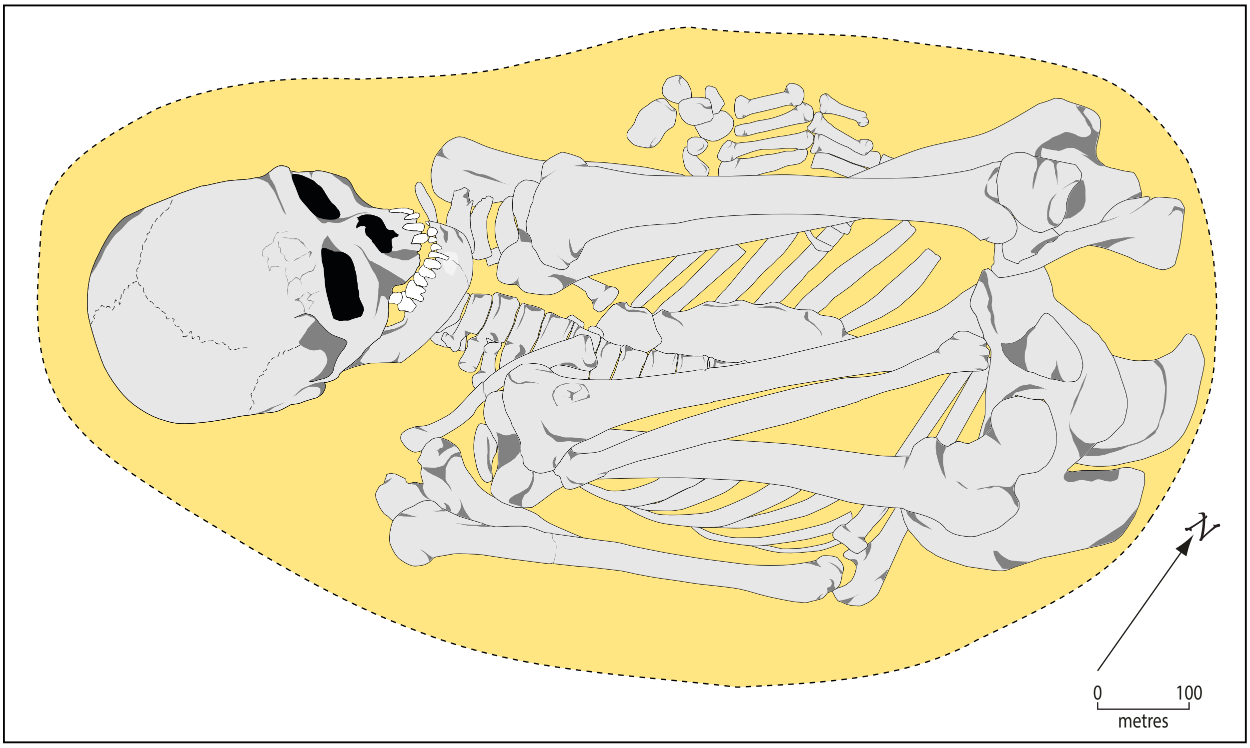

Figure 7.26. Kōiwi 21.

Kōiwi 22
Phase 9

This was a complete burial of a man who had been placed in an upright sitting position within a deep, straight-sided oval grave. His shoulders sat against the south wall of the grave, but the neck was draped forward over the knees with the head resting on the lower legs. The legs were tightly flexed and drawn up against the body and the ankles and feet were side by side. The arms were by the side of the body with the forearms crossing over the abdomen (Figure 7.27).

The position of the feet and ankles suggests some degree of binding of the lower legs. The right foot was lying slightly over the left foot and its metatarsals were pressed together into an arched position. Some binding or matting material probably constrained the foot. The feet sat very tightly together, despite there being plenty of room around them in the grave – another indication that they had been bound together and prevented from relaxing and splaying apart.

The joints of the pelvis indicated that this was a young adult, probably between the ages of about 25–35 and while the pelvis mostly appeared male, the skull gave a mixed reading, so this person has been considered a 'probable male' ('M?'). The skeleton was generally large and robust.

The teeth were fairly worn, though relatively free of dental pathology compared to others at the site, probably owing to his youth. His teeth bore evidence of growth disruption when he was a young child. Three of his lower front teeth (left I1 and I2, right C) had linear enamel hypoplasia – grooves in the enamel caused by a temporary cessation of growth between about the ages of 2 to 5 years and possibly in up to three separate episodes. The young man recovered from the illness or whatever caused the physiological stress and the hiatus in growth and went on to grow to a normal height with no other obvious signs of growth retardation or childhood illness remaining in the skeleton.

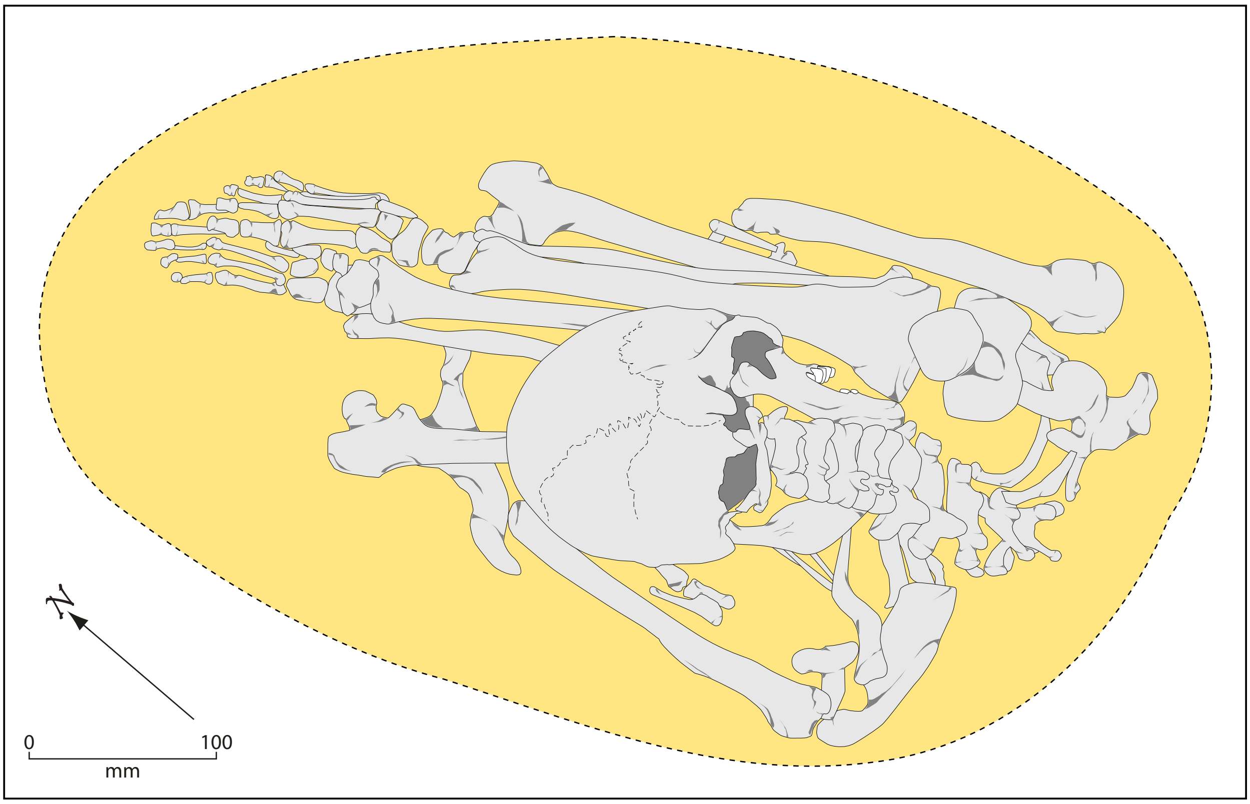

Figure 7.27. Kōiwi 22.

There was very little evidence of illness or disease in this man's skeleton, other than a couple of points of minor joint degeneration. There were also a few miscellaneous anomalies and developmental variations on several bones, detailed in the technical report.

Kōiwi 23
Phase 9

This burial of a very young baby was discovered beneath the base of the grave cut for Kōiwi 18. The tiny remains of the baby were in a small depression (265 x 268 mm) filled with fine, loose sand. The baby had been buried first, and Kōiwi 18 had been buried at a later date over the top without disturbing the baby. Only 10–20 mm of sand separated the two graves. It is unknown whether the proximity of the two burials was intentional. Other burials at the site were presumably marked somehow, as they appeared to have been revisited for retrieval of bones, so this baby's grave may also have been marked and the woman deliberately placed here, but this is uncertain.

The baby's skeleton was partially flexed with the torso straight but the legs tightly folded (Figure 7.28). The knees were not together but the feet had been together. The skeleton was fully articulated, showing this to be a primary burial

This baby was about the same age as Kōiwi 19 – between birth and about two months old – but this baby's long bones were shorter than Kōiwi 19, so although these two infants were at a similar stage of development, Kōiwi 23 was smaller.

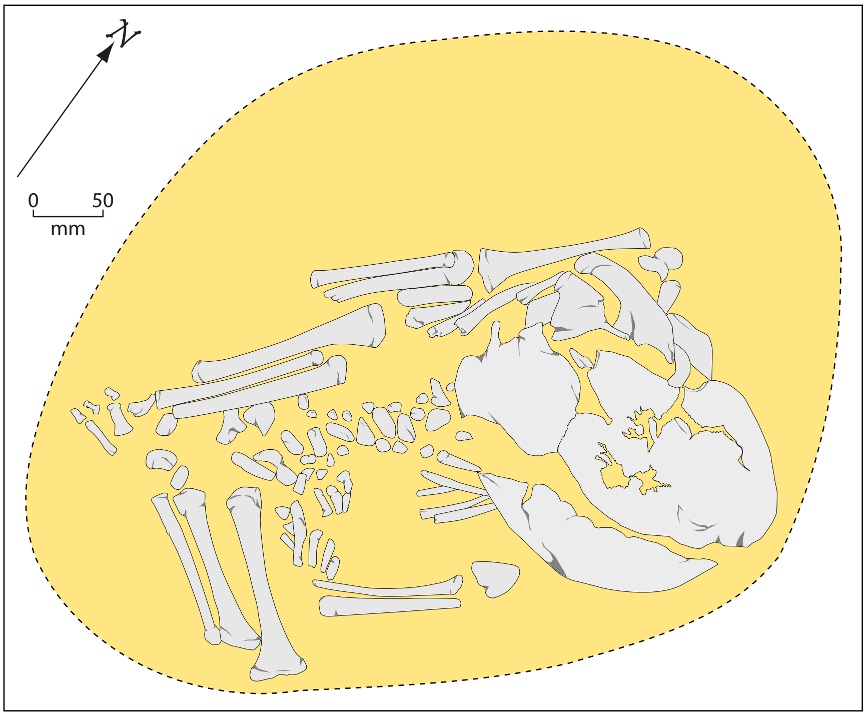

Figure 7.28. Kōiwi 23.

There were no signs of illness or ill health on the bones. The infant's bones were in fair condition, generally better than those of Burial 18, though some bones had weathered, with flaky or very fragile outer surfaces.

Scattered Bone

In addition to the 23 burials, there was bone scattered across the site in other non-burial features and layers. Over 841 fragments of human bone were recovered from non-burial contexts. Some of the scattering of bone fragments was caused by disturbance due to the levelling, construction and demolition of the restaurant building, but there had also been scattering of human bone in pre-European times, caused by the activity of those who occupied and buried their dead at the site.

Condition

The condition of the bone varied widely from very good to poor, weathered and flaked bone that appeared to have been exposed to the elements or been buried in poor soil conditions. There was no burnt bone and no bone bearing cut or gnaw marks. In this respect, the collection of loose, scattered bone at this site differed from that uncovered in the midden at the NRD site on the Manukau Harbour (Hudson and Campbell 2011) and in the thick occupation layer of the Masonic Tavern (Hudson 2014), located on the edge of the Waitematā Harbour, some 20 kilometres to the south of Long Bay. In contrast to those sites, at the Long Bay site there was no evidence of human bone being burnt, cut, gnawed or forcibly disarticulated.

Bones present

The kinds of bones that were present among the scattered human bone are interesting to note: it was generally small bones, not pieces of large bones that had become scattered. Small bones from various parts of the skeleton were present (e.g., hyoid bodies, xiphoid processes, ossified thyroid and costal cartilage, coccyx segments and even an auditory ossicles, a tiny bone from the inner ear). There were relatively few fragments of long bones of the limb. This is important to note in order to consider the means of scattering and fragmenting of this bone. When bone is broken for use as a material, such as to make tools or ornaments, or to remove the flesh for consumption we can expect to find fragments of long bone that have been broken through this processing of the body. Similarly, if whole burials are disturbed and damaged to a high degree, small fragments of the larger bones can be expected. The absence of this kind of fragmented, dispersed bone at this site adds to the impression that the scattering of bone here was largely accidental. Presumably, when graves were revisited to remove larger bones, small bones either remained in the grave cut or were scattered into the surrounding soil

The majority of bones/fragments were adult, but there was also a large proportion of subadult (infant, child and a few adolescent) bone amongst the loose bone. The presence of a lot of subadult, and particularly infant bone in the non-burial contexts could be a result of shallow infant or child burials being easily disturbed by either modern or pre-European activity over the grave.

Red ochre/ kōkōwai

There was a small group of infant bones stained red, presumably with kōkōwai (red ochre). The bones were scattered through sand disturbed by the restaurant building (Phase 14). There was not a lot of evidence for the use of kōkōwai in the burial ritual at this site, though kōkōwai staining is a relatively common finding with pre-European kōiwi. Red staining on bones has been noted at a number of archaeological sites (Trotter 1967, 1974, 1975; Prickett 1990; Hudson and Campbell 2011; Cruickshank et al. 2016) and its use was described by early observers of traditional Māori mortuary practices and has been noted to be a burial custom that was in common at all stages of pre-European history throughout the country (Oppenheim 1973: 44, 63). Two pieces of kōkōwai were found in the excavation, from Phases 10 and 12 (Chapter 5).

Disease and injury

A few of the scattered bone fragments had pathological bone changes or anomalies, generally similar to the kinds of bone changes that had been seen in the individuals in the burials at the site.

One adult cranial fragment (HR 430), of a probable male, had subtle changes in the roof of the eye socket that indicate a period of anaemia as a child. Another adult cranial fragment (HR 431) had porous new bone on the internal surface of the maxillary sinus – a sign of chronic sinus infection. This can result from respiratory infection or can be spread from dental infection.

Three foot bones (first proximal foot phalanges) had hollows or erosions in the joint surfaces that have already been described in several burials at the site. Two of these and one atlas (the first cervical vertebra, HR 1962) also showed signs of arthritis. One bone from the right hand MC2 (HR 1900) had a smooth, bulbous proliferation of bone that mushroomed from its shaft.

Finally, one hand bone (metacarpal, HR 1976) from a child was covered in finely porous new bone. This gave the shaft of the bone a 'puffy' swollen appearance. This kind of bone change results from inflammation that can be caused by infection or trauma to the bone. Without the rest of the child's skeleton it is unknown what caused this illness in the bone but the nature of the bone changes show that it was active, not healing, at the time of the child's death.

Discussion and conclusion

The full analysis of age and sex, ancestry, stature, disease, injury and burial practice is presented in Volume 2. A summary is presented here.

Burial practice

At least 23 people were buried at this site in three Phases. The first two burial Phases, Phases 3 and 9, date to the mid to late 15th century AD, while Kōiwi 2 from Phase 13 was dated to the 16th–17th centuries. Due to disturbance from restaurant construction, it isn't certain that all burials assigned to Phase 13 were contemporaneous; at least some were later than the main period of occupation. Men, women and children were buried here in simple graves, mostly without accompanying artefacts. In the case of Burial 5, a small kit of bone awls was placed in the grave by her head. The manner of burial of some of these individuals shows that the mortuary rites were not necessarily simple, and that they sometimes involved a multi-stage process in which graves could be revisited some time after the initial burial.

Some people were buried and remained undisturbed, leaving a complete skeleton in the grave. Among these, there were no obvious differences between males and females, adults and children in terms of body position or orientation. Others were later revisited in order to remove some bones from the grave. All of these revisited graves were missing the skull and the majority of the long bones, so retrieval of these bones appears to be the purpose of revisiting the graves. What was done with those bones is unknown; it is quite likely that they were gathered up for an additional stage of mortuary ceremony before final deposition in a cave or some site of secondary burial. Ethnographic and historic evidence (Oppenheim 1973) suggests that they could have been displayed for mortuary purposes to aid with grieving or to farewell the spirit, they could have been used to symbolise personal and political relationships, or they could have been desecrated for revenge or subjugation. The bones may have been deposited in a cave or location that acted as an ossuary, they may have been bundled together and buried as a secondary burial or they could have been scattered or used for materials to make items of human bone. A number of different such possibilities are indicated by historic documents describing Māori mortuary practices, which have been collated and discussed by Oppenheim (1973). Māori traditional knowledge of former burial rites would no doubt be able to provide further insight.

It is difficult to say whether there was any sex or age based differences regarding whose grave was to be revisited and whose remained undisturbed, since the revisited graves were often missing bones required for age and sex estimations. Of the seven graves classified as revisited, two were identified as male, while none were identified as female. Changes over time are not apparent, as the numbers for comparison in each Phase are small. As for who was revisited and who wasn't, it could be that some aspect of their individual status or manner of death determined what was to happen to their remains. It must be kept in mind however, that it is always possible that the 'primary' burials were simply waiting to become 'revisited' but that for some reason that revisitation never took place.

The mention of burials often causes people to think of grave goods and valuable items buried with the deceased and it is true that one of New Zealand's most famous excavated burials sites, Wairau Bar, is known for the elaborate artefacts placed in a small number of the graves (Duff 1977). But in fact, the provision of artefacts with the dead does not appear to be the norm, at least with late pre-European Māori burials. At the Long Bay Restaurant site, only three out of 25 individuals (12%) had durable artefacts (i.e., made of materials that have preserved) deliberately placed in the grave: Kōiwi 5, a woman with a kit of bone awls; Kōiwi 3, an infant with strings of *Antalis* shell beads; and Kōiwi 19 a newborn infant with stone flakes on the base of the grave, directly under the left leg.

Contrary to the once-held notion that grave goods, as a sign of status, were more likely to be found with males (e.g., Duff 1977), grave goods at this site were found with one woman and two infants. It is not clear what the meaning was of placing these items with the deceased. In the case of Kōiwi 5 and her kit of bone awls (Chapter 4) it may be that these items belonged to her and relate to a specialist skill in working textile or skins. It has been suggested that *Antalis* shell beads, present on cloaks, shrouds or as jewellery, are the only ornament material particularly associated with children's burials (Davidson 1984: 81; Leach 1977), though this suggestion needs to be researched in order to be better established. Other examples of burials of infants and young children with *Antalis* beads have been recorded in the lower North Island (Palliser Bay, Castlepoint and Paremata).

Although there are a number of uncertainties about the meaning of the variation in burial practice seen at the site, the Long Bay burials demonstrate the following:

1. mortuary treatment of a body after death could be a multi-stage process that involved returning to the grave;
2. whether purposefully or not, not everyone received this revisitation;
3. different parts of the skeleton received different treatment – the skull and bones of the limbs were removed, and sometimes other bones of the torso, but the small bones of the hands and feet and a number of other small bones were left behind;
4. it was not considered necessary to gather all the bones, even leaving lower leg bones behind in some instances;
5. revisitation of burials shows that they must have been marked or their location accurately remembered somehow (presumably this is not easy in a sand dune environment without clear marking);
6. this later stage of burial practice shows that the remains of the dead continued to have a role to play after an individual was deceased – this could have served emotional, social, spiritual or practical functions;
7. some people were buried with grave goods, but this was not the norm.

This is not the only site at which a number of different approaches to burial have been recorded. The Long Bay Restaurant revisited burials are interesting to compare to a similar group of burials at the NRD site (R11/859) on the Manukau Harbour. There, eighteen burials contained a very similar selection of small bones to those found in Kōiwi 7, 15 and 20. Bones of the hands and feet were always present and usually several of the following: the hyoid and/or ossified thyroid cartilage, xiphoid process, patellae, coccyx, one or more loose teeth or ribs. At the NRD site, these burials generally were in graves too small to have contained a whole body and so they did not give the impression of resulting from a 'revisited' grave. Rather, some mortuary process took place that resulted in these small bones being specifically collected. One possibility is that these were the small elements that detached from a corpse that was being left on a platform or in the open to decompose. These small bones could have detached from the rest of the body, or remained after the rest was taken away, and been gathered together and buried separately. The Long Bay burials indicate that such a collection of bones could also result from a primary burial being revisited to remove bones, leaving small bones behind.

While aspects of burial practice are similar to the NRD site, one clear contrast is in the nature of the scattered bone. At Long Bay, bone appeared to have become scattered accidentally through later activity. Few bones were burnt, there were almost no fragments of the limb bones, there was no evidence of cut marks, very few appeared to have been exposed to the elements or animal foraging, and some of the scattered bones were stained with kōkōwai – indicating an element of burial ritual. At the NRD site, scattered bone from all parts of the body had been dispersed through the overlying shell midden and had become burnt, finely broken, or bore cut or chop marks (Hudson and Campbell 2011). This is in part due to historic period ploughing which had disturbed bone out of shallow contexts, but other bone was clearly disturbed in pre-European times. At the Masonic Tavern site in Devonport (R11/2404) (Hudson 2014), a large quantity of scattered bone was dispersed through a cultural soil layer, and examples of burning and dog gnawing were present. At those sites, human bone had been left or become exposed and appeared to have been used, worked or consumed by dogs. Both of these sites contrast with the nature of the scattered bone at Long Bay, where the dispersal of bone appears more accidental and was probably to some degree caused by the disturbance when revisiting graves to remove certain bones.

Disease and injury

The Long Bay kōiwi also show evidence of disease and injury that give insight into aspects of the lives of these people. Violence seems to have affected some, with two women and a child killed by blows to the head. It is possible that they were killed in the same violent event – all three were buried in the last burial phase at the site. If so, they did not lie where they fell – other members of the society gave these bodies a burial that observed certain rituals or norms of their time: their legs were folded up, or their whole body was arranged in the crouched position, and the bodies were placed in individual graves. In contrast, those adult males at the site who had evidence of broken bones had relatively minor fractures from which they had healed. None appeared to have died from violence.

The people at the site showed many examples of skeletal or dental wear and tear that is fairly typical of pre-European Māori. Their teeth were heavily worn and many had arthritis in the joints. This kind of degeneration was not only found on older adults. Some young adults were already suffering spinal or dental problems that indicate heavy use and hard work for the bones and teeth. Arthritis mostly affected bones in the hand, foot, wrist and cervical (neck) or lumbar spine.

Heavily worn teeth were very common among pre-European Māori and the people of the Long Bay site were no exception. Their diet was clearly abrasive and many people had such heavy tooth wear that they were left with teeth worn to enamel-less stumps by the time they were in their mid-adult years. The majority of adults had at least one tooth that was severely worn like this and for several of them this had led to abscessing in the jaw or infection spreading to the bone of the face. Three women had 'fern root plane wear' – a specific kind of heavy wear and dislocation of the tooth has been suggested to result from the practice of feeding a stick of roasted fern root in an inward direction across the back teeth (Taylor 1963). Two older adult women also had other kinds of steeply angled wear that indicate some particular activity, possibly use of the teeth as tools, and this could merit finer study to establish kinds of use and activities. One woman and one man stand out as possibly having a slightly different diet that caused cavities that were not seen in others.

Volume 2 gives further detail of examples of cases of infection and inflammation, possible metabolic diseases and lists genetic anomalies and disorders. Notable among these are the fact that the Long Bay kōiwi provide further examples of probable gout in pre-European Māori. Gout among Māori has been a focus of study since the middle of the 20th century. This is partly due to the fact that modern Māori have for a long time been reported to have the highest prevalence of gout in the world, much higher than European New Zealanders. Traditionally associated with food and lifestyle, the contribution of genetic predisposition to the disease is increasingly being recognised. The finding of gout in two other pre-European archaeological sites, Wairau Bar and the NRD site (Buckley et al. 2010; Hudson and Campbell 2011) contradicts previously held notions that Māori were free of it until the introduction of a westernised diet and lifestyle. The presence of the disease at this site was probably due to a combination of genetic predisposition and a diet that was rich in certain proteins. Such discoveries are contributing to upending older theories of the history of gout in Māori and are helping to highlight the genetic predisposition to the disease, rather than attributing it only to modern diet and lifestyle.

The group of calcified nodules found with one woman (Kōiwi 2) at this site are probably calcified lymph nodes and may have resulted from an infectious process in her body, though they require further study to explore this suggestion. They are a very rare find archaeologically, and for this reason are worthy of further consideration. Together with the record of disease and injury for all people at the site, they add to our understanding of matters of health for pre-European Māori and, by future comparison to findings from other sites, can help to chart changes in this over time.

Discovering and then excavating and moving kōiwi from their resting place can be upsetting and unsettling and is not something that New Zealand archaeologists and osteologists take lightly. The kōiwi at Long Bay were excavated because the restaurant overlying them was due for extensive renovations that would have seriously disturbed them. As the full extent of the burials became known the decision was made to halt the project. It is probable that further excavation for carparks and utilities would have found even more kōiwi. When kōiwi are excavated this is done in consultation with tangata whenua. The archaeologist's task is to excavate carefully and respectfully, with the intention of preserving information about the individuals, who they were and how they lived, for future generations wishing to have an insight into the people of the past.

8 Discussion and conclusion

The small excavation at Long Bay has revealed significant information about the 15th century settlement of Tāmaki. The occupations occur within a poorly understood period of Maori history that has often fallen into a no-man's land between the highly significant archaeology of first settlement at the turn of the 14th century, and the Māori society that greeted Captain Cook in 1769. The Long Bay Restaurant site contributes to our growing understanding of the accelerating changes that took place in the 15th century.

Summary

The six clearly separated midden layers that were excavated in the roughly 13 x 12 m area of the restaurant allowed the site to be tightly dated using a Bayesian analysis, with occupation falling in a 50–60 year span from a little earlier than the mid-15th to the late 15th century, AD 1430–1485. The steep, smooth calibration curve in this period means the dating is exceptionally tight and the site appears to have been reoccupied around once a decade, although this apparent regularity is probably misleading, an artefact of the modelling method and calibrations. The six Phases could have been, and probably were, more irregularly spaced over that period.

If the site had previously extended west (inland) onto the flat behind the dune, this was not evident in either the 2014 or 2105–16 excavations, where evidence of 19th century ploughing, a mid-20th century campground and disturbance from restaurant activities was observed (Campbell et al. 2014). Occupation in the excavated area was also probably more intensive than the excavated material indicates. The foredune is unstable and each occupation layer was covered over with clean, windblown beach sand following site abandonment, clearly separating the Phases. This instability of the dune would have been initiated in each occupation by the removal of the dune vegetation, and dune mobility has also resulted in the truncation and deflation of occupation layers, with lag deposits of fire-cracked rock and weathered animal and human bone evident. These layers may originally have been deeper and covered a wider area, and some layers may have been entirely destroyed. Equally, some of the excavated layers may not survive elsewhere on the dune, while other layers may not be represented in the excavated area.

Phase 1

The first Phase of occupation at the Long Bay Restaurant site began, based on the Bayesian model, as early as AD 1430 (Table 3.2), although it is quite possible that there were earlier occupations than Phase 1 that have not survived in the shifting dune environment or may survive elsewhere on the site. In the first four occupation Phases, 1, 4, 5 and 7, the charcoal assemblage is dominated by trees and shrubs with very little bracken, indicating a fairly undisturbed environment. Phase 1 only survived over an area of 7 x 5 m in the north east corner of the site (Figure 3.6) but the distribution of weathered mammal and moa bone in Phase 4 suggested that this material was a lag deposit from Phase 1, which would originally have been much more extensive (Figure 3.2). The matrix was generally a mottled grey and yellow sand and the midden was not particularly dense. Surviving features from Phase 1 included one large firescoop and three smaller ones, as well as postholes forming alignments, possibly windbreaks.

Very little material culture was found: a single shell fishhook point and a single flake of Tuhua obsidian from Mayor Island, though it is possible that some of the Phase 4 stone material may be a lag deposit from Phase 1. Fish and shellfish were relatively plentiful. The shellfish assemblage was rich but not particularly diverse or even heavily dominated by tuatua (*Paphies* *subtriangulata*). The fish assemblage was less rich but, while dominated by snapper (tāmure, *Chrysophrys auratus*), had significant counts of gurnard (kumu, *Chelidonichthys kumu*) and yellow-eyed mullet (aua, *Aldrichetta forsteri*), and so was somewhat diverse and even. Small bird numbers were low; moa, mammal and sea mammal even more so. Broadleaf trees and shrubs dominated the charcoal.

Phase 4

Phase 4 was the densest Phase of occupation, both in terms of density of midden, density of features and number of formal artefacts recovered. Phase 4 covered most of the excavated area apart from squares to the south (Figure 3.10), and contained 23 firescoops, often intercutting in a matrix of brown charcoal-stained sand. A comparison of the material excavated from the general midden and from the firescoops indicates that firescoops were not raked out and reused, rather they burned down and another was cut into the dune and the accumulating midden. How regularly this occurred is difficult to say, but the evidence indicates an occupation of some days at least. If the occupying group was small and the midden substantially more extensive than the small area excavated, Phase 4 could represent an occupation of several weeks or even months.

Artefacts included 11 shell fishhook points and two moa bone one-piece hooks, two sandstone files, a broken basalt adze and some pieces of worked bone and shell. The obsidian assemblage was dominated by Tūhua obsidian with some from Te Ahumatā on Great Barrier Island, and there were several chert and greywacke flakes. More shell and fishbone were analysed from Phase 4 than any other Phase and in each case it was probably analysed to redundancy. Shellfish were represented by 28 taxa, dominated by tuatua but with significant quantities of cat's eye (*Turbo smaragdus*). Despite the high MNI, Phase 4 was the least diverse and least even shellfish assemblage. Fish were represented by 19 taxa, dominated by snapper with significant quantities of kahawai (*Arripis trutta*), red gurnard and yellow-eyed mullet. The assemblage is relatively diverse and even. Burnt fish and bird bone were common in Phase 4 which is not surprising given the number of firescoops. Small bird numbers were low, there was some tuatara (*Sphenodon punctatus*), significant quantities of kurī (*Canis familiaris*), kiore (*Rattus exulans*) and sea mammal, and the only non-artefactual moa bone found on site apart from a piece disturbed out of context in a Phase 3 burial. However, all the moa bone and much of the sea mammal was weathered, suggesting that it was a lag deposit from Phase 1 (Figure 3.2). As with Phase 1, charcoal was dominated by broadleaf trees and shrubs.

Phase 5

Phase 5 was separated from Phase 4 by a thin layer of clean sand and, where the sand lensed out, could be distinguished from Phase 4 by being lighter and less dense. It covered 5 x 8 m (Figure 3.13) and contained four firescoops and an area of ashy rakeout. Artefacts included two shell fishhook points, a trolling lure shank, probably of moa bone and a barbed bird spear point made from a long bone of a large bird species. The obsidian assemblage was dominated by Tuhua obsidian, there was a single chert flake and seven Motutapu greywacke flakes, none of which exhibited any polish or use-wear.

Tuatua again dominated the shellfish assemblage with significant quantities of cat's eye. The shellfish assemblage was fairly rich, the most diverse but, due to the low numbers of numerus minor taxa, not very even. Phase 5 had the lowest total fish NISP and 10 taxa were identified, and so it was a rich assemblage, but it was heavily dominated by snapper and was not particularly diverse or even. Few bird and mammal (almost all kurī) were identified and no sea mammal or moa. The charcoal assemblage remained dominated by broadleaf trees and shrubs, with very minor amounts of bracken.

Phase 7

Phase 7 covered 7 x 6 m (Figure 3.15) and, unlike previous Phases, it contained very few features, just three postholes clustered together cut into the mottled grey-brown matrix containing a sparse midden. Artefacts included three shell two-piece fishhook points, a one-piece hook, possibly of sea mammal bone, a broken trolling lure shank, probably of moa bone, an adze and a broken chisel, both of Motutapu greywacke. More than 90 individual human bones or bone fragments were scattered throughout this Phase. Phase 7 contained the largest obsidian assemblage, with Great Barrier Island sources now outnumbering Tūhua obsidian. Two chert flakes and nine Motutapu greywacke flakes were also recovered, none of which exhibited any polish or use-wear.

The shellfish assemblage was quite small, dominated by tuatua and neither rich nor diverse. While snapper was still the most common taxon in the fishbone assemblage, 12 taxa were identified and there were significant quantities of red gurnard and mackerel (*Trachurus* sp.). Phase 7 is the only Phase where snapper counted for less than 50% of the NISP. The assemblage was the only one to be both rich and diverse. The assemblage was notable for containing pilchard (*Sardinops sagax*) (NISP = 38, it was also found in low numbers in Phases 1, 4 and 12), which has not been previously identified in pre-European New Zealand sites. Snapper survivorship profiles (Figure 3.9) indicated that Phase 7, along with Phase 5, was the most weathered assemblage so the fact that small, fine pilchard bone has survived in the numbers it has indicates that many more pilchards were probably originally present. There was more bird bone than in any other Phase and 11 taxa were identified, more than for any other Phase. Even so, none were represented by NISP of more than 2, reinforcing the impression that birding was an opportunistic strategy throughout the occupation of the site. Several forest taxa were represented. Seven tuatara bones were found, some kurī and numerous kiore, a few sea mammal bones and no moa bone. Although kurī were not common, their coprolites were more numerous that in other Phases. Phase 7 also had a concentration of several thousand forest snails which would have been collected incidentally with which ever forest resource was being targeted and, along with forest birds, indicates visiting the forest to obtain specific resources though it is unclear what these are. Some of this may have been firewood, as there is a greater proportion of conifer charcoal in Phase 7 than in any other Phase. Some of the snails are found beneath bark or on fallen trees, but others are leaf litter taxa.

Phase 10

Phase 10 was similar to Phase 7, a sparse midden in a mottled grey-brown matrix, not as dark as Phase 7, containing few features, in this case two firescoops and a small pit. It covered 7 x 5 m (Figure 3.18). The only artefacts were four two-piece shell fishhook points. The obsidian assemblage was dominated by Great Barrier Island sources, with a few flakes of chert and greywacke. A lag deposit of fire cracked rocks indicates an overlying layer that has deflated. This deflated layer may have been quite substantial as it would have contained considerably more fire-cracked rock and hence, probably, firescoops and, possibly, midden than any other layer.

The shell assemblage was fairly small, with roughly equal amounts of tuatua and cat's eye and only very low numbers of other taxa. Because it was not dominated by a single taxon it was quite diverse but not very even. The fishbone assemblage was dominated by snapper with significant quantities of yellow-eyed mullet and red gurnard but only 10 taxa were identified. It was not very diverse but was quite even. There were a few birds, tuatara, kiore (but no kurī) and sea mammal. Bracken and small shrubs are beginning to dominate the charcoal assemblage and broadleaves are exclusively pūriri and pōhutukawa.

Phase 12

Phase 12, which ended around AD 1485 (Table 3.2) was similar to the 'grey layer' first described during the 2014 excavation (Campbell et al. 2014), but the dating indicates it is a different layer, or that the kurī bone dated in 2014 is intrusive. It covered the west and south of the excavated area and contained only a very sparse shell midden, though vertebrate remains were not uncommon. No formal artefacts were found, while the obsidian assemblage was dominated by Great Barrier Island sources. One chert flake was also found.

It contained very little shell and the fishbone assemblage was dominated by snapper. Only 7 taxa were identified and the assemblage was neither rich nor diverse. Small bird, mammal and sea mammal were present in only very low numbers. Bracken becomes more frequent in the charcoal assemblage, broadleaf trees are exclusively pūriri and pōhutukawa, but conifers such as matai and kauri continue to be exploited.

Phase 14

Overlying Phase 12 was Phase 14, a disturbed upper layer containing redeposited material and building and demolition debris. No excavation was undertaken outside the construction footprint so the extent of any upper layer or layers disturbed by construction is unknown. A date of AD 1500–1635 from a kurī bone from the 2014 excavations and a similar date of AD 1520–1670 from a calcified lymph node from Burial 2, Phase 13, indicate continued occupation after Phase 12 at least into the 17th century. It might be assumed that evidence of these occupations survives in better condition outside the area disturbed by restaurant construction.

Burial Phases

The three Burial Phases are not as well dated as the Occupation Phases since no bone, other than the Burial 2 lymph node, was dated. Also, because they were generally cut into and filled with fairly clean sand and had often then been disturbed by later occupation and wind deflation, the stratigraphic relationships between the burials and the Occupation Phases was often not clear. Three burials were securely located beneath Phase 4 contexts and so are assigned to Phase 3, while Burial 18 was excavated beneath the restaurant foundation wall and could be seen in profile to be cut below Phase 10, and so was assigned to Phase 9. Other burials at a similar level and with a similar fill were also assigned to Phase 9, while several at a higher level, including Burials 1 and 2 discovered prior to the main excavation, were assigned to Phase 13. The Burial 2 date at least shows that some of these attributions are correct, but it is quite likely that some Phase 9 and Phase 13 burials will be incorrectly assigned and even that some belong to other intermediate Burial Phases that have not been described.

Given that the six Occupation Phases represent repeated occupation within a short time frame with at least two Burial Phases fitting into this period, and if the occupants were the same group returning to the site on a semi-regular basis, it is likely that the burials originate with this group. Graves were evidently revisited to remove bones so the locations of the graves must have been known. Burial and revisiting burials to remove bones are clearly ceremonial activities, but there is no indication from the middens or material culture of any other ceremony or ritual associated with burial. At the NRD site (R11/859) at Ihumatao the midden can be interpreted as evidence of funerary feasting (Campbell 2011) where the firescoops surround but do not overlie the burial area. The presence of kōiwi and the rites of burial are tapu and highly dangerous to the participants. The tapu, then, must be controlled and made safe though rites of whakanoa in order to protect the participants and allow them to safely resume their normal day-to-day activities, and cooked food was one of the agents through which things could be made noa (Firth 1929: 242). There is no similar evidence at the Long Bay Restaurant site, where firescoops and burials occur in proximity and the midden is best interpreted as evidence of subsistence. It looks as though the Long Bay Restaurant site was being used for two distinct, seemingly unrelated and culturally contradictory purposes: food consumption and ceremonial interment of the dead. It may be that the midden material in fact does represent feasting, or it may be that the burials and occupations represent different groups, but there is no good evidence of either of these scenarios.

The rigid exclusion between activities such as food consumption and burial that we are familiar with in modern Māori culture may not have always applied in the past or to all kinds of people. The practice of burying the dead close to or within settlements is known in East Polynesia and has been documented at Wairau Bar and Oruarangi (Duff 1977; Furey 1996). In Davidson's (1984: 173) archaeological overview of Māori burial practice, she suggested that there appeared to be a general shift over time from primary burials close to settlements to secondary burial separated from settlements. This suggestion was based on a small sample, but in Tāmaki the contrast between the 15th century Long Bay burial practice and the 17th century NRD practice fits this suggested pattern. Even the seemingly most deeply established cultural norms can shift and change over time with varying context.

The early archaeology of Aotearoa

The radiocarbon dates for the Long Bay Restaurant site are relatively early and the site has yielded moa and seal bone, markers of early sites in the upper North Island. It is therefore worth examining what we mean by 'early.' The date of the first settlement of New Zealand by canoe borne colonists from East Polynesia is not yet fully established. While some have proposed a pre-AD 500 date (e.g., Sutton 1987), this is no longer accepted by archaeologists. Anderson (1991) examined the available early radiocarbon dates for New Zealand and applied a process of "chronometric hygiene" to determine which were reliable, and concluded that, prior to the 12th century AD, none were. In fact, the date of settlement is probably later. The Kaharoa tephra that erupted from Mt Tarawera and covers the north east North Island is tightly dated to AD 1314 ± 12 and no archaeological deposits have been definitively found beneath this layer (Furey et al. 2008), although swamp cores indicate some potential human activity immediately prior to the tephra (Newnham et al. 1998: 540; Lowe et al. 2000: 865). On balance, a date of first human arrival between AD 1280 and 1320 seems most likely; Walter et al. (2017) propose a post-1300 date.

Two phases or periods of pre-European Māori archaeology have been recognised since the 19th century when Haast (1871) proposed that the earliest inhabitants of New Zealand were a race of Palaeolithic "moa hunters" who were followed by the Neolithic Māori, whose migration to New Zealand bought kūmara horticulture. Duff (1947) proposed that the differences between the Moa-hunters and the agricultural Māori were due to two waves of migration from Polynesia: the first from tropical East Polynesia by a people who had lost their domesticated plants and animals, except kurī, and a second wave of people who followed once domesticates were reintroduced to East Polynesia from West Polynesia, and kūmara from South America, and who became the Māori.

Golson (1959) recognised that horticulture had been present from the beginnings of human settlement but also noted that early archaeological sites often contain a very different suite of artefacts as well as evidence of moa butchery and consumption. He proposed that the early period, from the first settlement to around AD 1450, be referred to as the Archaic Phase, which was followed by the Classic Phase, although he conceded the situation was more complex and the transition period from one to the other was most likely not short. In his model the change between the two was technological and they were defined solely by artefact typology rather than economy. The changes however were internal and there was only a single migration with subsequent cultural development occurring in isolation (Allen 1987: 17).

The stage models of Duff and Golson were essentially 'culture-historical' models, strongly influenced by similar models developed by V. Gordon Childe in Europe and Gordon Willey and Philip Phillips in North America (Groube 1967: 12; Allen 1987: 15). Changes in material culture for Duff and Golson reflected changes in economy and Māori adaptation to the environment. Archaeologists began to focus on the idea of the cultural adaptation, in a quasi-evolutionary sense, of tropical Polynesians to the temperate environment of New Zealand and subsequent adaptation to environmental changes such as climate change (Anderson 2016), even if some environmental changes such as deforestation, siltation and extinction are human induced (Anderson et al. 2014: 30). This approach became the explanatory framework for both the Archaic and the subsequent development of the Classic

The opposition of Archaic and Classic has the effect of polarising New Zealand prehistory between two extremes, useful in highlighting the differences between the two ends of the sequence but obscuring the continuities and changes from one to another. It implies that change took place all at once rather than gradually (Green and Shawcross 1962). When New Zealand archaeologists accepted a settlement date of ca AD 900–1000, or even earlier, this gave a period of at least 500–600 years for a small founding population of 'Archaic East Polynesian' settlers to grow, adapt to life on a temperate continental landmass and by about 1450, develop into the Classic Māori encountered by Cook in 1769. Accepting a shorter chronology has several implications that archaeologists are only now acknowledging. It implies a very short Archaic Phase of no more than 200 years. Exploration of New Zealand and exploitation of its stone resources must have been rapid and systematic since all high quality stone sources were transported widely from an early date (Walter et al. 2010). The numerous 14th century sites in New Zealand must have all been occupied nearly contemporaneously by a sizeable founding population – there isn't time for population growth off a low base to account for the observed pattern of occupation. Initial colonisation would have been a planned, large scale event, implying discovery of New Zealand and a return voyage in order to inform the homeland that New Zealand existed (Walter et al. 2017).

Various archaeologists have in fact proposed a transitional period, for instance Davidson (1984) developed a three-part sequence, based on settlement patterns, economy and technology, that might differ regionally but still relied on a long chronology. More recently Anderson (2016) proposed a transitional period from AD 1450–1650, marked by an expansion of population, movement into the interior and an increase in the extent and intensity of gardening.

Adding an additional transitional stage puts an even greater strain on the short chronology. Groube (1967) had earlier proposed that a model of New Zealand prehistory based on stages was unnecessary and implied a cultural evolution that had not taken place. He maintained that the two phases of Duff and Golson could be incorporated into a single cultural-evolutionary stage. Groube contrasted 'adaptive change', where culture adapts directionally to changing environmental conditions, with the 'evolutionary change' implied by the stage models of Duff and Golson, and more recently Davidson and Anderson.

Groube proposed that the proper model for pre-European New Zealand archaeology was one that depended on adaptive change and incorporated the period from first settlement to the arrival of Europeans in a single stage. Changes took place and these can be discerned in the archaeological record but, as he pointed out (1967: 11):

> the first people who came here (East Polynesian) were a neolithic, fishing, agricultural people… When Cook came to these shores the New Zealand Maori were still a neolithic, fishing, agricultural people … demonstrably there was no change in the economic status of the people, although practically all of their items of material culture, possibly their art styles, and probably their social organization were transformed from that of the first migrants.

There is no doubt that the archaeology of the first East Polynesian settlers in New Zealand, from ca AD 1300 to perhaps 1450, is notably different from the archaeology of the Māori observed and documented by Captain Cook in 1769, or by numerous missionaries, traders and explorers from the early 19th century. The first settlers would have been met with an abundance of terrestrial and marine resources in a pristine environment, including the moa as well as several other large, flightless bird species that have since become extinct, along with the species that Māori continued to exploit. Moa bone was an important industrial material, used to make tools and ornaments. Sea mammals, particularly various seal species, were also exploited but fur seal ceased to breed in the North Island from around AD 1500 (Smith 2002).

Early sites often contain rich and distinctive artefact assemblages, in fact it was this that Golson (1959) used to define the Archaic: adzes, one-piece 'U' shaped fish hooks made from moa and sea mammal bone and ivory, and composite two-piece trolling hooks, often with stone shanks (Furey 2004; Golson 1959; Prickett 1999, 2007). Personal ornaments such as reel necklace units, imitation whale teeth in ivory or sea mammal bone and disc pendants are distinctively early. Adzes were highly specialized, designed predominantly to make complex deep hulled voyaging canoes, and required high quality, fine-grained stone. There were few sources of such stone and it was moved over long distances from a small number of quarries (Best 1975; Turner 2000). Basalt from Tahanga on the Coromandel Peninsula and argillite from Nelson–Marlborough, and Colyers Island and Riverton, Southland are widely distributed at this time. The same is true of obsidian; Tūhua obsidian often dominates assemblages, although obsidian from several other sources is usually present (Walter et al. 2010).

Overall, the impression of life at this time was one where there were plenty of resources to go around and little competition for them. People occupied prime sites, often near river mouths, that provided ready access to resources and communication routes. Duff's (1947) proposition that they lived at peace is probably generally true, and people lived in undefended settlements on a permanent or semi-permanent basis, in what Anderson and Smith (1996) refer to as transient villages.

Groube (1969: 5–10) points out that the settlement patterns and many of the structures and artefacts attributed to the Classic Māori were first recorded in the historic period following contact with Europeans and adoption of European technologies and economies. Settled villages (kainga), for instance, arose largely as a response to European trade, and with them carved wharenui and pātaka also developed in the forms we are familiar with. Ornaments also changed, in particular the hei tiki became increasingly common as pounamu adzes, now superseded by iron, were converted to tiki, which were then traded to Europeans, often for muskets. This in turn led to the development of the 'gunfighter pā', small ring ditch fortifications better suited to musket warfare than the large and elaborate pre-European pā.

If many of the elements assigned by Duff and Golson to the Classic Māori are from a later date, this further reinforces the proposition that the culture of the first settlers ca AD 1300 was not markedly different to the culture of the Māori that Cook encountered in AD 1769 and the span of pre-European Māori history can be described without recourse to Stages, Periods or Phases. It was the arrival of Europeans, and particularly European crops and technology, that initiated a true phase change in Māori archaeology.

Major change is evident in the 15th century but, rather than an all-encompassing phase change from Archaic to Classic, these changes, firstly, were not necessarily directly connected; secondly, occurred at different rates in different places; and thirdly, occurred throughout the sequence and not just in a transitional period between two monolithic phases.

Some highly visible changes include the extinction of the moa by AD 1450 (Holdaway and Jacomb 2000; Anderson 2000), although moa were never as economically significant in the warmer, horticultural north as they were in the south; an early emphasis on rocky shore shellfish, larger and more easily exploited but also more easily overexploited, was replaced by an emphasis of soft shore species; the beginning of pā construction around AD 1500 (Schmidt 1996, 2000b); and the expansion of settlement from sheltered coastal locations to open coast or inland localities (Gumbley et al. 2003; Campbell et al. 2009; Anderson 2016). These various archaeologically visible events are often the result of changes that are less visible archaeologically – the building of pā signals a response to a (hypothesised) phase of population growth which, coupled with environmental decline (for which there is good archaeological and palynological evidence) led to growing competition over resources and increased warfare.

One of the first and most obvious economic changes for early Māori, and one that was undoubtedly a cause of some of other changes visible in the archaeology, though not necessarily a primary driver, was the extinction of the moa and other large flightless birds, and the contraction in the range of seals from throughout New Zealand to the southern South Island. Small birds continued to be exploited along with kurī and kiore as well as fish and shellfish. Similarly, both rocky shore and soft shore shellfish were exploited throughout the sequence, but the proportions change. Accompanying the loss of large prey species, population growth is often seen as a driver for cultural change putting increasing pressure on resources and leading to several interlinked changes in economy and settlement pattern. The first of these was an increasing reliance on kumara horticulture and an accompanying population decrease in those areas of the South Island that were too cold to grow kumara. In the North Island populations expanded out from their early favoured coastal locations to good gardening soils in inland situations (Anderson 2016). Warfare became more common and from AD 1500 pā begin to appear in the landscape (Schmidt 1996). Settlement centred around pā, which were political statements and monuments as well as defensive positions (Sutton et al. 2003).

Formal artefact forms, initially similar to their East Polynesian antecedents, began to change very quickly as people adapted to new materials (Furey 2004: 39). For instance, the proportions of one and two-piece fishhooks changed as moa bone for large one-piece hooks became less available (Groube 1969: 1). The use of new materials led to changes in artefact design and artefact densities are much lower in later sites. Drill points, used to make one-piece fishhooks from bone, become much less common once moa bone was no longer available. Increasing warfare was probably associated with increasing control over resources and trade and exchange systems seem to have been disrupted. The distribution of stones resources such as Nelson argillite, Tahanga basalt and Tūhua obsidian becomes more restricted and a smaller range of local stone sources are more commonly used. Adze manufacturing techniques also changed as easily flaked fine-grained basalts and argillites were no longer widely available and adzes began to be made in different forms using local rocks, often using hammer dressing and grinding techniques. Simple, expedient flake tools remain common throughout the sequence. The greatest change was in personal ornaments (Furey 2004: 41). Bone necklace units and pendants were replaced with ear pendants and hei tiki, often utilising pounamu which was worked by sawing and grinding. Weapons in stone and bone begin to appear in archaeological sites from around AD 1500 at the same time that defended pā develop; they are unknown from early contexts but presumably moa and seal were killed with heavy wooden clubs which could equally have been used on humans.

While long range mobility appears to have become restricted, in general settlements became more ephemeral as people became increasingly dependent on seasonal movement between gardens, fishing camps and other resources. Pā acted as socio-political foci for hapū, an anchor in the landscape to which they returned, as well as places to store and protect garden produce. Access to fisheries and resources was often dependant on pre-existing use rights and constantly renegotiated political alliances.

The Tāmaki context of Long Bay

The Long Bay Restaurant site dates to AD 1430–1485, which coincides with the end of Golson's (1959) Archaic Phase and the beginning of Anderson's (2016) transitional period. While we have aligned with Groube (1967) in preferring to examine pre-European Māori archaeology without the straightjacket of a stage model, it is likely that this was a period of accelerated change. Few early sites excavated in Tāmaki are well dated so it is not possible to say when, for instance, moa and seal ceased to be exploited, or to trace the details of changes in artefact styles. These events would have occurred at much the same time across the upper North Island but even here fine dating is not available – only recently have technological improvements allowed radiocarbon dates to be reported with a precision of ± 25 years that allows the Bayesian model for the Long Bay Restaurant site to be so successful. The calibration curve for the 14th century and the period of first settlement is much less smooth than for the 15th century and precise dates are lacking. Because it is so difficult to track change across the 14th century it becomes too easy to assign all early evidence to the Archaic and leave it at that.

Only two early sites have been excavated in the built up area of Auckland City, both recent excavations in Devonport: Torpedo Bay (R11/1945) (Campbell et al. 2018) and the nearby Masonic Tavern site, not yet fully reported (Russell Gibb pers. comm. 10 June 2017). Torpedo Bay contains two phases of occupation, one dating to the late 15th–17th centuries while the early phase dates to the 14th–mid-15th centuries. Charcoal and microfossil evidence suggest that the general area was cleared of vegetation by the time the site was first occupied but enough forest trees and wood remained to be collected for burning. A slope wash of soil dating to Phase 1 and containing kumara starch indicates that the slopes of Maunaguika above the site were probably gardened. A somewhat sparse midden was dominated by rocky shore species in Phase 1 and soft shore species in Phase 2, a typical pattern. The Phase 1 midden contained bone of moa and seal, a variety of small birds, kurī, rat, tuatara and a small fishbone assemblage that contained evidence of preservation of snapper for off site consumption. Shallow hearths containing stone but little ash or charcoal are implicated in snapper preservation.

The Mātātūāhu site (Q11/344) on the Manukau Harbour South Head is the source of the Brambley collection, an important and extensive collection of artefacts (Prickett 1987), including a wide variety of adzes and chisels, a twin-lobed pendant, drill points and moa bone one and two-piece fishhooks and tabs. Small-scale excavations have been undertaken but the excavated

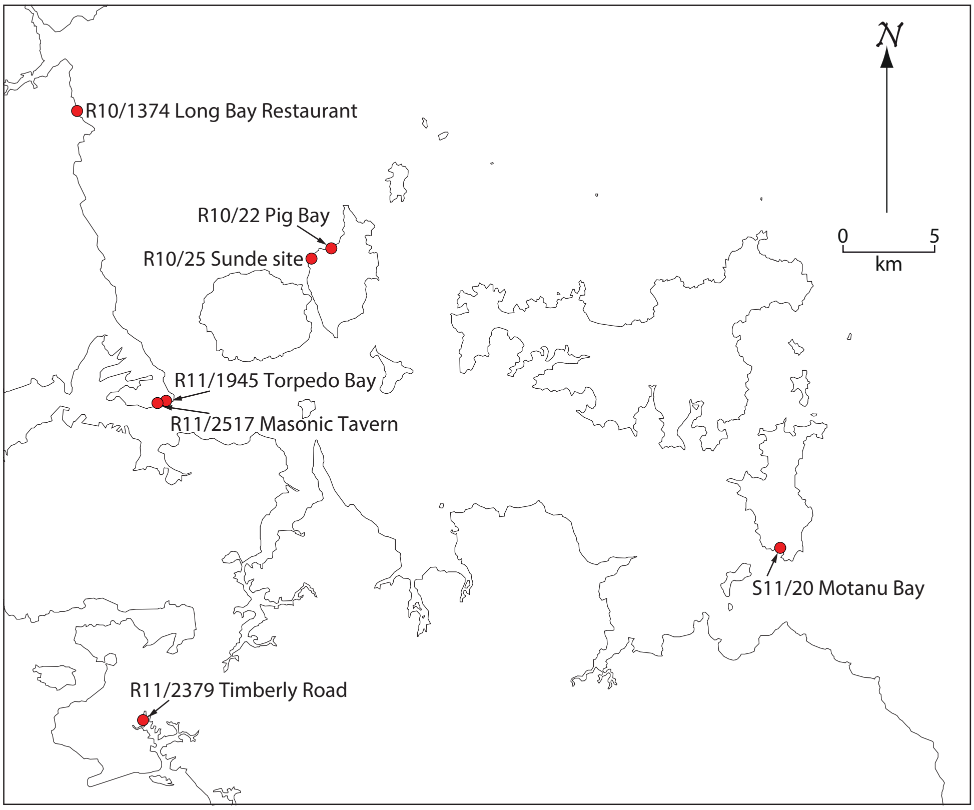

Figure 8.1. Excavated early sites in Tāmaki.

layers have not been definitively associated with the source of the Brambley collection (Ambrose 1961; Prickett 1987).

The remaining reported early archaeological sites in Tāmaki are all from islands in the Hauraki Gulf. The Sunde Site (R10/25) on Motutapu, excavated in the 1980s, contained a layer of midden sitting directly below the Rangitoto ash. The site is well known for the human and kurī footprints on the surface of this ash indicating rapid reoccupation of the area before the ash hardened (Nichol 1981). The midden was dominated by oyster (*Saccostrea cucullata*) and other rocky shore species, with a sizable assemblage of fish, bird and kurī bone. The small amount of moa was almost certainly imported from the mainland as industrial material. The site is not well dated: the eruptions that generated Rangitoto included two in the early to mid-15th century, depositing the layer of volcanic ash that relates to the Sunde occupation (Shane et al. 2013 cited in Davidson and Leach 2017; Needham et al. 2011). The artefact forms support a 14th or early 15th century date.

The Pig Bay site (R10/22), also on Motutapu Island just north of the Sunde site, was excavated by Jack Golson in 1958 and 1959 but only recently reported (Davidson and Leach 2017). The site is also not well dated; dates from beneath the Rangitoto ash on both shell and charcoal give 12th–13th century dates, somewhat earlier than accepted dates for first settlement. The stratigraphy is complex, with several occupation layers cut into layers of naturally redeposited Rangitoto ash and windblown sand. One adze of Nelson–Marlborough argillite and three of greywacke are of "Archaic" form. Most bone fishing gear is sea mammal bone with one possible piece of moa bone. Although most of the faunal material has been lost in the intervening 60 years, Smith (1981: 103) noted that the range of mammalian fauna was limited although Davidson and Leach (2017: Footnote 4) report that over 500 catalogued 'seal/dog' entries are among those missing. The bird assemblage is small and dominated by seabirds, reflecting the probable loss of forest on Motutapu following the Rangitoto eruption. The surviving fish assemblage is dominated by snapper. Davidson and Leach (2017: 34) conclude that the site was mostly occupied between the Rangitoto ashfall and the end of the 15th century, thus largely post-dating the Sunde site, though artefact forms and the presence of seal certainly indicate some occupation in the 14th to mid-15th centuries. The Pig Bay occupation probably overlaps with the Long Bay Restaurant site.

The Mōtanau Bay site (S11/20) on the south coast of Pōnui Island in the Hauraki Gulf was excavated by Vic Fisher in the late 1950s and subsequently reported by Molly Nicholls (1964). Three occupation layers were described. Artefacts included moa bone fishhooks and basalt and chert drill points, artefacts types that indicate an early occupation. Some seal bone was identified, but no moa bone other than the bone artefacts, along with kurī, bird and fish, but these have not been analysed further. These excavations were not dated. The site was subsequently re-excavated by the University of Auckland field school in 1994 under the direction of Geoff Irwin. These excavations have not been reported but are summarised briefly by Sheppard et al., who describe "several shell midden layers of Archaic age" (2011: 52) containing a small amount of moa bone as well as bone of other extinct bird species. X-ray fluorescence analysis of obsidian indicated that about two thirds came from Tuhua, with most of the rest from the Coromandel Peninsula, with small quantities from Great Barrier Island (the closest source). They interpreted the site as representing "a substantial hunting and fishing camp of a group of mobile and maritime people" (2011: 52). The 1994 excavation material dates to the 15th century (Schmidt 2000a: 72; Sheppard et al. 2011: 52).

A firescoop at Timberly Road (R11/2379) near Auckland Airport yielded a late 14th century date although the rest of the excavated site dated to the 16th–17th centuries (Farley et al. 2015; Farley and Bickler 2017). This was an isolated feature roughly 20 m south of the main excavation; such finds serve to indicate that people spread out over the landscape from an early date even if their use of it remained at a low level for many years.

Several other sites around Tāmaki, including the Hauraki Gulf Islands, have been described as early on the basis of artefact forms or the presence of moa or seal bone, though none have been systematically excavated or dated. Often artefacts and bone are found in the intertidal zone, implying a beach occupation now at least partly eroded by the sea and often damaged by roading and housing. The artefacts are therefore disturbed out of their initial context. Most of the early sites are characterised as middens, since they are marked by visible shell, but they are often more than just simple dumps of food waste. Site activities may include gardening, cooking, storage, manufacture of artefacts in bone, stone and perishable materials, and hunting, fishing and shellfish gathering. The survival and condition of these sites is generally unknown and is probably quite variable, but it seems probable that some good evidence of the early settlement of Tāmaki survives, even if some of it may not be readily accessible.

Like other early sites around the country, those in Tāmaki contain a wide range of stone source materials both local and imported. Tūhua obsidian usually predominates but obsidian from the Coromandel Peninsula, Aotea and Northland is often present. Despite Tāmaki having its own source of adze rock (Motutapu greywacke), adzes made of Tahanga basalt and Nelson–Marlborough argillite are common. The early sites of Tāmaki would have had close links to sites of similar age throughout the upper North Island but these links remain unexplored.

Conclusion: temporal patterns at Long Bay

While it seems probable that the sheltered harbours of Tāmaki would have been occupied as early and as extensively as anywhere else in the upper North Island, good evidence for this is sparse. Torpedo Bay, the Masonic Tavern site and probably the Sunde site are all early, while Pig Bay and Mōtanau are a little later, probably overlapping with the early Phases of occupation at the Long Bay Restaurant site. First settlement in New Zealand occurred around the turn of the 13th century and the Long Bay Restaurant site was first occupied somewhat more than a century after this. By this time moa were extirpated in the North Island, if not extinct throughout New Zealand, and seals no longer bred as far north as Tāmaki, although fur seal was exploited throughout the Long Bay Restaurant site sequence, indicating the presence of non-breeding populations.

The six Phases at the Long Bay Restaurant site are all tightly dated, following each other in quick succession over a span of roughly 55 years. Recent dating of site R10/289, 500 m north of the Long Bay Restaurant excavation on the Vaughan Flat, indicates that occupation there may have overlapped with later Phases of the Restaurant site (Trilford and Campbell 2018) while 15th century dates were also obtained during the 2006 excavations on the Awaruku Headland (Phillips and Bader 2007). These may represent different occupations to those from the Restaurant site but they demonstrate that occupation during the 15th century was not confined to the dune, as in fact we would not expect it to be. The Restaurant excavations are only a keyhole into a much larger area that would have been utilised during each occupation. For instance, rocky shore shellfish species were returned to site from the headlands at either end of the bay, 300 and 900 m distant, while forest resources such as birds, wood and leaf litter were also brought on site throughout the sequence from an unknown distance inland, but presumably increasingly far as the bushline receded. Conversely, coastal resources such as fish and shellfish were transported to the Awaruku Headland. Neither the Restaurant site, the Awaruku headland nor the Vaughan Flat were the centres of occupation, rather occupation spanned a much larger area than just one of these places where archaeological evidence survives and has been excavated and analysed.

The immediate environment of Long Bay would not have been readily gardened (and so the forest would not have been cleared quickly, see charcoal analysis on Chapter 3). The sands of the beach flat could potentially have been used for kumara gardening though they are subject to drying out, but the sandy loams of the headlands are poorly drained, podzolized soils that are very wet and slippery in winter and vary hard when dry in summer (DSIR 1954). These soils would not have been suitable for growing kūmara. The peaty soils of the Awaruku and Vaughan wetlands could potentially have been used for taro, but no microfossil evidence was found during excavation at either the Awaruku or Vaughan wetlands (Phillips and Bader 2007, 2010). The Long Bay sites appear to have lacked any significant horticultural component, but given they were a component of a wider local settlement system, gardening would have been carried out elsewhere and garden produce brought on site. Both kūmara and taro starch were found in middens excavated on the Awaruku headland (Phillips and Bader 2007). The extent of the 'local' settlement pattern is unclear, but potentially included much of the inner Hauraki Gulf, where there is an abundance of resources.

There are two models of social change in the 15th century, both with their ultimate causes in population increase. In the more established model, this led to increasing competition for resources, increased territoriality, a breakdown in long distance trade and exchange systems (marked by movement of high-quality stone), and increased warfare, with pā built from AD 1500 on. In the other model, population increase leads to increasing self-sufficiency of local communities and high-quality stone is no longer moved over long distances because people no longer need to move over long distances to maintain biological and social reproductive contacts (Walter et al. 2010). Trade and exchange systems are redundant rather than disrupted. The first model is economic, the second is social. It should be evident, however, that economy and society are closely interlinked, and these two models are not mutually exclusive, rather they are different aspects of the process of social and economic change in the 15th century.

The Long Bay Restaurant site is a stratified site that spans much of this crucial period of 15th century change, and so is uniquely situated to tease out some of the social and economic threads of cause and effect. Charcoal analysis indicates that the local forest was largely intact during Phase 1, in other words the Phase 1 occupation is the first occupation of the wider Long Bay area, or close to it. This is as much as 150 years after first settlement and represents a possible change in settlement patterns similar to patterns that are well documented in the Western Bay of Plenty. Here initial settlement was centred on the Tauranga Harbour (Mallows 2007; Holmes et al. 2014) but around AD 1450 spread east along the Papamoa dune plains (Campbell et al. 2009) and south to the fertile inland valleys that drain into the harbour (Campbell and Harris 2007). At the same time, or a little later in the 15th century, large scale settlement of the Waikato Basin commenced as people moved from the West Coast harbours to occupy fertile inland soils (Gumbley et al. 2003; Campbell and Hudson 2013). Similarly, in Tāmaki settlement has spread out from favoured locations on the Devonport Peninsula and the Hauraki Gulf islands to less favourable locations like the clay-based soils of the northern coastline (including Long Bay), though this process is not rigorously documented elsewhere in the region and we can't comment on the extent and timing of it from just a single example. In the North Island Māori had always been reliant on horticulture, but with this expansion of settlement in the upper North Island away from favoured coastal locations, they became even more so (Walter et al. 2010; Anderson 2016).

The first three Phases of occupation at the Long Bay Restaurant site, Phases 1, 4 and 5, are marked by moderately dense shell middens and numerous firescoops, particularly in Phase 4. Phases 7, 10 and 12 contain significantly less dense shell midden, though still significant quantities of fish and bird bone, and far few features, although it is quite possible that these occupations included cooking areas and dense midden deposits that lay outside the excavated area. It was during Phase 7 that Great Barrier Island obsidian sources become the most numerous (48%) although Tūhua obsidian is still common (42%). In Phases 4 and 5 Tūhua obsidian accounts for 70% and 89% of the assemblage respectively, while in Phases 10 and 12 the proportions are reversed and Great Barrier obsidian accounts for 85% and 70% of the assemblage respectively (Table 5.2, Figure 5.3).

Cruickshank (2011) has demonstrated a shift in Tāmaki from assemblages dominated by Tūhua obsidian to assemblages dominated by Te Ahumatā obsidian around AD 1500 AD. This shift can, on the basis of the Long Bay Restaurant site evidence, be dated to the mid-15th century, though it may have been a process extending over several years, in which case the process extends into the late 15th century. Walter et al. (2010) have suggested that the pre-circa AD 1500 distribution of high quality stone sources – Tahanga basalt throughout the North Island, Colyers Island and Riverton argillite across the lower South Island (Jennings et al. 2018) and Nelson-Marlborough argillite and Tuhua obsidian throughout both islands – reflects the need for small, scattered coastal communities of early settlers to maintain reproductive, economic and social contacts. As populations stabilised and communities became self-sufficient, these networks of contacts became less important and trade and exchange systems become less important. At the Long Bay Restaurant site this process occurred between Phases 7 and 10, perhaps as early as AD 1450. It is notable that moa bone artefacts are found no later than Phase 7. Moa is unlikely to have been present locally as late as mid-15th century but it is possible that moa bone was also moving around in parallel to high quality lithics (alternatively, the artefacts may have been made of 'sub-fossil' bone collected from former kill or processing sites).

To procure high-quality stone over long distances, voyaging canoes must be made, and they are made with specialised adzes of high-quality stone. When long-distance connections are no longer necessary to maintain communities, high-quality stone is no longer moved as far, voyaging canoes cease to be made and local stone readily available to the self-reliant community is quite adequate for the job at hand. By the end of the 15th century, as a result of increasing competition between self-sufficient communities, pā begin to be built, but even here pā are not exclusively defensive structures. As importantly, large, repeatedly occupied pa are social foci of the community and political statements of power. Within the changing social and political landcsape much of the status that may have previously been ascribed to voyaging canoes is now associated with pā.

At the Long Bay Restaurant site these events seem to have occurred in sequence. Initially, expansion from favoured locations to the less favoured uninhabited coastal environments at Long Bay (and, it may be assumed, other similar sites throughout Tāmaki) around AD 1430, signalling the establishment of self-sufficient communities. This was followed by a change from Tūhua obsidian to Great Barrier obsidian beginning around AD 1450–1465, signalling that these communities were no longer reliant on long-distance trade and exchange. Pā construction is thought to have begun at the end of the 15th century (Schmidt 1996) and is argued to reflect an increase in conflict. Although there is no evidence of pā at the Long Bay Restaurant site and there is no evidence of traumatic injury in Burial Phases 3 or 9, two women and a child from Burial Phase 13 appear to have died from blows to the head indicating an increase in violence in later Phases.

It isn't known whether these injuries were due to external conflict – violence inflicted by adversaries from another social group – or from conflict that was internal to the group. A comprehensive study of the evidence of violence in pre-European skeletal remains could help to illuminate this by demonstrating patterns regarding which members of society were most vulnerable to violent injury and whether there was change in evidence for violent injury over time or by region, but such review has been undertaken to date. Reviewing evidence for health and disease among pre-European Māori, Houghton (1980) referred to individual examples of violent injury, but noted that there was insufficient evidence to comment on whether such injuries increased over time as pā developed. Few examples of trauma in pre-European Māori have been described in published literature since Houghton's synthesis, with the exception of the reanalysis of the kōiwi from Wairau Bar, which included one case of perimortem head trauma (Buckley et al. 2010), though an increasing number are documented in bioarchaeological technical reports, including at least four other probable cases of violent head trauma, meaning that review of bioarchaeological evidence for trauma in pre-European Māori could now be more insightful (Campbell and Hudson 2011; Hudson 2011, 2015, 2016, 2017; Littleton et al. n.d.; Littleton and Wallace 2006; Littleton 2015).

The Long Bay evidence allows us to refine the economic and social models of 15th century outlined previously. Populations increased to the point where communities could become economically self-sufficient and this then becomes evident in the archaeological record through such signs as expansion of settlement. Long-distance connections were maintained for a little longer and there was a lag, of perhaps a generation, before they became socially self-sufficient and high-quality stone ceased to move long distances. The system of trade and exchange, dependant on voyaging canoes and the procurement of high-quality stone to make then, would have been expensive to maintain and easily disrupted, and once the system was disrupted there was no need to re-build it. Self-sufficient communities cease voyaging and become more inward looking, laying greater claim to their own resources. Social and political, though not necessarily economic, competition develops, and pā construction begins as a sign of this at the end of the 15th century as the local settlement pattern intensifies.

This seems like a simple chain of cause and effect – population increase leads to self-sufficient local communities, leads to cessation of long-distance voyaging and exchange, leads to increased territoriality, leads to warfare and pā construction. But history is not linear and this apparent simplicity obscures what is likely to be a more tangled web of local changes occurring at different times and in different ways that had separate, though interrelated, causes. For instance, it isn't clear that a date of AD 1450 for the beginnings of this process of contraction of social networks, marked in Tāmaki by the change from Tūhua to Te Ahumatā obsidian, can be generalised to the rest of the country. At Long Bay it may have been triggered by some political, social or economic circumstance particular to Tāmaki and networks may have been maintained for longer elsewhere. Equally, expansion of settlement would probably have been a process extending over years or generations and would have continued after stone distribution patterns changed. The Long Bay Restaurant site is a demonstration that change is a gradual process that would have occurred throughout the sequence and not just in some transitional interlude between two monumental phases that mark either end of the pre-European Māori occupation of Aotearoa.

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