Whales and whale bone technology in New Zealand prehistory

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Abstract

This thesis explores the use of whales as a material resource, and the role that these animals played in the Māori lifeway during New Zealand prehistory. The research examines the methods used in procuring and processing whale bone, and discusses the sorts of items that prehistoric Māori manufactured from whale bone.

Two approaches to the analysis of the role of whales as a resource are taken in this thesis: the first is a distributional study which compares the relationship between whale stranding hot-spots and the geographical distribution of archaeological sites at which whale bone has been reported. It was hypothesised that a strong correlation between these two datasets would indicate that people were locating their settlements near to whale stranding hot-spots to take advantage of the high rate of whale strandings. Secondly, a taphonomical analysis of an industrially worked whale bone assemblage from Kahukura, Murihiku, was undertaken to identify the methods used in processing the bone and to determine the tools being used and the artefacts that were being manufactured.

Industrially worked whale bone occurring in New Zealand archaeological sites was processed using tools which were not intended for the specific use of processing whales. Adzes were the most commonly applied tools, although the use of anvil stones to provide a solid platform for bone working is unique to this resource.

Whale bone in archaeological sites does not correlate strongly with the geographic distribution of whale stranding hot-spots, showing that although Māori were taking advantage of whale strandings whenever they were encountered, they were not a resource which was relied on or factored into their subsistence strategy. The overall finding of this thesis is that Māori utilisation of whale strandings was opportunistic. Communities were not locating their settlements to be close to whale stranding hot-spots, nor is there evidence for a specialist whale bone working tool-kit. However, Māori clearly had a good understanding of whale strandings and the physical properties of whale bone, and were efficiently processing and utilising this resource whenever it was encountered.
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Chapter One

Introduction

1.1. Whales as a resource in prehistoric New Zealand

This thesis investigates the opportunistic use of whales in prehistoric New Zealand through two research approaches; firstly by examining the relationship between whale stranding sites and Māori settlement locations, and secondly by undertaking a case study of whale bone processing methods and technology at an excavated archaeological site. The Polynesians who first settled in New Zealand around 700 years ago would have been well aware of the value of whales as sources of large quantities of meat and industrial bone. Upon settling on the temperate shores of New Zealand, these people were faced with the challenges of adapting to their new environment and obtaining enough food and material resources to support their population. Māori whale exploitation has its roots in tropical Polynesia. Evidence for the use of whale bone and teeth in the manufacture of artefacts in tropical Polynesia has been observed in various locations including the Marquesas Islands, Society Islands and Hawaii (Anderson and Sinoto 2002, Davidson 1984, Kirch 1986, Walter 1996). Whales are the largest creatures that Māori would have encountered upon reaching New Zealand, rivalled only by the largest moa species (Aves: Dinornithiformes) and elephant seals. Over 30 whale species are endemic to the coastal waters of New Zealand and several of these species commonly strand on New Zealand shores.

In considering the major sources of animal-derived material resources for artefact manufacture in pre-European New Zealand we tend to think mainly of moa bone, and to a lesser extent, dog bone, bird bone, seal and sea lion bone. These animals provided food as well as good quality bone for working into an array of tools and ornaments. Often overlooked are the whales; these animals are rarely considered to have been a significant resource in prehistoric New Zealand. We know that Māori were exploiting whales, as whale bones and teeth appear in archaeological sites throughout New Zealand, and often
show signs of having been worked – yet little research has been conducted into the potential importance of whales as a resource of raw material in pre-European New Zealand. There is no evidence that cetaceans were hunted in Māori prehistory (apart, perhaps, from dolphins), which means that the only access to the resource was through stranded or beached whales. Encountering a stranded whale would have been an extremely significant event in the lives of early New Zealanders. A stranded whale could represent food for an entire group for several months, and many kilograms of raw bone for the manufacture of tools, not to mention an array of other possible resources obtainable from a whale carcass such as oil, skin and baleen or teeth. Processing whale bones would have required different methods than those commonly employed for the working of moa bone or terrestrial mammal bone, due to the unique properties of whale bone. In large whale species the bones can be very big, and carry a significant quantity of good quality cortical bone.

Note: The term ‘whale bone’ is used throughout this thesis to refer to the bones from cetacean species. Although many authors refer to the bones of whales as ‘whalebone’ this term actually applies specifically to whale baleen which was commonly used prior to the development of spring steel in making hoops for crinoline, corset stays, umbrella ribs, whip handles and fishing rods (Bannister 2008: 22). In order to avoid confusion, I will be referring to the bones of whales as ‘whale bone’ throughout this thesis, which is in line with the way that other bone resources, such as ‘moa bone’, are referred to. Whale species will be introduced using their common name and taxonomic name, and thereafter will be referred to by only their common names throughout this thesis.

1.2. Related archaeological research involving the use of whales

The most comprehensive studies undertaken on the role of cetaceans in the prehistoric New Zealand economy are Ian Smith’s (1985) PhD thesis in which he carried out an in-depth study on sea mammal exploitation in prehistoric New Zealand (Smith 1985), and Michael Taylor’s (1984) MA thesis which involved a taphonomic analysis of the Twilight Beach bone refuse that contained a large quantity of cetacean bone (Taylor 1984). Smith’s 1985 research included a distributional study of common whale stranding
locations and whale bone from archaeological sites as well as the procurement of seals and cetaceans and their values as food sources. The study was focused on the frequency of representation of different sea mammal species in the archaeological record. A correlation between pilot whale (*Globicephala melas*) bone in archaeological sites and common stranding locations for this species was identified, which Smith (1985) argued is evidence of the opportunistic exploitation of beached whales. This study provides a good platform for an analysis focused on the role of whale bone in New Zealand prehistory and how whale strandings might have affected prehistoric settlement patterns.

Taylor’s (1984) research was based on the analysis of the midden material excavated from Twilight Beach, Northland (M02/14) and the taphonomical processes which had affected the bone refuse, including the marks left by human modification. Several pieces of whale bone were identified and many exhibited some degree of working. The Twilight Beach whale bone assemblage provides a good comparison for other sites where whale bone working is identified. Since the mid-eighties, some more focused studies have included the analysis of cetacean bone at Houhora, an early Māori village in Northland where eight common dolphin were identified along with bones from at least one pilot whale and one medium sized whale (Furey 2002, Taylor 2002). These were analysed by Taylor (2002), who was able to reconstruct the sequence of dismemberment from the cut marks on the dolphin carcasses. There is a definite lack of comparable studies of South Island whale bone assemblages which raises the question of whether the geographical area had an impact on the way that whale bone was utilised, and what impact the relative abundance of alternative resources had on the use of whale bone.

The identification of whale bone artefacts in excavated assemblages in New Zealand is a relatively common occurrence. Some of the more well-known and important early assemblages include Sarah’s Gully on the Coromandel (Sewell 1988), Wairau Bar near Blenheim (Andersen 1940), Houhora in Northland (Furey 2002, Taylor 2002), King’s Rock in the Catlins (Lockerbie 1940), and Little Papanui on the Otago Peninsula (Skinner 1960). Whale bone artefacts from these sites vary from ornamental objects – such as whale tooth and dolphin tooth necklaces, combs, amulets, patu and pendants – to more
utilitarian objects such as paua prisers, fish-hooks and shanks. Whale bone was clearly an important resource in prehistoric New Zealand where raw bone materials in the natural environment were restricted mainly to moa in the early years of settlement, and various small birds, domestic dogs, and marine mammals.

1.3. Whale strandings in New Zealand

The New Zealand Whale Stranding Database (NZWSDB), established in 1988 from a variety of national records, holds archives of all the recorded stranded cetaceans on the New Zealand coast (Brabyn 1991). The database contains entries dating back to 1840, but cannot be considered to be even close to complete until after 1978, when the Marine Mammals Protection Act was introduced and it became government policy to record all strandings. The frequency of contemporary strandings is most likely much lower than during pre-European times. Industrial whaling in New Zealand waters began in the early nineteenth century and severely reduced coastal whale populations, in particular, the southern right whales (*Eubalaena australis*) and humpback whales (*Megaptera novaeangliae*) (Gaskin 1972). These species are only now starting to recover from the devastating losses to their populations. The industrial fishing industry has also impacted on cetacean population numbers in New Zealand waters – particularly the dolphins.

Using the NZWSDB it is possible to map whale stranding ‘hot-spots’ on the New Zealand coast. The frequency of whale strandings around these hot-spots raises the question of whether these locations were recognised by the early Polynesian settlers of New Zealand and prompted them to settle or seasonally frequent these areas in order to exploit stranded whales. This knowledge may have been especially pertinent to the Murihiku (Southland) region – a challenging environment where tropical horticulture was impossible for the Polynesian settlers, but with resources that attracted people early on in the New Zealand sequence. It is possible that one of the factors attracting people to the Murihiku region was access to stranded whales (Jacomb *et al.* 2010). Smith’s (1985) detailed distributional study on the occurrence of sea mammal remains found a clear correlation between pilot whale bones and places where strandings of these animals are frequently recorded. He found that ‘positively’ and ‘tentatively’ identified pilot whale
remains were concentrated around the western margins of the Foveaux Strait area, the northern shore of Cook Strait, the Coromandel Peninsula, the Hauraki Gulf and Northland (Smith 1985, 1989). All of these areas have pilot whale strandings recorded in the last century. The only area that Smith found yielded no pilot whale remains archaeologically, but which was recorded as a place where pilot whales commonly strand, was Hawke’s Bay. It is unlikely that the whale stranding distribution patterns have changed drastically in the last two and a half decades since Smith carried out his research; however the number of excavated sites which contain whale bone has certainly increased.

Building on Smith’s distributional study with whale bone data excavated from sites after the mid-eighties, this thesis will re-evaluate the correlations between whale bone in archaeological sites and the common whale stranding locations, to identify any changes. The focus of the distributional study in this case will be to identify whether Māori people were making informed settlement choices based on the likelihood of encountering stranded whales within the vicinity of their settlement. This could have been either permanent or seasonal settlement; however the latter seems more likely in the early period, as the collection of resources required a transient lifestyle based around seasonal resource fluctuations. Settlement patterns in Murihiku have been strongly linked with specialised and seasonal resource collection. Occupation sites in this area are often short term camps which focus on the gathering of a restricted range of resources. For example, the Hakapureierei site (C46/31) is thought to represent a series of small, short-term occupations all of which contain sea lion and fur-seal bone, pāua and worked whale bone (Jacomb et al. 2010, Walter and Jacomb 2005). It is possible that people were living there for a few days or weeks a year to gather resources, and whales may have been an integral part of this occupation, however little is known about how this resource was used and what importance it played in the life of the Māori people.

1.4. Stranded whales as a source of industrial bone

There are numerous sites in New Zealand where cetacean bone has been found; these are distributed from the south of the South Island right up to the northern tip of the
North Island. In these sites the whale bone turns up in varying quantities and contexts; from large-scale whale bone processing sites with large quantities of material (e.g., Furey 2002, Taylor 1984), through to single artefact find sites. However, compared to the other bone resources which were regularly used by Māori people such as moa, human and bird, whale bone is recovered much less frequently from archaeological contexts. The generally low incidence of whale bone compared to the other bone resources is one of the main reasons that little mention has been made of the potential significance of whales as a material resource. It is possible that the amount of whale bone found in archaeological sites around the coast of New Zealand significantly underrepresents the importance of these animals as resources. Smith and Kinahan (1984) studied cetacean remains from archaeological sites on the coast of South Africa. They describe whales as an ‘invisible’ resource, and state that the reason whale bone is scarcely found in archaeological sites on the South African Coast is because the bones are so large and heavy they were often not transported to sites unless they were intended to be used for tool manufacture – in which case, only the high quality bones best suited to industrial manufacturing were taken. It is much easier to butcher a whale carcass where it is found on the beach, remove any meat for consumption, and leave the heavy bones behind if they have no industrial value. This theory accounts for the general underrepresentation of evidence in South African archaeological sites of whales being used as a source of food. This theory could be applied to New Zealand to explain the often highly fragmented bone commonly found in archaeological sites; Māori were likely removing the cuts of meat and the most valuable bones for tool manufacture at the stranding location for transport to their base camp or village, and leaving the remainder behind.

Whale bone in New Zealand archaeological contexts is often found to display evidence of human modification through the use of tools during the manufacture of artefacts, and commonly shows signs of cutting, drilling, chiselling and adzing. Complete artefacts made of whale bone are also quite common. As a resource it is still prized by present-day Māori for its qualities as a raw material for manufacturing items. Hori Parata, a Kaumatua of Ngatiwai and expert on Māori whale bone processing, considers the most highly prized bone for carving to be that of the odontocetes, particularly the jaw bone of the sperm
whale (*Physeter macrocephalus*) (H. Parata 2013, pers. comm.), which are known to regularly beach on the New Zealand coast (Brabyn 1991). Sperm whale meat has a very high oil content which, when eaten, tends to produce a laxative effect (Cawthorn 1997, Smith and Kinahan 1984), but they were prized for their dense mandibles as a high quality raw material suitable for carving (Taylor 2002). Most whales that commonly strand on the coasts of New Zealand have some degree of workable bone similar to that which is common in the mandibles of *odontoceti*. However, the smaller species generally have a much lower amount of dense cortical bone, making them less desirable to exploit for industrially workable bone. The cancellous bone of whales, which makes up the vast majority of whale bone, is highly porous and fragile, rendering it unsuitable for the manufacture of artefacts. Animals which were less attractive for bone exploitation may have been used primarily as a food source, and evidence for the butchery of whale carcasses for the purpose of removing meat has been identified at Twilight Beach (Taylor 1984), and at Houhora (Taylor 2002).

The utilisation of whales for meat, whale oil, skin and viscera as well as bone was highly likely, but evidence of this is often very difficult to extract from the archaeological record, and is outside of the scope of this thesis. Usually, all that is left is the bone remains, however the taphonomical processes which affect the bone, in the ‘journey’ from a raw material extracted from a whale carcass to its abandonment, can leave many clues as to how the bone was processed and used during its ‘life’. The concept of *chaîn opératoire* or ‘operational sequence’ can be used to describe the techniques used to transform a raw material into a functioning artefact (Bar-Yosef and Van Peer 2009). Bone assemblages from sites which have been interpreted as probable whale bone work-floors, such as Kahukura (Brooks *et al.* 2010) and Hakapureirei (Jacomb *et al.* 2010) form a coherent group bound together by a methodological system which can be analysed using a variety of methods to determine the processing sequence. Processing whale bone involves the use of extremely resilient tools in order to provide enough force to break the large bones down into workable pieces. Possible glimmers of these tools have been identified in a scatter of sites, particularly in the Murihiku region (see Brooks *et al.* 2010, Jacomb *et al.* 2010).
1.5. Research objectives

This research is focused on two central aims:

1. To explore the hypothesis that people were settling near areas where whales were commonly known to strand in order to be in the best possible position to exploit this resource.
2. To determine the processing methods that were applied to industrially worked whale bone in New Zealand prehistory, and to identify the tools that were employed and the products that were being manufactured.

This study combines two research components; the first section is a distributional study which compares the geographic distribution of common whale stranding locations with the geographic distribution of archaeological sites where whale bone has been found. Through this comparative distributional study it will be possible to identify if there is any correlation between Māori settlement patterns during prehistory, and patterns of whale strandings. Opportunistic exploitation of stranded whales has been identified in the New Zealand archaeological record, and their use for both meat and industrial bone has been documented. However, it is not known whether the archaeological record of whale use represents stranded whales which were actively sought out, or whether it represents chance encounters. Although the chance stranding of whales cannot provide the basis for subsistence, they could have served as a substantial and potentially predictable economic windfall and may have been a factor in Māori settlement location choice during prehistory. This component of the research tests the hypothesis that stranded whales were a predictable resource, and during prehistory Māori located their sites near to whale stranding hot-spots. If this hypothesis is correct, we will expect to see a positive correlation between whale stranding hot-spots and archaeological sites at which whale bone has been reported. However, if the hypothesis is null, there will not be a correlation between these sites.

The second section of this thesis is a taphonomical analysis of the assemblage from the whale bone working-floor at Kahukura (G47/148). Kahukura is used as a case study in this thesis to gain a better understanding of how whale bone was treated as an industrial
resource and how it compares to other bone resources available to Māori in prehistoric New Zealand. The Kahukura archaeological site is a Māori fishing camp occupied during the 15th century where a total of 3000 fragments of industrially worked whale bone were excavated from a midden layer. The research focuses on the Murihiku region, where the Kahukura site is located. This region is a good candidate on which to test the theory that whale strandings may have influenced Māori settlement location choice because, as identified by Smith (1985, 1989), a correlation exists between archaeologically excavated whale bone in this region and recorded pilot whale strandings. Furthermore, it has been proposed by Jacomb et al. (2010) that, in an area relatively devoid of resources, Murihiku may have been settled, at least in part, as a response to the high number of whale strandings which occur there. Analysis of the whale bone remains from Kahukura may indicate what importance this resource served at the site and whether access to this resource may have been a drawing factor.

1.6. Thesis structure
This thesis combines two approaches to exploring the use of whales in New Zealand prehistory: a distributional study, and a study of processing methods using an industrially worked whale bone assemblage. Chapter two is the first of two background chapters, and discusses the biological and ecological aspects of cetaceans in the context of New Zealand, including common species and their migration paths. This section will also give an overview of the NZWSDB including the trends of common places where whales strand, common species which strand, and the various factors involved in these events. Archaeological evidence of whale use and the distribution of sites which contain whale bone will be introduced and compared with the NZWSDB. Chapter three is a second background chapter and reviews the ethnographic evidence for the human use of whales, both in New Zealand and internationally. The chapter will discuss Māori use of stranded whales and its industrial qualities and applications. Chapter four presents the comparative distribution section of this research in which modern whale stranding data is compared with the geographical distribution of whale bone in New Zealand archaeological sites. This section explains the source of the data and the methods used in the collection and analysis of this data, then presents and discusses the results of this
study, illustrated with a series of maps. Chapter five explores the theory and methodology used in previous studies that have analysed the processing methods applied to whale bone in New Zealand and internationally. These methods are reviewed in order to apply suitable methods to this study. Chapter five describes the theoretical approach and methods used in the taphonomical study of the whale bone from Kahukura. Chapter six presents and discusses the results of the processing analysis of the whale bone material from Kahukura. Chapter seven gives a synthesised discussion of the results of both the distributional study and the processing study, and explores the ramifications of these results on how we understand the settlement of the Kahukura site within the broader context of the Murihiku region and New Zealand as a whole, and how whales as a resource fitted into the Māori lifeway. Finally this thesis is evaluated for its effectiveness in exploring the use of whales in New Zealand prehistory and the implications of this research for future studies are considered.
Chapter Two

*Whales: a biological and ecological overview*

2.1. Introduction

Whales are members of the order cetacea, which encompasses some of the largest mammal species to inhabit the planet as well as some much smaller species, such as the dolphins and porpoises. Dolphins and porpoises are not generally referred to as ‘whales’, and although they are equally members of the cetacea order, they will be termed separately for the purpose of this thesis. What unites the cetaceans into one recognisable group is that they are water-dwelling mammals, and this environment has modified their behaviour and appearance so drastically that they have become far removed from what we typically consider to be mammals. Unlike the pinniped family, the cetaceans have lost all terrestrial contact and are fully adapted to life in the water. The evolutionary modifications which allow cetaceans to live permanently in water have also had an impact on their bone structure, giving their bones special properties which are favourable for the manufacture of bone artefacts.

The New Zealand waters are home to over half of the world’s known species of cetaceans (Gaskin 1972). The cetacean order is divided into two suborders: the mysticeti (baleen whales), which includes rorquals and right whales; and odontoceti (toothed whales), which includes dolphins, beaked whales, porpoises, dome-headed dolphins and sperm whales. Many of the cetacean species that can be found in New Zealand waters are known to beach on New Zealand shores. Since 1978, 41 out of an international total of over 80 cetacean species have been recorded as having become stranded on the New Zealand mainland and surrounding islands. Although many of these species are dolphins and porpoises, larger species such as the sperm whale (*Physeter macrocephalus*) are included. New Zealand’s location in the South Pacific Ocean falls in the middle of the migration route of many cetacean species that move seasonally between the cold Antarctic and sub-Antarctic waters and the warmer, tropical waters of island Polynesia.
Identification of stranding patterns across the cetacean order can contribute to the understanding of whale procurement by Māori in New Zealand prehistory. If geographical or seasonal stranding patterns are visible in the current whale stranding record, then the probability of stranding events in a particular geographic area can be predicted. One of the hypotheses that this thesis will test is the theory that Māori were incorporating the predictability of whale stranding trends into their settlement location selection. If this hypothesis is correct, it will be visible archaeologically as a correlation between occupation sites where whale bone has been excavated, and areas where whale species are known to frequently become stranded.

This chapter has two parts. Firstly, a description of the biology of whales with a particular emphasis on their skeletal system is given, to provide a platform for understanding whale bone as a material resource, which could be used for the manufacture of artefacts. Secondly, an overview is given of the current understanding of cetacean ecology in the oceans around New Zealand, and the main causes of whale strandings. Use of whales in New Zealand prehistory was essentially opportunistic, thus it is important to understand the causes of whale strandings as these events influence Māori access to these animals.

2.2. Adaption to a fully aquatic life

The ancestors of the cetaceans were primitive terrestrial mammals which began to adopt an aquatic mode of life about 60 million years ago (Baker 1999). They have since evolved along two separate lines – odontocetes (toothed) and mysticetes (baleen). Toothed cetaceans are the dolphins, porpoises, beaked whales and sperm whales. The terms ‘dolphin’ and ‘porpoise’ are generally agreed to be two separate families in which the cetaceans with a long beak and many pointed teeth are dolphins, and those with no beak and spade-shaped teeth are porpoises (Baker 1999: 10). However, these terms are loose, and there is no biological basis to them. The term ‘whale’ is generally applied to cetaceans over about 10 metres long (Bannister 2008). Only whales fall into the mysticetes suborder, whereas relatively few odontocetes are whales.

The path of cetacean evolution has seen the whales shed most of the external traces of their terrestrial ancestry and adopt an almost fully streamlined morphology lacking hind
limbs and hair, and having flippers, flukes and in some cases a dorsal fin. Their bodies have a thick layer of blubber, and they possess specific adaptations for swimming and diving which counteract the upward buoyancy that comes with air-filled lungs. As part of this evolutionary process of adapting to a fully aquatic life, the cetacean skeletal system has changed markedly from the terrestrial mammal skeletal system. Cetacean skeleton modifications are diverse and include the loss of the hind-limbs to obligate locomotion through water, with the exception of a free-floating vestigial pelvic girdle; the modification of the skull to accommodate a melon, or spermaceti organ; the development of a large and flexible ribcage with a minimal sternum; the transformation of thoracic limb into flippers; the modification of the vertebral column to become more uniform; and the loss of the sacrum (Cozzi et al. 2009). Although the most obvious changes have occurred at the gross anatomical level, the evolutionary modifications also occurred in the structural properties of the bone tissue, ranging from the extremely high to extremely low density (Gray et al. 2007). A life suspended in water reduces the static weight-bearing requirements of the skeleton, which is the primary function of the skeletons of land mammals as well as of some flightless birds such as the moa.

Cetacean humeri have become greatly foreshortened and robust, with large muscle attachment sites, whereas the more distal bones of the fore-limb are wider and flatter to form the streamlined flippers (Felts and Spurrell 1965). Photodensitometry measurements from radiographs of humeri of the fin whale (Balaenoptera physalus), beluga whale (Delphinapterus leucas) and pilot whale (Globicephala melas) show a lack of a medullary cavity, and instead display a core of porous bone tissue (Felts and Spurrell 1965). The density of the humeral bone tissue in the largest of these, the fin whale, increases towards the edges of the bone, but lacks a uniform, compact wall of cortical bone (Felts and Spurrell 1965). In all three species, the humeri are made up entirely of porous bone which is less dense in the central region and more compact around the outside; even in the most compressed regions, porosity is apparent to the naked eye (Felts and Spurrell 1965: 185). It is thought that the lack of a medullary cavity in cetacean limb bones provides the flipper with strengthened resistance during fast swimming when the limb is used for steering (Benke 1993, Cozzi et al. 2009). The lack of a dense cortical
shell is a common feature of most cetacean bone elements, and the bones are generally much lighter than those of terrestrial animals. The spongy inner structure of cetacean bone is filled with fatty marrow, and about one third of the total oil yield from cetaceans is held in their bones (Taylor 2002). The qualities of specific whale bone elements lie at the extreme limits of what can be considered ‘normal’ in osseous tissues. At the other end of the bone density spectrum is the male rostrum bone of the Blainville’s beaked whale (*Mesoplodon densirostris*), which has been found to be the most highly mineralised, stiffest and hardest bone known (Zioupos et al. 1997). A separate study has explored the mechanical properties of the tympanic bulla of a fin whale, a bone which serves a purely acoustic function, and found similarly high mineral content (Currey 1979). The high degree of mineralisation affects the mechanical properties of the rostrum, and causes the bone to resemble ceramic material which, although extremely hard, is also very brittle when force is applied (Zioupos et al. 1997: 733).

Some cetacean elements, or portions of elements, however, have a thick cortical layer which, although still relatively porous when compared to land mammals, is attractive to people looking for suitable bone for working. For example, the mandibles of toothed whales are widely known to be a good source of dense bone (Mulville 2002, Taylor 2002). This was recognised by Māori, who favoured the sperm whale jaw bone for artefact manufacturing. However, the mandible bones of baleen whales also exhibit good quantities of workable bones, especially in the larger species. The mandible, ribs and scapulae of the bowhead whale (*Balaena mysticetus*), which was hunted by the Inuit and Yupik people in the northern Pacific and Arctic waters, were prized for good quality bone for making a variety of everyday objects (Whitridge 1999: 109) (see Chapter 3). It is most likely that any kind of stranded whale, whether it is a toothed or a baleen whale, will yield a quantity of dense and workable bone; the larger the whale, the more likely it is that there will be significant portions of quality bone for working, regardless of species. The size of the workable bone will determine what size of artefacts can be manufactured. The sperm whale jaw, for example, provides a very long, thick piece of dense cortical bone, which is both robust and durable. The size and length of the jaw bone means longer artefacts can be made, and the range of artefacts possible is not restricted by size, as
they would be with smaller whale species. Although some species may have been more sought after, Māori were still reliant on those species that became stranded, rather than being able to be selective. The only option for selection was to be positioned where the species with the best bone for working were known to beach most often. Māori knowledge of whale movement and ecological patterns around New Zealand may have allowed them to predict such locations, given their reliance on the coastal environment for a significant proportion of their diet during most of New Zealand prehistory.

2.3. Whales in New Zealand waters

There are several environmental factors that affect the distribution of cetacean species throughout the global oceans, and these can be broken into two groups: static features (bathymetry), which include the oceanic terrain; deeps and shallows; basins and seamounts; and mobile features (hydrology) which include currents, water temperature and water density. These two groups of factors, along with the rise and fall of seasonal temperatures in the temperate and sub-polar regions, have important and complex effects on the distribution of the different cetacean species (Gaskin 1972). Some whale species are migratory or follow predictable oceanic or biomass fluctuations, whereas others tend to be less predictable. Of the approximately 80 known cetacean species throughout the world, over half of these are known to inhabit the waters around New Zealand.

Information about cetacean strandings around New Zealand is held by the New Zealand Whale Stranding Database (NZWSDB), which was set up in 1988 for the Department of Conservation (Brabyn 1991). The database is regularly updated when whale strandings occur, and holds a range of information including the date, the name of the species, the stranding location (in GPS coordinates), the number of individuals, the condition of the animal/s and the contributing factors (if known). Since 1978, 42 different stranded cetacean species have been recorded in the New Zealand Whale Stranding Data Base (Table 1).
Table 1: Number of stranding events and number of individual whales involved for all stranding whale species in New Zealand (since 1978).

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Number of stranding events</th>
<th>Number of individuals stranded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pygmy sperm whale</td>
<td>305</td>
<td>376</td>
</tr>
<tr>
<td>Long-finned pilot whale</td>
<td>257</td>
<td>7569</td>
</tr>
<tr>
<td>Gray's beaked whale</td>
<td>241</td>
<td>381</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>179</td>
<td>227</td>
</tr>
<tr>
<td>Cuvier's beaked whale</td>
<td>71</td>
<td>73</td>
</tr>
<tr>
<td>Minke whale</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Strap-toothed whale</td>
<td>62</td>
<td>75</td>
</tr>
<tr>
<td>Pygmy right whale</td>
<td>49</td>
<td>50</td>
</tr>
<tr>
<td>Killer whale</td>
<td>42</td>
<td>61</td>
</tr>
<tr>
<td>Bryde's whale</td>
<td>32</td>
<td>33</td>
</tr>
<tr>
<td>Humpback whale</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Shepherd's beaked whale</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Andrews' beaked whale</td>
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<td>23</td>
</tr>
<tr>
<td>Antarctic minke whale</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Short-finned pilot whale</td>
<td>11</td>
<td>54</td>
</tr>
<tr>
<td>Arnoux's beaked whale</td>
<td>10</td>
<td>18</td>
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<tr>
<td>False killer whale</td>
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<td>315</td>
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<tr>
<td>Hector's beaked whale</td>
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<td>7</td>
</tr>
<tr>
<td>Dwarf sperm whale</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ginkgo-toothed beaked whale</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sei whale</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Fin whale</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Blainville's beaked whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Pygmy blue whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Southern right whale</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Melon-headed whale</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>True's beaked whale</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Spade-toothed whale</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pygmy killer whale</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Grand Total</td>
<td>1451</td>
<td>9422</td>
</tr>
</tbody>
</table>

The recording of stranding data became widespread with the introduction of the Marine Mammals Protection Act in 1978, but it is still not a perfect record, and low human population numbers in some areas can mean that many strandings go unrecorded.

Although stranding data are important, and can indicate which species are present, they are of little value when trying to determine numbers within whale populations around New Zealand. It is notoriously difficult to estimate the population of whales due to their transient nature, and the populations and distribution of many whale species are not well studied or understood. Furthermore, modern day populations are often not considered
to be representative of the pre-whaling population numbers; this is especially true for the large whales that were hunted in New Zealand waters.

Commercial shore- and ship-based whaling in New Zealand during the nineteenth and twentieth centuries significantly depleted the resident population of southern right whales (*Eubalaena australis*), as well as the blue (*Balaenoptera musculus*), sperm (*Physeter macrocephalus*) and humpback whales (*Megaptera novaeangliae*) which migrate past New Zealand. Southern right whales were once seasonally abundant around the coasts of New Zealand, and populations of these slow-moving whales inhabited its sheltered harbours during the breeding season. The pre-whaling southern right whale population of the southern hemisphere has been estimated to have been between 55,000 and 70,000 (IWC 2001). Within the New Zealand Economic Exclusion Zone (EEZ), they are now found primarily in the Auckland Islands where the breeding population is only around 1000 individuals (Patenaude 2002). The sperm whale population was reduced as a result of whaling, but the impact was not as severe as it was on the southern right whale, probably because female sperm whales are smaller and less attractive to whalers (Taylor 1997). Today the general stock of sperm whales is thought to consist of about 360,000, down from a pre-whaling population of 1,110,000 (Whitehead 2002). Of the other large whales that were hunted, the South Pacific humpback whale populations were heavily reduced due to illegal Soviet whaling in the early twentieth century (Clapham and Baker 2002). Humpback whales are seasonal migrants, and move between their summer Antarctic feeding grounds and their winter breeding grounds around Tonga, Niue and the Cook Islands. A small but slowly growing population of humpback whales still use New Zealand’s coastal waters as a migratory route between the Antarctic waters and their winter breeding grounds around tropical Polynesia (Clapham and Baker 2002, Taylor 1997).

### 2.4. Whale stranding causes

The word ‘stranded’ can be defined as having run aground and also refers to the state of an aquatic animal, such as a whale, which has faltered ashore and become lodged on land. The word ‘beached’ usually refers to a dead animal that has washed ashore. The
discussion of whale strandings in this section will be within the context of pre-European New Zealand, so causational factors such as fishing-net entanglement and boat strike will be excluded. There are several different types of strandings. A single stranding can involve a solitary individual or a mother-and-calf pair. The term ‘mass-stranding’ refers to the stranding of a herd which can comprise between two and several hundred individuals of the same species. Generally, baleen whales are not frequent stranders; however, when they do strand it is usually individually. There are no records of baleen whale mass-stranding events in New Zealand or internationally (Cordes 1982). Toothed whales are much more frequent stranders, and some toothed whale species often strand in large herds of up to several hundred individuals. Strandings events can also be distinguished between a live whale becoming stranded, and a whale which has died at sea and the carcass of which has been cast ashore, or beached. The distinction between these two states is often not clear, however, as animals frequently run aground while alive but later die on shore before they are discovered. Whales which die at sea initially sink (except right whales which float), but sometimes the carcass can become inflated with gas and will be buoyed up to the surface if the water is not too deep (Brabyn 1991, Cawthorn 1997). Tides and currents can then cause these dead animals to be washed ashore. In these events the carcass is often in bad condition by the time it reaches the shore, although the bone would still be quite usable. The causes of live whale strandings are generally not well understood. Live solitary strandings are often thought to be influenced by disease or parasitism, as a result of which the animal seeks out shallow water for refuge (Cordes 1982). Ill health can have an impact on a whale’s ability to come up to breathe, and it has been suggested that weak whales may run themselves aground in shallow water as a survival instinct to avoid drowning (Perrin and Geraci 2009).

The causes of mass-strandings are much more difficult to pin down. Mass-strandings only occur in toothed whale species (Cordes 1982, Geraci 1978), and are thought to be caused by a complex inter-play of factors. Coastal configuration and beach types are thought to be the mostly likely explanation for mass-strandings of whales, and sloping, sandy beaches have been found to be the most common stranding traps (Brabyn and McLean 1992, Dudok Van Heel 1962). Brabyn (1991) found that New Zealand mass-strandings of
offshore delphinids, in particular the pilot whale (*Globicephala melas*), are most likely to occur in four hot-spot areas: Whangarei, Hawke’s Bay, Golden Bay and the Chatham Islands. These areas were found to share morphological features: “most involve some form of protrusion from the coastline, and virtually all are associated with long, gently sloping beaches” (Brabyn and McLean 1992: 473). Gently sloping, sandy beaches are thought to distort echolocation signals in a way that rocky coastlines do not, causing whales to perceive a sea passage where none exists (Dudok Van Heel 1962).

Geomagnetic navigation errors have also been suggested as causes of mass-strandings (e.g., Kirschvink et al. 1986, Klinowska 1985), and periods of high solar activity have been correlated with increased frequency of sperm whale strandings in the northern hemisphere, thought to be caused by geomagnetic disruption (Vanselow et al. 2009). Disease and parasitic infections have been proposed as causes of mass-strandings (e.g., Duignan et al. 1995), however, disease cannot be attributed to mass-strandings which often recur in the same location. Sick animals should strand anywhere. Social cohesion and interdependence has been found to be an influencing factor in mass-stranding events (Connor 2000, Cordes 1982). Whales are social animals often forming large groups based around a dominant male. Herd strandings have been related to one or more individuals within a group being affected by disease and becoming stranded; other members of the pod have also become stuck on the shore after responding to distress calls of the originally stranded animal (Connor 2000, Cordes 1982).

Analysis of the New Zealand whale stranding record was last carried out and published by Brabyn (1991) using all of the 1140 recorded stranding events involving 8287 individual animals prior to April 1989. The analysis showed that the five most frequently stranded species, which accounted for 48% of all of New Zealand’s strandings, were pygmy sperm whales (*Kogia breviceps*), pilot whales (*Globicephala sp.*), sperm whales (*Physeter macrocephalus*), common dolphins (*Delphinus delphis*) and Gray’s beaked whales (*Mesoplodon grayi*). Three species account for 84% of stranding individuals: pilot whales, false killer whales (*Pseudorca crassidens*) and sperm whales. These three species often strand as pods and can involve up to several hundred individuals. Some of the frequent
mass-stranding species showed geographical clumping which were identified as stranding hot-spots. Individual strandings influenced by disease are evenly distributed (Brabyn 1991), whereas mass-strandings tend to follow patterns based on coastal topography, and are most common in ‘whale trap’ coastal configurations (Brabyn 1991, Brabyn and McLean 1992). The following information about New Zealand whale stranding trends is summarised from Brabyn’s (1991) analysis of the NZWSDB:

**Sperm and pygmy sperm whales**
Sperm whale herd strandings cluster at Kaipara Harbour where five out of the 11 recorded strandings occurred. Pygmy sperm whales have the highest number of recorded strandings, with 147 events, however only 10 of these events were herds, and most of these herds were only two individuals, with the largest herd consisting of only four whales. Opoutama was the most common location for pygmy sperm whale herd strandings.

**Offshore delphinids**
Pilot whales are the most frequent mass-stranding species in New Zealand, with 71 herd stranding events identified. As well as being the most frequent stranders, they also hold the record for most individuals in a herd stranding with 450 animals stranded at Kawa Bay on Great Barrier Island in 1985. Geographical hot-spots where pilot whale herds have stranded three or more times were identified at: Whangarei Harbour, Mahia Peninsula, Golden Bay and the Chatham Islands; and with two events at: Houhora Heads, Doubtless Bay, Kipiro Bay, Great Barrier Island, Mercury Islands, Te Kaha, Clifton and Stewart Island. Other offshore delphinids also showed geographical clustering of herd stranding locations, with four out of five southern right whale dolphin herd stranding events occurring at Farewell Spit, and three out of seven false killer whale herd stranding events occurring at Opoutama.

**Inshore delphinids**
Inshore delphinid strandings were found to have a close association with the known distribution and relative abundance of these species, and there were not enough herd stranding events to identify any specific hot-spots. Inshore delphinids generally have a low incidence of live strandings.
Beaked whales
Beaked whales make up 27% of all strandings and 16% of herd strandings. With the exception of Gray’s beaked whale, the number of whales in beaked whale herd strandings is low and usually consists of two, but can be up to six, individuals. Gray’s beaked whales are the second most common herd stranding species after pilot whales. The only identified herd stranding concentration for this species is around the Chatham Islands, and single strandings are concentrated around the Chatham Islands, Te Kaha, Hawke’s Bay and Wellington. Gray’s beaked whales are thought to be restricted to the region between the Antarctic and the temperate waters of the Southern Hemisphere (Macleod et al. 2006: 281).

Baleen whales
Baleen whales make up only 10% of the whale stranding record, and involve only individual strandings. No baleen whale herd strandings have ever been recorded in New Zealand. The most commonly stranded baleen whale species is the minke whale (*Balaenoptera acutorostrata*); these occur evenly between the North and South Islands. Four minke whale strandings have been recorded at Golden Bay and four humpback whale strandings have been recorded at New Plymouth – these may represent hot-spots. Five pygmy right whale (*Caperea marginata*) strandings have been recorded at Stewart Island. All other baleen whale species strand at such low rates it is not possible to identify any geographical trends. Prior to the arrival of Europeans, southern right whale strandings were probably much more common due to the species often dwelling close to shore and breeding in the shallow harbours around New Zealand. The decimation of the southern right whale population as a result of whaling activity is probably responsible for the low number of strandings seen today, and this theory is probably applicable to the humpback whale stranding numbers also.

2.5. Opportunistic whale use in New Zealand
The last comprehensive analysis of the whale stranding record by Brabyn (1991) identified a number of places where the coastal configuration creates a ‘whale trap’ environment, for offshore delphinid mass-stranding species. These ‘whale trap’ areas are eastern Northland, Whangarei, Hawke’s Bay, Golden Bay and the Chatham Islands, sites
that are characterised by gently sloping beaches and jutting peninsulas, or tidal flats with sand spits (Brabyn 1991, Brabyn and McLean 1992). Sperm whale mass-stranding events were found to most frequently occur on the Kaipara coast (Brabyn 1991). The most commonly stranding species of cetaceans in New Zealand, based on modern records (see Table 1) are pygmy sperm whale, long-finned pilot whale, Gray’s beaked whale and the sperm whale. There are no ethnographic mentions of using the former three species in the manufacture of bone artefacts, but sperm whale is commonly cited to have been an important bone source (see Chapter 3). In archaeological sites where whale bone has been reported, it often displays signs of industrial modification consistent with bone reduction and the manufacture of artefacts. All of these frequently stranding species, as well as the less-common stranders, would have been utilised to some extent for their bone. The most commonly reported whale species identified through archaeological bone remains is the pilot whale, and it is often the only species which is identifiable (e.g., Smith 1985, 1989, 2013, Taylor 1984, 2002). It is extremely rare for archaeologically excavated worked whale bone and whale bone artefacts to be identified to species (Smith 1985). Although DNA analysis could be used to overcome this problem, the technique has never been employed for archaeologically excavated whale bone in New Zealand so far. This makes it difficult to identify from archaeological material whether Māori people had preferences for bone from a particular species during prehistory. Based on the rarity of whale strandings, however, and the low abundance of alternative bone sources, it is most likely that Māori people would have exploited bone from any available whale stranding. In the next chapter, an in-depth overview of whale bone use both internationally and during New Zealand prehistory is given, using archaeological data as well as ethnographic accounts.
3.1. Introduction

This chapter details how whales have been used by prehistoric cultures around the world and how these uses are identified archaeologically. There are three ways of procuring whales: either by actively hunting from an oceangoing vessel, by driving vulnerable animals into the shore and forcing them to become beached, or by exploiting live or dead animals that have naturally become beached. Actively hunting whales is a dangerous and specialised activity that requires sturdy vessels, a sophisticated set of hunting implements including harpoons, and a means of transporting the carcass back to shore. Whale hunting also requires an in-depth knowledge of the prey as not all whales are suitable targets; an ideal species of whale is a slow-swimming docile animal which will not sink when dead. Driving whales ashore can be significantly easier than hunting; this method requires only a boat and something which can be used to direct the whale, such as a long spear. This activity takes advantage of animals which have strayed too close to shore or are vulnerable in some way, such as a mother with calf or a sick animal. Exploiting a naturally beached whale does not require any specialised activity and relies entirely on chance discovery. Identifying these methods of procurement archaeologically can be challenging, and is sometimes not even possible. People have been using whales for nearly 300 millenia, and over time many prehistoric cultures around the world have developed strong ingrained traditions around the exploitation of these resource-rich animals. The many uses of whales, including as a food source, are outlined in this chapter, as well as how the bones were used for artefact manufacture, architectural support, fuel and as unmodified objects. Polynesian people including Māori have strong cultural traditions relating to whales, both as a food source and as a source of industrial bone, which feature in their mythology and in their economic repertoire.
3.2. Evidence for the exploitation of whales internationally

The earliest indirect archaeological evidence for the use of whales comes from South African sites with lithic industries dated to the Middle Stone Age (280,000 – 50,000 years ago), e.g., PP13B and Ysterfontein 1 (Avery et al. 2008, Jerardino and Marean 2010) and Late Stone Age (50,000 – 8000 years ago), e.g., Geelbeck Dunes (Kandel and Conard 2003). At these sites the remains of coronuline barnacles have been found, one of several genera collectively termed whale barnacles (Darwin 1854), which live on the skin of baleen whales. These barnacles can end up in archaeological sites having been carried there attached to the skin, blubber and meat that people have processed from whale carcasses (Kandel and Conard 2003, Smith and Kinahan 1984). In Europe, early evidence of whale use was found in the Upper Magdalenian layers of Nerja Cave, southern Spain, dated to between 13,500 and 14,500BP, including barnacles which live on the skin of the southern right whale (Álvarez-Fernández et al. 2013). Whale meat, with skin and barnacles still attached, was probably cut from a beached whale carcass and brought to the site, which is now located a kilometre from the beach, to be cooked and consumed. These barnacles are evidence of the use of whales even when the bones are not present.

However, Magdalenian sites such as Istaritz, France, have also revealed that people were using whale bone as a raw material for artefact manufacture as well as exploiting whales for food (Pétillon 2008). The whale bone artefacts at Istaritz occur through the entire Magdalenian sequence of the cave site thus representing production that was a technical tradition consistent through time, and indicating that cetacean bone was regularly exploited through an ingrained knowledge of the animals and their unique bone qualities. The majority of the whale bone artefacts from Istaritz “are related to hunting technology – especially projectile elements (points and foreshafts)” (Pétillon 2008). The selection of whale bone over terrestrial mammal bone and antler is attributed by Pétillon (2008) to two factors: the size of the elements, which allows for larger tools to be fashioned; and the distinctive mechanical properties of cetacean bone. Palaeolithic sites with whale bone are thought to be grossly underrepresented in Europe due to the sea level rise at the end of the last glacial maximum, which would have inundated all the
coastal sites where whale bone would be most likely to be found (Erlandson 2001, Pétillon 2008).

The most commonly found archaeological indicator of whale use is the bones, and these are consistently turned up in archaeological contexts internationally, although some areas were more intensively focused on whales as a resource than others. The most well-known and well-studied areas are the Pacific Northwest, particularly around the Vancouver Island area, where whales formed an important component of the Native American subsistence economy (Losey and Yang 2007, Monks et al. 2001) and the North American Arctic, where Inuit and Yupik people (collectively known as the Eskimo people) relied heavily on cetaceans and other marine mammals for food and raw materials (Betts 2007, McCartney 1980, Whitridge 1999). Two modes of whale procurement have been documented ethnographically in these areas: organised whale hunting, and opportunistic whale scavenging (Losey and Yang 2007). Archaeological evidence for the utilisation of whale resources on the Pacific Northwest Coast, identified by whale bone in cultural contexts, extends back as early as 4000BP (Losey and Yang 2007, Monks et al. 2001). It is often impossible to determine if whale bone in a site represents whale hunting or scavenging. Whale hunting evidence includes strike marks, tools embedded in whale bones, and the presence of artefacts known to be associated only with whaling. The presence of whale bone that does not depict the nature of procurement does not indicate organised whale hunting, and problems involving the archaeological identification of whale hunting are frequently encountered, even in places where whaling remains a strong and continual tradition (Losey and Yang 2007, McCartney 1980, Mulville 2002, Whitridge 1999). Evidence for the systematic hunting of whales began at least 3000BP on the Northwest Coast, but is thought to have been restricted to the Nuu-chah-nulth, Ditidaht and Makah peoples (Monks et al. 2001). Regardless of the method of procurement, whales provided a range of resources for the prehistoric cultures on the Pacific Northwest Coasts of North America, including food, oil, tool-making materials and architectural superstructures. The Mackenzie and the Thule Inuit peoples of Northwest Canada also hunted whales (*Balaena mysticetus*) for their valuable meat and bones. The bowhead whale was the preferred target of the Eskimo people for two main reasons
(Whitridge 1999): bowheads are slow swimmers and are docile enough to be approached easily and closely by boat; and unlike many other Arctic mysticetes, bowhead whales do not sink when they are killed, so they can be recovered immediately. They are also the largest cetacean species to penetrate the Arctic waters, with adult females reaching up to 18–20 metres long. A single bowhead whale could provide up to 10,000 kg of edible meat, skin and blubber (Betts 2007, Savelle 1997).

Uses of bowhead whales extend well beyond the edible components of the whale (McCartney 1980), and could provide several hundred kilograms of baleen and high-quality bone to be used as a raw material in tool manufacture (Savelle 1997). Bowhead whale bone often lacks a marrow compartment and tends to have a much thicker cortex, than that usually seen in terrestrial mammal bone (Betts 2007). In conjunction with this, whale bone typically has a more enlarged Haversian system (the network of cavities through which blood vessels travel in bone) throughout the cortex allowing it to bear more load and absorb more energy than terrestrial mammal bone (Scheinsohn and Ferretti 1995: Table 3). These bones were critical for Mackenzie Inuit tool manufacture and were worked into a range of durable implements that made use of the favourable structural resilience of bowhead whale bone, including harpoon heads, spear prongs, mattock blades, adze sockets and sled shoes (Betts 2007). All of these tools commonly made from whale bone were items that were subjected to a high degree of stress, wear or damage; the use of whale bone in their manufacture meant that they could better withstand this stress and wear than if they were made from another material, such as terrestrial mammal bone or antler (Betts 2007).

As noted above, whale bone typically has a very porous structure mostly made up of cancellous bone, and with a very thin, compact cortical bone layer. The bone element with the densest and thickest cortex is the mandible (Mulville 2002). This trend occurs across all cetacean species, although it is particularly marked in odontocetes, or toothed whales. This bone is known as the ‘jaw pan’, and its strength, size and efficacy as a raw material have been exploited by a number of whale bone utilising cultures in the northern and southern hemispheres. Two possible flax beaters, a scraper and a pierced
plaque found in the Norse sites of Kilpheder and Bornish in Scotland were made from cetacean mandible (Mulville 2002). In New Zealand, the sperm whale jaw bone is preferred over the same bone from other species, both for its size and density (H. Parata 2013, pers. comm.). This is a preference that probably has a long history, which may date back to the prehistoric time prior to European contact, and may have even originated in tropical Polynesia, long before the colonisation of New Zealand.

Whale bones can be extremely useful in an unmodified state as well as a raw material for the manufacture of artefacts, and they have been identified as an important architectural resource in regions such as in the Arctic circle, where other construction materials were scarce (McCartney and Savelle 1993, Mulville 2002, Savelle 1997). Savelle (1997) developed an architectural utility index for the bowhead whale which was used as an economic frame of reference to apply to whale bone assemblages from Thule Eskimo sites. Bones were grouped into either frame utility (long and thin, used for roofs) or bulk utility (sturdy and compact, used for walling). Elements with the highest architectural utility are the ribs, maxilla and mandible for frame utility, and the vertebrae for bulk utility. Savelle (1997) determined that element distributions conformed to the expectations of the architectural utility index – meaning that people were selecting bones from whale carcasses based on their architectural value. Whale bone has been found in architectural settings in various cultures and locations around the world, including the Thule Eskimos of the Pacific Northwest. Prehistoric people on the coast of Namibia and South Africa have been found to have used whale bone as the structural framework for huts in seasonal camps (Smith and Kinahan 1984). The whale bone used in these huts is thought to have been either scavenged from beached animals, or washed up on the beach and collected. At the Neolithic site of Skara Brae in Orkney (Childe 1931 cited in Mulville 2002), the jaw bones of a whale were found lying over the hearth of a hut, as if they had fallen from above. These bones have been interpreted as the rafters of the roof, supporting an outer layer of thatch or slate. Interestingly, the use of whale bone in architectural structures has never been documented in prehistoric New Zealand, probably due to the large amount of suitable timber available.
Going beyond the architectural uses of unmodified whale bone, other uses for the uniquely large bones, which are not applied to other mammal bones, have been noted in various parts of the world. The unfused epiphyseal plates from whale vertebra were thought to have been used as pot lids in a number of Hebridean and other Scottish sites, and some had holes drilled in the middle to allow steam to escape (Mulville 2002). A whale scapula was excavated from a well in Athens and dated to c. 850BC; the bone featured several small cut marks on its surface, and has been interpreted as once being a table top on which leather was cut and worked (Papadopoulos and Ruscillo 2002). Whale vertebrae were also used as seats (e.g., Smith and Kinahan 1984) or chopping blocks (e.g., Mulville 2002). Another common use of whale bone was for fuel. Whale bone has a high oil content and burns relatively well (Mulville 2002).

While artefactual and architectural utility were probably the most important determinants in the transport of large whale bone to sites, some smaller elements could have been carried into a site as part of large butchery units (Whitridge 2002). Whitridge (2002) used these bone ‘riders’ to investigate the cultural and social status aspects of bowhead whale meat distribution at a Thule Eskimo site in Arctic Canada. Butchery units in historic Inuit cultures, which were descended from the same migration groups that gave rise to the Thule people, were ranked, and certain cuts of whale meat were allotted to partakers in the whale hunt based on rank. Usually when whales are butchered, the meat is removed from the heavy bones for ease of transport, but there are some small bones that may be carried with the meat as they are not very heavy, and are difficult to remove. Whitridge (2002) found that some of these small bones were present in the higher social standing butchery units, and using this information he was able to determine that the surface scatter of whale bone at a Thule camp site was a predictor of spatial arrangement in community social relations and ritual when compared with information about social standing from house excavations. This method of study could be used to determine the cuts of meat being transported to sites as well as how cultural factors influence the distribution of the bones. Generally, however, there is little evidence internationally for the transport of bones to sites as part of joints of meat, and this phenomenon is much more likely to occur with smaller cetacean species which have
smaller, lighter bones (Mulville 2002). Furthermore, in the absence of an established whale hunting and utilising culture to provide an ethnographic base for the interpretation of whale bone distribution in prehistoric archaeological sites, there is very little that can be derived from the distribution of ‘rider’ bones in an archaeological site. This is particularly pertinent in a place like New Zealand where there is no ethnographic information about the cultural and social status of particular cuts of meat. Most of the whale bone that is found in archaeological sites around the world has been either used in architectural superstructures or, as is the case of New Zealand, as a raw material for the manufacture of ornaments and implements.

The roots of New Zealand whale bone use are in tropical Polynesia, where archaeological evidence of whale use has been documented in several locations. New Zealand examples of shaped whale tooth pendants and imitation whale tooth pendants, such as the necklaces excavated at Wairau Bar, show a cultural connection with the shaped whale tooth pendants from the Maupiti and Hane sites in French Polynesia and tabua from Fiji (Duff 1977). The Polynesian whale tooth pendants are made from the teeth of sperm whales, and later examples were highly regarded and ritualised symbols of status in nineteenth century Polynesia (Walter 1996). Fijian tabua are made from highly polished sperm whale teeth and circulated as part of a ritualised currency exchange which still operates to some extent today (Gosden and Marshall 1999, Whimp 2008). Throughout the Pacific, references to the role of cetaceans in Polynesian culture show that generally “cetaceans appear as companions, helpers, guides, and both givers and receivers of protection” (Whimp 2008: 176).

3.3. Whales and Māori society

Pre-European Māori are not thought to have a history of maritime whaling (Anderson 1998, Smith 1985) – that being the persistent pursuit and capture of medium to large whales in the open sea, by harpooning or other means. Māori canoes were unsuited to this kind of hunting, and there is a lack of any archaeological evidence indicating that these animals were ever hunted. Harpoon heads, which are typically the type of weapon used for hunting whales, have been found in some excavations, but they are thought to
have probably been used to hunt dolphins and sharks (Davidson 1984: 72). Anderson (1998: 136) describes a dolphin hunt conducted by Ngai Tahu people at Akaroa in 1840 in which a dolphin was hunted using bone-tipped spears with flax lines. The animal was roasted and “a dozen men ate about twenty-five kilos of meat before turning the remainder over to the women and children”. Harpoon heads found in New Zealand archaeological contexts are too small to have been effective tools to hunt the larger cetacean species, but were well suited to the pursuit of dolphins, sharks and large fish. Although Māori people became very involved with whaling after European contact (Cawthorn 2000), it is most likely not an activity that they had been involved in prior to the arrival of the foreign whalers. The whale bone found in New Zealand archaeological sites was most likely derived from stranded animals, carcasses that were washed up on the beach, and possibly to a lesser extent from animals which were driven ashore, although it is difficult, if not impossible, to separate these three procurement methods archaeologically (McCartney 1980).

While whales provided food and material resources, they also feature in tribal traditions. Māori have long maintained a strong cultural and spiritual relationship with whales, and oral traditions tell of the role whales played in navigation from the homeland, Hawai’iki, to the shores of New Zealand. While Māori people used a range of navigational tools when undertaking ocean voyages – including astronomical, oceanographic and meteorological observations as well as biological clues such as knowing the seasonal north-to-south migration routes of the humpback, sperm and southern right whales, and birds such as bar-tailed godwits, shining and long-tailed cuckoos (Cawthorn 2000) – whales are also said to have guided the first Māori on their voyage to New Zealand. In one legend whales are said to have calmed the water during a storm for the canoe of the Tainui tribes (Haami 2012). Over time the great mammals gained status which saw them included in the pantheon of supernatural beings with varying relevance across the different tribes (Cawthorn 2000), and were considered trusted guardians of ocean-going vessels and rescuers of distressed seafarers, such as in the case of shipwrecks (Best 2005). Whales commonly feature in Māori mythology and are often portrayed as intelligent and anthropomorphised creatures with which people are able to
communicate. Māori have several names for the different species of whales which vary between tribes, and are “part of the family known as ‘te whānau puha’ meaning ‘the family of animals that expel air’. While ‘tohorā’ (or tohoraha) is considered an all-embracing term for whales, it also refers to the southern right whale” (Haami 2012).

Other traditional names listed by Haami (2012) include:

- Hakurā or iheihe – scamperdown whale
- Paikea – southern humpback whale, or a whale with a white belly and deep grooves along its length
- Pakake – minke whale
- Parāoa – sperm whale
- Ūpokohue – blackfish or pilot whale
- Miha pakake – a whale calf.

Place names relating to whales are also common throughout New Zealand, reflecting the importance these creatures held in Māori society. Haami (2012) notes some of these names, including: Moutohorā (captured whale), an island off the coast at Whakatāne; Te Ara-a-Kewa (the path of the right whale), the name for Foveaux Strait; Whangaparāoa (bay of sperm whales) in Auckland and the East Cape; and Te Waiū-o-Te-Tohorā (the breast milk of the whale) which is a spring of white water associated with the hills around the Papamoa and Tauranga area that represent a family of whales (father, mother and baby) that lost their way, and became transformed into the range of hills after drinking from a magical spring.

There are several legends surrounding whales and their relationship with the Māori people. Probably the most well-known of these is the legend of the ancestor, Paikea, one of the 71 sons of the great rangatira Uenuku who lived in Hawai‘i. Of these 71 sons, 70 were chiefs as their mothers were of noble birth, but one son, Ruatapu, was born of a slave wife, and thus was not a chief like his brothers. Ruatapu was jealous of his brothers and determined to gain revenge on his father. He bored a hole in the bottom of Uenuku’s new canoe and filled it with chips of wood, and the sons set out on its first voyage. When they were far out to sea, Ruatapu unplugged the hole and let the water rush in. The
canoe filled with water and sank. All of Ruatapu’s brothers were drowned except for Paikoa who called on Tangaroa to help him. Tangaroa sent a whale to carry him on its back to the shore. But instead of going back to Hawai’iki, the whale took Paikoa to the shores of the east coast of New Zealand, where he settled. The story has minor variations between tribes, but Paikoa is generally considered to be one of the most important ancestors of Ngāti Porou and Ngāi Tahu (Orbell 1962, 1995).

Another legend that involves riding on the back of a whale is that of Tinirau and Kae. The story has many versions throughout New Zealand and the Pacific Islands, but generally tells of how Kae helped Tinirau, who was the ancestor of all fish and lived on a sacred island. As thanks for Kae’s help, Tinirau summons his pet whale, Tutunui, and cuts off a slice of its flesh to give to Kae as payment for his help. He also offers Kae a canoe to get back to his homeland, but Kae asks if he can ride Tutunui home instead. Tinirau reluctantly agrees, but tells Kae that when Tutunui gets close to shore, he must disembark or Tutunui will become stranded on the land. Despite Tinirau’s instructions, Kae rides Tutunui all the way onto the beach and the whale becomes stranded. Kae cuts up Tutunui and feeds his village with the whale’s meat. The smoke from the cooking fires drifts all the way to Tinirau’s island and he smells his pet whale being cooked. Angered, Tinirau sends a group of women to Kae’s land to capture him. They trick him and take him back to Tinirau’s island where Tinirau kills Kae to avenge Tutunui’s slaughter (Royal 2012). The theme of whale riding, as seen in the Paikoa and Tinirau stories, is common in Māori oral storytelling and relates to the tradition of whales as kaitiaki (guides). Other well-known whale riders include “Te Tahi-o-te-rangi, an ancestor of the Mataatua tribes, who rode a whale named Tūtarakauika from Whakaari (White Island) to the mouth of the Whakatāne River, and Tūnui, the Hawke’s Bay tohunga, who was seen riding his pet whale, Ruamano, out of the Keteketerau outlet on his way to Cape Kidnappers” (Haami 2012).

Another legend involving whales is the so-called mauri (life force) of whales at Te Mahia peninsula, Hawke’s Bay. The mauri is a hill called Takamaautahi that is thought to resemble a whale in form (Best 2005). The hill at Te Mahia is considered to exude a
drawing force that attracts whales in to shore so they become stranded on the beach (Best 2005, Phillipps 1948). The mauri of the whales at Te Mahia is said to have gained its power when the canoe Takitimu landed there. On board was the tohunga (priest) Ruawharo, who possessed the mauri of the whales; it was at Te Mahia where he laid the mauri in order to attract whales on to shore where they would subsequently become stranded (Haami 2012). The power to attract whales onto shore meant a much better chance of being able to exploit the beached animals for food and other valuable resources. Best (2005:58) describes a stranded whale as “a gift from the gods to the Māori”, which not only provided them with copious amounts of meat but also provided bone with which to fashion a range of implements.

There are very few ethnographic and early historical mentions of the utilisation of natural whale strandings. Smith (1985: 10) remarks that considering the European interest in sea mammals “the scarcity of recorded observations of Māori exploitation of these animals is somewhat surprising”. The records which do exist coincide with the whaling or post whaling period, and European influence is often obvious (e.g., Barton 1927: 45, Beattie 1920, Polack 1838: 398, Starke 1986). All of the early historical accounts mention stranded whales being used as a source of food, often with vivid descriptions of the excitement over a large quantity of food, and the terrible smell. Conflict over the right to a stranded whale carcass in described by Polack (1838: 398): “Many a battle has been fought by hostile gourmands for the carcass of a whale thrown on shore long after its death.” Best (2005: 58) describes a stranded whale as providing a bounteous ‘cut and come again’ dish.” In his ethnographic account Best (2005) also comments on the bones of stranded whales being used to fashion “many kinds of implements” and indicates that the sperm whale (*Physeter macrocephalus*) was the preferred species for this purpose. There are also a small number of recorded observations of the Moriori people celebrating the event of whale strandings in the Chatham Islands. On an island that was totally devoid of land animals other than birds, the meat from such strandings was of extraordinarily high value (Richards 1982:7). Baucke (1922) describes the stranding event of a pod of pilot whales:
Who hears the sudden cry passed along “Ai we-e! he rong mon !” (Listen, you, a whale ashore.) For at once, no one sees whence, the shore becomes a moving mass of beckoning, shoutin, ecstasy! Fires flare here and there, sudden coughs of exploding blocks of flint indicated that “knives” are being forged, whose razor-keen shards are being fixed on the loops of split doubled back supplejack, to be presently raked, each rake deeper into the living flesh of the helpless cetacean, mingling his agony, groans with the thunder of the surf, and the happy jubilation anticipant of gargantuan feasts for these stone age revellers; where everyone who can may push in and hack by right of commonality. (Baucke 1922)

This description indicates a specific knowledge and a long-held tradition of whale stranding exploitation within Moriori culture, and shows that perhaps on the Chatham Islands whale stranding events were ‘free-for-all’ situations in which there was no hierarchical division of the meat within the community. A similar observation was made by Polack (1838: 398) that, “Agreements are often entered into by native tribes residing on either coast of a river, that, in the event of any monster of the deep drifting on their respective shores, each shall partake of the fish fairly.” But he then goes on to mention that one party proceeded to devour a whale that had washed ashore from a whaling boat without alerting the neighbouring party. When they discovered they were not getting their fair share, the aggrieved tribe armed themselves for a fight, “but a composition was entered into by the belligerents, and they mutually gastronomised on the fish in amity, contending only, with their usual determination, which party could devour the largest quantity” (Polack 1838: 398).

Early European contact was closely tied with sealing and whaling, and hunting whales for oil meant that Māori had access to large quantities of bone and meat from these carcases. John Boultbee, who was a sealer on the coast of the South Island in the late 1820s, wrote in his journal of an encounter while sailing between Ruapuke Island in Foveaux Strait, and Otago. Boultbee describes a group of Māori on the east coast of the South Island utilising a whale wounded by whalers, which they had either driven ashore or which had become naturally stranded on the beach:
As we were pulling along shore on our way, we saw a number of wild looking fellows on a rocky beach cutting a whale into junks and carrying it away – they were as greasy and dirty as might be expected from the nature of their employment. It seems the Lynx (Whaler) had been to these parts and had struck several whales, which got away, and this was one of them. These people sent us a present of some of the whale, which was brought to us by a man to our hauling-up place. (Boultbee in Starke 1986:87)

Māori commonly took advantage of the meat from whales which had drifted ashore from ships or were brought ashore by boats whaling locally; Morton (1982) states that the meat from whale calves was particularly favoured. On the other hand, in Beattie’s (1920) interviews with Māori, he is told by the interviewee that “[whales] sometimes washed ashore and he never heard of its being eaten as there was abundance of hapuku, etc, to eat. When the whalers were ‘trying-out’ the Māoris would eat a little of the flesh of newly killed ‘fish’ but this was ‘only as a taste – not as a practise’”. Another interviewee mentioned that fishhooks were sometimes made from whale bone, and when they were they were called “iwi-wera-matau”, and not “matau-paraoa”, as paraoa was a weapon (Beattie 1920).

The varying reactions to using naturally stranded whales for food may be attributed to local traditions, Māori relationships with European whalers, and whether there were stocks of alternative and more preferred types of food, such as the hapuku mentioned above. Many of the descriptions indicate that the Māori people were comfortable eating meat from a whale carcass which had already begun to decompose, and that they found the meat to be both a tasty luxury and not in any way unhealthy. Also consistent throughout the ethnographic and early historical records is the mention of the use of whale bone as a resource for manufacturing items, and although this resource increased greatly with the arrival of European whalers, there was already a deep-rooted tradition of its use, which accelerated as a result of the whaling operations. Māori used whale bone and teeth for the manufacture of a range of implements, weapons and ornaments (Anderson 1998) including combs, necklaces and pendants, cloak pins, carver’s mallets,
fishhooks and striking weapons (Firth 1959: 66). European whalers were interested in harvesting whalebone (baleen), blubber and oil; the remainder of the carcass was disposed of into the sea to sink or wash ashore for the local Māori people to utilise (Cawthorn 2000). The accelerating demand for Māori artefacts spurred the whale bone carving industry to meet the demands of European trade and exchange, and the number of whale bone items being manufactured – particularly weapons such as patu – dramatically increased as shown by the relatively large number of whale bone artefacts of post-European contact manufacture in New Zealand museum collections.

3.4. Whale bone artefacts

Although ethnographic references can provide insights, the physical archaeological record is the best source of information about the ways that whale bone was processed and the artefacts that were manufactured. Whale bone and teeth used in the manufacture of artefacts have been documented in the New Zealand archaeological record since the early days of the discipline, and are recognised as important components in the catalogue of Māori bone resources. A range of artefacts were made, and can been separated into three loose groups: implements – items which are used in everyday life to serve a utilitarian purpose; body ornaments and amulets – items which serve to decorate the body and/or hold spiritual significance or talismanic properties; and weapons – either as items used in combat or symbolic forms.

Although the following section attempts to cover the range of whale bone artefacts from the published and unpublished literature, there are many shortcomings. The range of artefacts produced from whale bone is diverse; rigidly categorising items can lead to oversimplification, especially with personal ornamentation items, which typically have a wide assortment of forms that vary over time and space. Also, there is probably a misrepresentation of the actual range of items due to a lack of material identification by archaeologists, and the number is most likely much higher than what has currently been identified. Furthermore, there is a vast number of whale bone artefacts held in museums that have yet to be identified as such, and lack secure provenance information. Due to the increase in access to whale bone that occurred with the advent of commercial
whaling in New Zealand, the number of artefacts produced after European contact is probably much higher than the number made during pre-history, and separating these items requires good provenance information. However, this section is not a detailed study of the range of artefact forms made from whale bone; rather it is an acknowledgement of the variety and an attempt to bring these items together for the purpose of identifying the differing treatments of whale bone as a resource. An in-depth study of whale bone artefacts is an avenue that has yet to be travelled, which would yield much more information about the use of this resource.

**Ornaments and implements**

*Fish hooks and lure shanks* – The most commonly found whale bone implements are fish hooks. Although fish hooks were more commonly made from wood, shell, and moa or human bone (Best 2005: 34), there are several examples found in whale bone (e.g., Higham 1968, Lockerbie 1940, Sewell 1988, Smith 1981a). Lure shanks can also be found made from whale bone (e.g., Skinner 1960), though examples of these are rare.

*Ripi 'paua prisers'* – Whale bone levers, used for prising paua off the rocks, have been found restricted to the Murihiku region, e.g., Hakapureirei (Jacomb et al. 2010) and Rarotoka (Centre Island) (Harsant 1986). These tools have not been identified in other areas of the country, with the exception of two examples provenanced to Otago (Harsant 1986), and are often found made from whale bone indicating a specialist and localised tool kit. Ripi are typically long and slender (often measuring between 10 and 25 cm in length) with a functional edge at one end and a knobbed handle at the other. Personal ornamentation and amulets

*Cloak pins* – Although it is rare to find whale bone examples of these artefacts, they still warrant a mention in this section. Symbolically, cloak pins served as status indicators, and functionally, they pinned the edges of a cloak together (Furey 1996). Cloak pins are not thought to have been common items during prehistory, and became much more common after European contact (Davidson 1984). Whale bone or ivory cloak pins have been found at Warrington Beach, Otago (Allingham 1988), Oruarangi Pa (Furey 1996), and Panau Pa (Jacomb 1995, 2000). The Oruarangi Pa examples are similar to the
specimens collected by Cook (Kaeppler 1978), many of which were most likely also made of sperm whale ivory.

**Combs** – Māori combs, as well as being used to comb hair, were used as ornaments to hold men’s topknots in place. Combs were an important symbol of high status and prestige (Shawcross 1964). The largest archaeologically excavated assemblage of whale bone combs is from Oruarangi Pa where 32 complete and fragmented combs, in either whale or dolphin bone, were found. These combs were probably made from the lower jaw bone of the cetaceans, which provided a large enough surface area, and had the strength without thickness that was required to make fine-toothed combs (Furey 1996). Large combs were thought to have been popular in the later period, and were visible in the drawings of Sydney Parkinson on Captain Cook’s first voyage to New Zealand (Shawcross 1964). They were most commonly made from wood or cetacean bone, but with wood being the more readily available material it is most likely that this was the material used most frequently of the two. Captain Cook collected thirteen examples of Māori combs during his three expeditions to New Zealand, and of these, four were wooden and nine were whale bone (Kaeppler 1978). The whale bone combs that Cook collected are, on average, much longer than the wooden combs which ranged from between 9.5 and 12cm long, whereas the whale bone combs ranged between 17.5 and 35cm long (Kaeppler 1978). The variation in length between the materials may have been for a cultural reason, but it may have also have been due to the fact that whale bone was a stronger material that could support longer tines. An archaeological assemblage from the Kauri Point Pa site has several wooden comb examples that survived well in the swampy environment and show some of the same forms as the bone examples from Oruarangi Pa (Furey 1996). Many of the combs have decorated frames with knobs on one side – a feature of the combs at Kauri Point and also in the Parkinson engravings from Cook’s first voyage (Furey 1996). These knobs range from simple to intricately carved designs featuring stylised faces and animals. Some of the combs also feature engraving and shell inlays. Many of the combs were decorated on only one side, or had less elaborate decoration on the reverse surface.
**Whale-tooth pendants** – Based on the Polynesian sperm whale tooth necklaces of Fiji, these pendants were comprised of several units that were designed to represent whale teeth (Duff 1977). They were made from human, moa and whale bone and are a distinctive component of early Māori material culture. One of these necklaces found at Wairau Bar, consisting of 21 units, was cut from sperm whale teeth (Duff 1977), and was likely to have been of high value. The units of these necklaces are most commonly found in moa bone, and more rarely in whale bone or ivory. One pygmy-sperm whale (*Kogia breviceps*) tooth necklace has been identified from Twilight Beach, and consists of a set of notched but otherwise unmodified teeth (Taylor 1984).

**Rei puta** – Rei puta are bone pendants, and are one of the more rare personal ornaments. Apart from one example from Oruarangi Pa, no other specimens have been found in a specific site context. These elusive artefacts also appear to have been rare at the time of European contact, and were only observed by European explorers in the northern North Island, although elongated pendant forms were known in the South Island (Furey 1996). Another example of a rei puta, held by the British Museum, is thought to have been collected by Captain Cook on his first journey to New Zealand, due to its similarity with one that is depicted in a Sydney Parkinson engraving (Kaeppler 1978). They were thought to represent a tuoro or eel god and were connected to fishing ceremonies as a form of talisman to bring the wearer good luck (Graham 1923). The rei puta from Oruarangi Pa is made from a sperm whale tooth which has been split longitudinally and curves outward at the lower end – a characteristic that is commonly seen in Māori pendants and is descended from the whale tooth and imitation whale tooth pendants found throughout the Pacific (Furey 1996). The pendant has two carved indentations at the end which represent eyes, a feature that is characteristic of the various depictions and examples of the ornament (Graham 1923). It is suspended by cord which is threaded through two holes at the top of the pendant.

**Amulets and other pendants** – There is a diverse range of amulet and pendant forms, and whale bone is among the common materials used in the manufacture of these items. Pendants and amulets in whale bone are usually heavily modified (unlike some other materials such as shells, small bones or teeth), as the bones are so large they do
not have a form that can be accentuated. The chevoned amulet is a particularly intricate and rare form of whale tooth amulet featuring chevoned edge decoration. Although there is variation in style, these pendants are typically formed by the joining of two symmetrical pieces (Skinner 1934, 1960). The chevoned amulet is especially rare and until the recent excavation of one at Kahukura (Brooks et al. 2010) none have been found within a secure archaeological context.

Weapons

*Whale bone patu (patu parāroa)* – Patu – rounded hand clubs which often have decorated handle butts and are found in a range of forms – were most commonly fashioned from wood, stone (patu ōnewa) and whale bone (patu parāroa). Typically, sperm whale bone was used for these highly prized weapons (Best 1902). They are generally associated with the ‘Classic’ Māori period and are thought to have been relatively common items at the time of European contact. However, the discovery of similar forms of whale bone and wood clubs in the Society Islands suggests that they were present throughout the duration of New Zealand settlement (Davidson 1984). There are various archaeological examples of these artefacts. At Oruarangi Pa, several both intact and fragmentary whale bone patu have been found, and many of these exhibit a decorative knob at the end of the handle (Furey 1996).

*Hoeroa* – The hoeroa was a striking or throwing weapon typically made from whale bone. They generally measured about five feet in length and were slightly curved with one sharpened edge. A cord was threaded through a hole in the butt end and the other end was held by the thrower to enable the weapon to be retrieved quickly by pulling the cord (Best 1902). Best (1902: 242) describes the hoeroa as usually being made from the rib of a sperm whale.
Chapter Four

Archaeological whale bone distribution and the modern whale stranding record

4.1. Introduction

This chapter explores the geographical distribution of whale bone that has been excavated from New Zealand archaeological sites and compares this with the geographical distributions of whale stranding locations. This chapter is arranged in three sections: firstly, a description of the methods used in the data collection and analysis of the distribution of archaeological sites at which whale bone has been excavated, and the results of this study; secondly, a description of the methods used in the collection of the data and analysis of the distribution of New Zealand whale strandings; and thirdly, the results of this comparative study are discussed and summarised.

Whales clearly had a role in the subsistence strategies of prehistoric New Zealand, but the extent of this role is not well understood. One of the research questions that this thesis explores is whether the possibility exists that whales were, to an extent, a predictable resource and that people located their occupation sites close to areas where whales were known to strand frequently. The correlation between archaeologically excavated whale bone and stranding locations has been explored Smith (1985) to determine if whales being opportunistically sourced, who found that virtually all of the evidence for whale exploitation occurred in sites which were located in areas where whales naturally strand indicating that whale bone was procured from stranded whales rather than hunted. Strong geographical correlations between the distribution of archaeological sites with whale bone and whale stranding hot-spots could indicate Māori settlement location preference. Furthermore, if archaeologically excavated whale bone which has been worked correlates more with some species than others then this may indicate that some species were favoured over others.
Whale bone in a raw material state found in New Zealand archaeological contexts probably indicates that a stranded whale was exploited within the vicinity. The presence of whale bone in archaeological sites is, in itself, indicative of the value placed on whale bone as a material resource, as it is possible to flense a large whale carcass without having to remove the bones (Mulville 2002). The large and unwieldy size of the bones of most whale species makes long-distance land transport of them difficult, necessitating the processing of bones – either through primary or secondary reduction – to occur at, or close to, the site of the whale carcass (Smith and Kinahan 1984). Processing is defined as actions that reduce a portion of bone in size, creating fragments of waste bone in the process; the terms ‘primary reduction’ and ‘secondary reduction’ are borrowed from lithic analysis (Yerkes and Kardulias 1993). Primary reduction involves reducing large bones into smaller and more workable portions; secondary reduction refers to the shaping and detailing actions that give the artefacts their intended form and finish (Yerkes and Kardulias 1993). Primary reduction often occurs at the source of a material; the workable portions are then either further worked on site, or they are transported to another site for secondary processing. This is seen archaeologically with lithic resources: because rocks are heavy to carry, the most cost-effective method of material procurement is to create workable blanks, or rough-outs at the source of the material, resulting in sites, such as stone quarries, having high quantities of primary reduction by-products, or debitage (e.g., Jones 1984). A parallel between lithic sources and large whale bones can be drawn, and an assumption is made here that primary reduction debitage in the form of chopped bone debitage is evidence of the bone being sourced from within the near vicinity. This is further reinforced by the lack of any identified whale bone working sites located away from the coast.

The presence of whale bone artefacts or prepared tabs (partly worked sections of cortical bone which have been prepared for further working) at a site does not indicate that a whale carcass was exploited and processed nearby, since whale bone tabs and artefacts are small and more easily transportable. Similarly, whale bone artefacts have been excavated from many sites around New Zealand, but these sites are not necessarily the location of their manufacture as the items may have been traded far from their original
location of manufacture. Identifying sites where whale bone working has occurred requires the presence of debitage; this analysis focuses on these by-products as the archaeologically visible remains of whale bone processing. A cohesive assemblage of debitage fragments from a processing site can hold a large amount of information about the methods and tools used in the processing, and what the bone was being used for.

Archaeological sites where industrially worked whale bone has been found in New Zealand indicate that Māori were exploiting whales for their bone. It is possible that, with their knowledge of whale stranding trends, Māori may have maximised their chances of encountering this resource by positioning themselves close to coastal areas where strandings were common. In order to explore this hypothesis, a distributional study was carried out which compared the distribution of archaeologically excavated whale bone with the distribution of whale stranding locations. Two sets of data were used for this study:

1: A compilation of all of the New Zealand archaeological sites at which cetacean bone has been found in an unworked or worked state.

2. The New Zealand Whale Stranding Database (NZWSDB) which has records of all the cetacean strandings which occurred on the New Zealand coasts from between January 1978 and April 2013.

4.2. Data collection: Whale bone in archaeological sites

A compilation of all the sites in New Zealand from which cetacean bone has been excavated was created by searching though published literature (New Zealand Journal of Archaeology, Journal of the Polynesian Society, Journal of Pacific Archaeology, New Zealand Archaeology Association Newsletter (1957–1987), Archaeology in New Zealand, New Zealand Archaeology Association Monographs, Records of the Auckland Institute and Museum, Records of the Canterbury Museum, and various books), and unpublished literature (theses, site record forms, ArchSite searches, unpublished reports for The Historic Places Trust). Sites of interest needed to have unworked cetacean bone or bone with evidence of industrial working. Industrial working evidence included reduction
debitage pieces, and bone remains with tool marks on their surface. Bone pieces which were described as having butchery marks were not included in the ‘worked’ category, as this was not considered to be evidence of industrial bone use, and more likely indicates meat consumption. Both whale and dolphin bone was included in this study because in most site records the type of cetacean is often not identified.

In the study, it is assumed that bone working was occurring within close vicinity to the animals’ beaching location. Sites with whale bone artefacts were only included when they were associated with unworked and worked whale bone. This is because artefacts are known to be highly transportable and will often be found far from their place of manufacture. When any archaeological site at which cetacean bone was found was located in the literature, the site details were recorded in a spread sheet (see Appendix One) which included the following information:

1. Site name – this is the name that the site is commonly known by, and often refers to the location of the site
2. Site number (New Zealand Archaeology Association Site Recording Scheme)
3. GPS location coordinates
4. The nature of the material found (i.e. unworked, worked, and finished artefacts)
5. The types of whale bone artefacts (if present)
6. Class of cetacean (if known) and species (if known)

Limitations of the data
It is almost certain that this is not a complete record of all of the sites in New Zealand where cetacean bone has been found. It is quite possible that some archaeological sites with cetacean bone have been missed due to the low frequency of publishing of site reports, and the sheer volume of archaeological sites. Furthermore, problems with whale bone identification in excavated material has almost certainly impacted on the number of archaeological sites in which cetacean bone is reported. Cetacean bone in archaeological contexts can be highly fragmented due to the fragile nature of the porous bone structure, resulting in archaeologists often being unwilling to identify it further than ‘sea mammal’ bone, a term which covers both pinnipeds and cetaceans due to the morphological
similarities of the bone structure. Indeed, the number of sites encountered during the literature search which only mention ‘sea mammal’ bone being present was frustratingly high. Unfortunately, without the widespread use of DNA analysis in the taxonomic identification of faunal remains from archaeological contexts, this problem is unlikely to be easily resolved.

Another issue that is important to acknowledge is that some areas of New Zealand have received less archaeological attention than other areas, potentially creating the appearance that there was no whale exploitation occurring in the region, while overrepresenting other areas which have been more extensively excavated.

**Results**
A total of 83 sites containing cetacean bone were identified through the published and unpublished literature search (Figure 1). The identified cetacean bone from 57 of these sites was distinguished as either whale bone or dolphin bone, and in some sites both cetacean families were present (Figure 2). Cetacean bone from 18 sites could not be identified to a taxonomic family. In most cases species was not able to be identified, however cetacean bone from 17 sites were able to be taxonomically identified. Of these sites, 12 were identified as containing pilot whale bone, three sites were identified as having Hector’s dolphin bones, one site had pygmy sperm whale bones, and one site had common dolphin remains. Most of these sites were analysed by Smith (1985), who made the taxonomic identifications. In most cases whale bones remain unidentified to species due to several factors which make taxonomic assignment incredibly difficult (see Chapter 3).
Figure 1: Location of all archaeological sites with cetacean bone present.
Figure 2: The distribution of whale bone reported in New Zealand archaeological sites according to species.
Of the 83 identified sites, 28 contained whale bone that displayed evidence of industrial processing and was classed as ‘worked’, and 70 contained whale bone with no evidence of industrial processing – classed as ‘unworked’. Of the 83 archaeological sites identified, 18 of these also had finished whale bone artefacts present, although these were only recorded if other types of whale bone were also present at the site. Some sites had more than one type (worked, unworked and artefacts) of whale bone in occurrence. In order to determine the incidence of industrially processed whale bone in New Zealand archaeological sites, and to distinguish any hot-spot areas where processing worked or unworked whale bone occurred more frequently, the sites were mapped based on the type of bone identified. Sites with only dolphin bone were excluded from this study. Sites with unworked whale bone, worked whale bone and a combination of both are shown in Figure 3.

Some areas of New Zealand display observable clumping of archaeological sites and may be areas where cetacean exploitation happened at a higher rate than in other areas. Five areas – Northland, Hauraki Gulf/Coromandel Peninsula, Golden Bay, Banks Peninsula and Southland – are identified as having a higher number of archaeological sites with whale bone than the rest of the country. These regions are also hot-spots where evidence of industrial whale bone working is reported more frequently than in other areas (Figure 3).
Figure 3: The distribution of industrial processing evidence on whale bone present in New Zealand archaeological sites.
4.3. Data collection: The New Zealand Whale Stranding Database

Whenever a cetacean stranding is reported to the Department of Conservation, key information about each stranding event is recorded in the New Zealand Whale Stranding Database (NZWSDB). Information extracted from the NZWSDB for this study was provided by the Department of Conservation, and included all of the New Zealand stranding records for cetacean species from between 1 January 1978 and 18 April 2013. Information held for each record includes:

1. Date the stranding occurred
2. Species
3. Region and location description
4. GPS location coordinates
5. Condition of the animal (live, wounded/sick, freshly dead, decomposed, unknown)
6. Factors contributing to the stranding (entanglement, accident/collision, deliberate kill, beach cast, stranded, unknown)
7. Number of individual animals stranded
8. Type of stranding (i.e. unknown, single individual or a mother and calf pair, or >1 individual (unless it was a mother and calf)

There were 2619 stranding events between 1 January 1978 and 18 April 2013, with a total of 11,663 individual cetaceans. A total of 770 individual animals from 176 stranding events could not be taxonomically identified, and have been removed from the study. Cetacean strandings which have been identified as having modern-day, human-related contributing factors – ‘entanglement’, ‘accident/collision’, and ‘deliberate kill’ – have also been removed from the dataset, as they are not thought to have been causes of strandings during New Zealand prehistory, thus are not reflective of the time period of concern. Because this thesis is about the opportunistic use of whales as a resource, the ‘oceanic dolphin’ family is excluded from this study with the exception of pilot whales (*Globicephala* sp), included because they are the most commonly identified cetacean species in New Zealand archaeological sites, and their bones are often found to exhibit signs of industrial processing (Smith 1985). Pilot whales are relatively large compared to
the other oceanic dolphins, and thus have a larger quantity of potentially workable bone. Furthermore, pilot whales are known to beach relatively frequently and in large numbers (Brabyn 1991), making them the most accessible cetacean species for opportunistic exploitation. Also, strandings that occurred in the Chatham Islands have also been removed, since the Chatham Islands have a high rate of whale strandings (Brabyn 1991) and a unique archaeological record that deserves to be treated separately from the New Zealand mainland. The remaining 6,452 cetaceans from 1,268 stranding events are shown in Table 2 below.

**Limitations of the data**

Data from the NZWSDB has several limitations which must be noted. Firstly, the modern whale stranding record will not completely reflect the prehistoric whale stranding rates. The main reason for this is that population levels for some whale species have been altered (in some cases drastically) through commercial whaling as well as other anthropomorphic effects, such as commercial fishing by-catch, boat strike, and oceanic pollution. Some species have probably been largely unaffected by these issues, but in the absence of a prehistoric whale stranding record little can be definitively stated about the potential differences between these time periods. As noted earlier, to minimise this limitation, the stranding records which list the contributing factor as being either ‘entanglement’, ‘accident/collision’ or ‘deliberate kill’ have been removed from the dataset as these contributing factors are considered to be modern anthropomorphic causes of whale strandings. However, contributing factors are often not obvious; many strandings may have been caused by these factors but are not recognised as such.
Table 2: New Zealand cetacean strandings recorded in the NZWSDB.

<table>
<thead>
<tr>
<th>Family</th>
<th>Common Name</th>
<th>Stranding events</th>
<th>Individuals stranded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaked whales</td>
<td>Gray's beaked whale</td>
<td>211</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td>Cuvier's beaked whale</td>
<td>66</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Strap-toothed whale</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Southern bottlenose whale</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Andrews' beaked whale</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Shepherd's beaked whale</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Arnoux's beaked whale</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Hector's beaked whale</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Ginkgo-toothed beaked whale</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Blainville's beaked whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>True's beaked whale</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Spade-toothed whale</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Beaked whales Total</strong></td>
<td><strong>403</strong></td>
<td><strong>533</strong></td>
</tr>
<tr>
<td>Oceanic dolphins</td>
<td>Long-finned pilot whale</td>
<td>219</td>
<td>5,130</td>
</tr>
<tr>
<td></td>
<td>Short-finned pilot whale</td>
<td>11</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td><strong>Oceanic dolphins Total</strong></td>
<td><strong>230</strong></td>
<td><strong>5184</strong></td>
</tr>
<tr>
<td>Porpoises</td>
<td>Spectacled porpoise</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Porpoises Total</strong></td>
<td><strong>2</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>Right whales</td>
<td>Pygmy right whale</td>
<td>46</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Southern right whale</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Right whales Total</strong></td>
<td><strong>48</strong></td>
<td><strong>49</strong></td>
</tr>
<tr>
<td>Rorquals</td>
<td>Minke whale</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Bryde's whale</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Humpback whale</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Antarctic minke whale</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Blue whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Pygmy blue whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Sei whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Fin whale</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Rorquals Total</strong></td>
<td><strong>129</strong></td>
<td><strong>130</strong></td>
</tr>
<tr>
<td>Sperm whales</td>
<td>Pygmy sperm whale</td>
<td>300</td>
<td>369</td>
</tr>
<tr>
<td></td>
<td>Sperm whale</td>
<td>152</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Dwarf sperm whale</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><strong>Sperm whales Total</strong></td>
<td><strong>456</strong></td>
<td><strong>554</strong></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td></td>
<td><strong>1,268</strong></td>
<td><strong>6,452</strong></td>
</tr>
</tbody>
</table>
Another possible limitation of the data is that whale strandings often go unrecorded in New Zealand, especially in areas of low population density. The database relies on the public for reporting strandings, and some events may go unreported or may be erroneously reported.

However, although there are several limitations in both of the data sets, the information available still has the potential to show interesting results, and provides a new way of considering Māori use of whales in New Zealand prehistory.

**Results**
The four most commonly stranding species with >150 stranding events since 1978 are pygmy sperm whales (300 strandings) (Figure 4); long-finned pilot whales (219 strandings) (Figure 5); Gray’s beaked whales (211 strandings) (Figure 6); and sperm whales (152 strandings) (Figure 7). The stranding locations for these four species have varying distributions. Pygmy sperm whale strandings tend to be concentrated around the Hawke’s Bay area, the Kaipara coast and Northland, with a smaller concentration occurring in the Wellington region (Figure 4). Long-finned pilot whales have a wider distribution of stranding locations but show a dense clumping around the Golden Bay area (Figure 5). Gray’s beaked whales tend to strand more frequently in the North Island, particularly around the Bay of Plenty and the Hauraki regions, with small clusters also occurring in Hawke’s Bay and Tasman Bay (Figure 6). Sperm whale strandings appear infrequently in most coastal areas, but have a dense concentration occurring on the Kaipara coast (Figure 7). From these maps it is clear that although whales can strand anywhere around the coasts of New Zealand, there are some identifiable trends which may have been known to Māori during prehistory – in particular the highly localised concentrations, such as long-finned pilot whales in Golden Bay and pygmy sperm whales in Hawke’s Bay.
Figure 4: Stranding locations of pygmy sperm whales on the New Zealand coast.
Figure 5: Stranding locations of long-finned pilot whales on the New Zealand coast.
Figure 6: Stranding locations of Gray’s beaked whales on the New Zealand coast.
Figure 7: Stranding locations of sperm whales on the New Zealand coast.
In the 35 years from 1978–2013 of recorded whale strandings in the NZWSDB, 6452 stranded whales were recorded on the New Zealand coast. On average, 184 whales strand annually, and of these 146 are long-finned pilot whales (N=5,131). This is because the long-finned pilot whale commonly strands in large pods which can constitute up to 300 individuals. Also within this 35-year period, a total of 1787 long-finned pilot whales stranded in the Tasman region (Table 3), where the most common stranding location was Farewell Spit. Northland also has a high record of long-finned pilot whale strandings with 1085 individual whales stranding in this period (Table 3). Long-finned pilot whale strandings are the ubiquitous stranding events on the New Zealand coasts, and this has probably been a consistent trend even during prehistory. Locating a settlement or seasonal camp in the Tasman or Northland coastal regions would have increased the chance of encountering pilot whale strandings, which would have offered a massive windfall of potential resources including bone and presumably meat.

Table 3: The regional distribution of long-finned pilot whale (*Globicephala melas*) strandings.

<table>
<thead>
<tr>
<th>Species</th>
<th>Region</th>
<th>Count of stranding events</th>
<th>Sum of stranding events</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Globicephala melas</em></td>
<td>Auckland</td>
<td>19</td>
<td>783</td>
</tr>
<tr>
<td></td>
<td>Bay of Plenty</td>
<td>13</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>Canterbury</td>
<td>8</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Gisborne</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Hawke’s Bay</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Manawatu</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Marlborough</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Nelson</td>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>Northland</td>
<td>34</td>
<td>1085</td>
</tr>
<tr>
<td></td>
<td>Otago</td>
<td>14</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Southland</td>
<td>14</td>
<td>670</td>
</tr>
<tr>
<td></td>
<td>Taranaki</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Tasman</td>
<td>42</td>
<td>1787</td>
</tr>
<tr>
<td></td>
<td>Waikato</td>
<td>8</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>Wellington</td>
<td>12</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>West Coast</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>220</strong></td>
<td><strong>5131</strong></td>
</tr>
</tbody>
</table>

Whale strandings in New Zealand fluctuate seasonally. Generally, stranding records show high numbers in summer and low numbers in winter, although the extent of seasonality varies between species (Brabyn 1991). Mass strandings appear to have a bimodal seasonality, with more stranding events peaking in both February and October, whereas
single strandings only peak during the summer months (Brabyn 1991). The seasonality of long-finned pilot whale strandings varies regionally, with strandings in Northland occurring more frequently in the months of September, October and November, as opposed to strandings in the Tasman region which peak during the months of January, February and March (Brabyn 1991). An understanding of the seasonal fluctuation of important food and material resources in their environment would have been vital to prehistoric Māori, as seasonal camps were an important part of their subsistence economy and mobility between areas to optimise resource use was fundamental to their way of life.

4.4. A comparison of the data sets
Comparison between archaeological sites containing whale bone and the whale stranding data shows some correlations. Archaeological whale bone concentrations occur in Northland, Hauraki/Coromandel Peninsula, Golden Bay, Banks Peninsula and Murihiku. All of the four most common species frequently stranded in the Northland, Hauraki and Coromandel Peninsula areas so it is unsurprising that whale bone regularly occurs in archaeological sites within these regions. Golden Bay has a high number of long-finned pilot whale strandings (Figure 5) which coincides well with the concentration of archaeological sites in this area at which whale bone has been reported. The Murihiku region has relatively frequent occurrences of long-finned pilot whale and sperm whale strandings which coincides with the high number of archaeological sites containing whale bone in this area. However, the Banks Peninsula region does not appear to be a frequent stranding location for any of the four most common stranding species, with the possible exception of Gray’s beaked whale, which has a scatter of strandings south of Banks Peninsula that correlate with the locations of the archaeological sites quite well (Figure 6).

Another interesting trend is the high concentration of strandings which occur around the Hawke’s Bay area: all of the species had stranding events in this bay, but these were particularly frequent for pygmy sperm whales and Gray’s beaked whales. However, no whale bone has been identified in any archaeological sites in the area. The lack of
archaeological sites with whale bone is probably due to the fact that only a low number of coastal midden sites have been extensively excavated in this region. More excavations may be necessary to order to learn more of the probable use of stranded whales in this region. There are other large gaps in the distribution of archaeological sites with whale bone: the entire west coast of the South Island is devoid of any archaeological whale bone, as is most of the North Island below the Coromandel Peninsula, apart from a scatter of sites in the Wellington region and one near Gisborne. The lack of sites in these areas is probably caused by a combination of factors, which may include a lack of archaeological excavation, low archaeological site incidence, or low prehistoric population densities, which would have decreased the chance of encountering a beached whale.

The Murihiku region, where the study site Kahukura is located, has a surprisingly high number of whale bone sites considering that it was a relatively inhospitable environment which offered limited resources (Jacomb et al. 2010). It is possible that stranded whales were a target species for the inhabitants of Murihiku – if not just as a source of meat, then certainly as a high quality industrial bone resource (Jacomb et al. 2010).

Although archaeological sites throughout New Zealand with whale bone correlate with some whale stranding hot-spots there is not a strong trend of correlation with the major stranding areas such as Hawke’s Bay and Northland. This indicates that stranded whales were not a target species in the prehistoric Māori subsistence strategy. More evidence is needed, but the incidence of whale bone in archaeological sites at this stage indicates the opportunistic use of whale strandings which have occurred near to Māori settlements, rather than the settlement location being chosen because of the whale stranding rates in the area. At virtually all of the archaeological sites where whale bone has been identified, whales features as a very minor component of the subsistence economy. If stranded whales were focused on, then archaeologically we would expect to see this resource featuring in much greater concentrations in archaeological sites, and this is not the case. Instead the archaeological record reflects the very occasional use of whales which
correlates with the generally low incidence of whale stranding throughout the country and the probability of encountering these events.
Chapter Five

*Kahukura whale bone utilisation and processing analysis*

5.1. Introduction

A technological study was undertaken to identify what processing methods were used in the reduction of the Kahukura whale bone as part of the artefact manufacturing process. This analysis was carried out to address the research question of how the whale bone was being worked at Kahukura, and to determine what the whale bone was being used for. This chapter is organised in three sections. Firstly, a description of the archaeological methods used in the excavation of the Kahukura site is given. Secondly, an epistemological discussion about methods used for the taphonomical study of bone is presented. Thirdly, the methods chosen for the analysis of the Kahukura whale bone assemblage are described.

5.2. Kahukura: the archaeology

The Kahukura archaeological site is located in the sand dunes of a small beach between Dummy’s Beach and Long Beach, on the southern Catlins coast (Figure 8). The site was first entered into the New Zealand Archaeological Association (NZAA) Site Recording Scheme in 1974 by Stuart Park, following the exposure of a human skeleton there in 1968, which he investigated and reburied in 1974. Another burial was apparently exposed at the site in the 1980s, however the details of this are largely unknown (Brooks et al. 2010). During another inspection of the site in 2008 a human tibia and fibula were observed eroding from the dune face at the eastern-most exposure of the site. The bones were fully uncovered at the request of iwi representatives, and were found to be the remains of a middle-aged woman of Polynesian descent (Walter et al. 2008). The Kahukura site was one of the coastal sites investigated during an archaeological survey of the Southland coastal marine environment in 2008 as part of the Southland Coastal Heritage Inventory Project (SCHIP) carried out by Southern Pacific Archaeological Research (SPAR), and was identified as requiring urgent salvage excavation to mitigate
further damage from coastal erosion (Brooks et al. 2010, Walter et al. 2008). The site was deemed to be of high value, as the material eroding from the exposed middens suggested that the site was early, and may have dated to around the fifteenth century (Brooks et al. 2010, Walter et al. 2008). Excavation of the site was carried out as a University of Otago archaeological field school in February 2009.

Kahukura is situated in an area rich in marine resources, particularly fish, rocky shore shellfish and sea mammals. During the early period of prehistoric New Zealand settlement, the main focus of subsistence in many areas of the South Island was moa and seal hunting, but it is thought that after the rapid decline of moa and seal populations in the Catlins, the main sites were probably abandoned in favour of new economic strategies focused on fishing, shellfish gathering and the hunting of small birds (Jacomb et al. 2010). Since Kahukura was inhabited after the loss of moa, identifying the economic foundation of the occupation at Kahukura was one of the primary research objectives of the excavation. The possibility of the site being a short-term specialist food gathering/hunting area, where fishing, shellfish gathering and the exploitation of whale strandings occurred, fits in well with the settlement strategies of this time period in which the exploitation of marine resources was becoming the main focus of subsistence activities in the South Island.

Figure 8: Map showing the location of the Kahukura site (Aerial photograph from Brooks et al. 2010).
**Excavation methods (Brooks *et al.* 2010)**

A local 5 x 5 m grid was overlaid on the site, each grid square was divided into 25 1 x 1 m quadrants, and the area within the 1 x 1 quadrants was divided into four squares labelled NW, NE, SE and SW. Finds were bagged, and features recorded using this provenance information. Five excavation areas were opened up, resulting in a total excavation area of 69 m$^2$. The site was excavated by hand over a period of three weeks, and all soils were sieved through 3.2, 4.5 and 6.4 mm screens, with one unsieved bulk midden sample retained from each level of each excavation unit. All of the excavation areas, features and artefact finds were logged using a Leica TPS1200 robotic total station and the data were managed by a GIS using the local grid system.

The stratigraphy of the site was complex, with a lot of extensive lensing; however, five main layers were identified across the site:

**Layer 1:** Light grey-brown sand with poor topsoil development and some modern waste

**Layer 2:** Scant shell and fishbone lens within a dark grey sand matrix in places. In some places this layer is only represented by a band of shell or fishbone

**Layer 3:** Light grey-brown sand

**Layer 4:** Dense midden layer with occasional sand lenses

**Layer 5:** Sterile yellow-grey sand

**Layer 6:** Not present across the whole site; thin layer of shell and fishbone, with charcoal staining in places.

**Interim excavation results**

The layers identified at the site most likely represent three phases of occupation; Layer 6 represents the earliest evidence of habitation at Kahukura, during the Archaic phase (Golson 1959a). This scant cultural deposit overlies the natural sand dune, and is represented by flakes of Nelson argillite, Mayor Island obsidian, and a one-piece fishhook (Brooks *et al.* 2010, Jacomb *et al.* 2010). This occupation was short-lived in nature, and
probably represents a brief visit by people with a close association with areas in the north of New Zealand (Jacomb et al. 2010). After some time, during which wind-blown sand covered the earliest layer of occupation, an extensive settlement was established at Kahukura. This phase of occupation at the site is evidenced by the thick, dense layer of midden found in Layer 4 and was the main period of habitation at the site. Marine shell samples were taken from the upper section of Layer 4 for radiocarbon dating, and the dates indicate that the main occupation of the site occurred sometime between AD1400–1650, with a high likelihood that it was in the range of AD1450–1550 (Brooks et al. 2010) (Figure 9). The main subsistence activity at Kahukura during this phase of occupation was probably fishing, which is evidenced by the large fishhook assemblage, and the range of fish species identified from the midden deposits (Jacomb et al. 2010). Other economic strategies represented in the midden include shellfish gathering, fowling and sea mammal hunting, as well as the opportunistic use of whales (Jacomb et al. 2010). Domestic dogs were present, but moa bone was only identified at the site in very small quantities of material suited to industrial use, and is not thought to have been a significant economic pursuit at the site (Jacomb et al. 2010). After the main phase of occupation the site was briefly visited again later, and this third phase of occupation is represented by the intermittent midden lens deposits in Layer 2.

Figure 9: Radiocarbon dates from Kahukura.

The main research questions involved determining the basic deposition sequence of the cultural horizons identified at the site, identifying the areal layout of the site, and understanding the subsistence strategies and resource use at the site (Brooks et al. 2010). Six areas of the site were selected for excavation to maximise the amount and
value of information recovered, and to answer the range of research questions that were posed. These areas (Figure 10) are discussed below.

Figure 10: Locations of the excavation areas at Kahukura.
**Area 1**

This area was selected for excavation because it was located at the southern-most extent of the site, and because it was one of the areas being subjected to intensive wave erosion. The area measured 2 x 5 m, and was excavated down to the surface of Layer 5. A small amount of midden and an oven feature were found in this area, and at the base of the excavation a single flake of Mayor Island obsidian and the butt end of a Duff type 1A adze were recovered. It is most likely that this level represents some of the earliest occupation on the site, as this adze type that is only found in very early sites.

**Area 2**

This area was situated midway along the beach in the section where dense, stratified midden was eroding out of the dune face. The area measured 4 x 5 m and contained a thick deposit of midden (Layer 4) which largely contained shell and fishbone. The area contained evidence of whale bone working and, along with pieces of worked whale bone, there was a large stone located in Layer 4 which was possibly used as an anvil surface for working the bone. A large grinding stone was also recovered from Layer 2. A number of small post holes were found which had been dug into the culturally sterile subsoil at the base of the excavation.

**Area 3**

This area was located immediately north of the burial excavated in 2008. This area was excavated in order to determine the stratigraphic context of the burial in relation to the rest of the site. The area excavated measured 6 x 2 m and ran along the dune face. A small amount of midden containing shell and fishbone was recovered. No further burials or the grave cut of the original burial were located in the excavation of this area.

**Area 4**

This area was chosen for excavation in order to investigate the inland area of the site. The culture layer in this area was a thin, charcoal-stained deposit with no midden. At the base of this layer (surface of Layer 5) a piece of worked whale bone was recovered, as well as an adze made of what may be Nelson argillite, and a flake of Mayor Island obsidian.
These items were found on the surface of the culturally sterile subsoil, which suggests they may have been deposited during the earliest phase of occupation at the site.

**Area 5**
This area was a narrow trench excavated between Areas 2 and 4 to record a continuous stratigraphic profile perpendicular to the beach.

**Area 6**
This area was a 4 x 5 m unit located 3 m south of Area 3. Very little midden was recovered from the excavation of this area, but it did contain several artefacts, including 19 fish-hooks, a number of stone flakes, and some pieces of yellow and orange ochre.

**The whale bone working floor**
One of the most significant findings of the Kahukura excavation was the large quantity of worked whale bone. A total of 3000 pieces of whale bone were excavated from the Kahukura site. Of these, 344 had their positions logged with the Total Station on site, and the remaining 2514 pieces were either provenanced to quadrant on site, or sorted from the bulk midden samples by Kate Lilley (as part of her Masters’ research). The vast majority of pieces came from Area 2 (Table 4), which was identified in the field as being a whale bone working floor (Brooks et al. 2010).

<table>
<thead>
<tr>
<th>Area</th>
<th>NISP</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>2967</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>3000</td>
</tr>
</tbody>
</table>

Almost all of the pieces of whale bone from Area 2 came from Layer 4 (NISP = 2959), which was the dense midden layer with intermittent sand lenses, with a small amount coming from Layer 3 (NISP = 5). The rest of the whale bone in Area 2 was not
provenanced to layer, and came from a test pit (NISP = 1) and an investigative trench (NISP = 2). The high density and close proximity of all the whale bone pieces from Layer 4, Area 2 indicate that the assemblage was probably the result of industrial whale bone working activities occurring in this area. It is quite possible that this assemblage is the result of as little as a few hours of whale bone working, and may have been deposited very rapidly, or over a much longer period of time. The methods used in the analysis of both this assemblage, and the other whale bone from the site are outlined below.

5.3. Visually identifying whale bone

Bone is made up of two types of osseous tissue: cortical bone and cancellous bone. Cortical bone forms the dense outer shell of the bone and its main function is providing the bone with strength to support the body. Cancellous bone is less dense and typically occurs within the outer shell of cortical bone. Typically, much of whale bone is made up of cancellous bone with a thin layer of cortical bone. The most robust bones in whales are the mandibles, which are composed almost entirely of cortical bone and form a solid piece of parallel-sided bone near the articulation with the skull, known as the ‘jaw pan’ (Savelle 1997). At the microscopic level whale bone has a more pronounced haversian system (the network of spaces in which blood vessels travel within the bone) throughout the cortex (Betts 2007). This gives whale bone its characteristic porosity and permits it to bear a heavier load and absorb more energy before breaking (Scheinsohn and Ferretti 1995).

Whale bone in archaeological sites is usually easy to identify visually because of its unique properties and the size of the bones, but if the pieces are highly fragmented it can be quite difficult. It may be possible to confuse whale bone with other sea mammal bone such as seal or sea lion, as they share a similar porous bone structure. The most obvious distinguishing factor of whale bone is its size. For smaller cetacean species such as dolphins, however, it can be a problem separating pinniped and cetacean bone, and often archaeologists are reluctant to identify bone beyond the non-specific term ‘sea mammal’. Sea mammal bone with industrial working is more likely to be whale bone, as there is only limited evidence for the use of seal and sea lion bone for industrial purposes.
(Smith 1985: Appendix 15). This is probably due to the relative lack of cortical bone in
seals and sea lions, in comparison to some of the larger whale species. If there are good
cortical surfaces on fractured sea mammal bone fragments found in archaeological sites,
then whale bone is easily separated from pinniped bone. The cortical surfaces of whale
bone fragments will be very flat because they are derived from a much larger bone than
is found in pinnipeds, and cortical fragments from pinniped bones would be expected to
be much more curved. Furthermore, there are no small bones in large whale species that
could be confused with these much smaller sea mammal species.

All of the whale bone from Kahukura was visually identified using the above principles,
and it was mostly easily separated from the other vertebrate remains in the site because
of the shape and size of the pieces, and their distinctive morphology. Professor R. Ewan
Fordyce of the Department of Geology at the University of Otago, and Dr Ian Smith of the
Department of Anthropology and Archaeology at the University of Otago assisted in the
identification of the only two pieces which were able to be identified to element and
taxa. The bone from Kahukura is generally well-preserved, and although whale bone can
be quite fragile – especially the cancellous portions of bones – it appears to have suffered
very little post-depositional damage, except for probably some minor cancellous bone
crumbing.

5.4. Selecting a methodological approach to processing analysis
The analysis of processing was based on research methods applied in similar
archaeological studies of the bone industries of Arctic Inuit (Betts 2007, LeMoine and
bone tool industry has been well described in Betts’ (2007) study which provides a
baseline reference for the analysis of the industrial processing of whale bone in
archaeological contexts. The methodology used in Betts’ (2007) study involves the
identification of manufacturing actions which have been inflicted on the bone during
processing, and which leave characteristic marks on the bone fragments. Manufacturing
actions are defined as “a process of removing bone from a larger element or unit and is
generally specific to both the type of raw material being worked and the stage of
reduction of the tool” (Betts 2007: 134). This type of method is based on chaîne opératoire or ‘operational sequence’, which can be broadly defined as the study of how lithic items were produced, but can also be applied to other raw materials including bone (Bar-Yosef and Van Peer 2009). Sellet (1993: 106) defines the analysis of chaîne opératoire as “a technological approach that seeks to reconstruct the organisation of a technical system at a given archaeological site”. Consequently, the chaîne opératoire aims to describe and understand all cultural transformations that a specific raw material has undergone, be it stone, wood, or bone or any other resource that is used and modified by people. The method aims to chronologically isolate the actions and mental processes that go into the manufacture of an artefact and its maintenance (Sellet 1993). The chaîne opératoire begins with the procurement of a resource and ends with the discard of the artefact. The concept has been widely used in French archaeology and similar studies have been developed in the United States by processual archaeologists (Sellet 1993). The operational sequence approach relies on the principle that a lithic (or bone) assemblage is “not a random, but a methodically interconnected association of artefacts” (Bar-Yosef and Van Peer 2009: 105). Even when fragmented into many pieces, a lithic or bone assemblage forms a complete group which is bound together by the methodical process used in the reduction of the material. The chaîne opératoire methodology seeks to understand the technological processes which create an assemblage, rather than the finished products alone. Although the concept is most commonly used in lithic studies, it has also been successfully applied to bone reduction in technological studies, such as of the use of walrus bone during the Paleoeskimo period in Arctic Canada (Monchot et al. 2013).

The fragmented and heavily worked nature of the pieces from the Kahukura whale bone assemblage, and the distinct lack of finished whale bone artefacts at the site, makes this methodological approach vital for understanding the tools and processes that were utilised in the reduction of the bone, and determining how the assemblage was formed.

The approach is also appropriate for this assemblage because the process of reduction that has been applied to the whale bone at Kahukura has many similarities with lithic tool
production. Stone is typically worked by striking a core with a hammer-stone, causing the stone to fracture and create flakes which display characteristic scar patterns, which can be used to determine the sequence of reduction. Although there are significant differences between the material properties of stone and bone, the reduction process of large whale bones at Kahukura has created an assemblage very similar to lithic debitage. The chipping technique which has been applied to the bone has created a large quantity of debitage fragments which morphologically resemble stone flakes, and display dorsal scars.

A number of analytical tools for lithic reduction sequences fall under the chaîne opératoire umbrella. These include the “replication of core reduction sequences, refitting of the products of core reductions, analysis of scar patterns and superpositions and technological classification” (Bar-Yosef and Van Peer 2009: 105). Replication involves experimental knapping to determine the mechanics of creating a series of flakes from a core (Bar-Yosef and Van Peer 2009). Replication of the bone working sequence can be carried out much in the same way as stone working. However, because whale bone in New Zealand is rare and difficult to obtain, experimental replication of whale bone reduction was not considered to be a viable option for this study. Refitting was also not considered to be a useful tool in the analysis of the Kahukura material due to the large number of bone fragments present in the assemblage, and the time constraints of the research. Refitting is described by Laughlin and Kelly (2010: 429) as being comparable to “putting together a very complex three-dimensional jigsaw puzzle with no picture on the box, an unknown number of the pieces missing, and bits of other puzzles thrown in”.

The analysis of scar patterns and superpositions uses the physical evidence exhibited by the reduction products, which can show their position in the reduction sequence. Careful observation of these marks hypothetically allows the researcher to reconstruct the relative sequence of actions (Bar-Yosef and Van Peer 2009). This method of analysis was deemed applicable to the Kahukura whale bone as a way of interpreting the pattern of morphological similarities within the assemblage. Objective observation is used to create a set of technological typologies, in which each type is identified by its technologically
relevant attributes. The occurrence rate of the various types is used to determine the relative importance of the different processing methods in a given assemblage (Bar-Yosef and Van Peer 2009). A technological typology was created for the analysis of the Kahukura whale bone assemblage to determine the commonly employed processing strategies at the site. These are outlined in the following section.

5.5. Methods for the analysis of the Kahukura whale bone assemblage

The whale bone from Kahukura was washed and sorted from the other material, in the Anthropology and Archaeology Department laboratories at the University of Otago. Following this, each individual piece of whale bone in the assemblage was analysed using the following methodological procedure. In the analysis, the whale bone from Area 2 is interpreted to be a discrete feature which represents a single (or several closely related) processing event which may have accumulated in as little as a few hours of time, and this assemblage is treated separately in the analysis of the results.

Each fragment of bone from the assemblage was analysed using the naked eye. Measurements (using callipers) were taken of each bone piece recording the length (parallel to the long axis of the bone, following the cortical grain), width (measured laterally to the grain of the bone), and thickness (the depth of the bone from exterior to interior, or if no cortical bone was present, the thinnest measurement) (Figure 11). Fragments that measured below 20 mm in length were not measured; instead these were just counted and weighed. Each bone piece was weighed on an electronic scale. The presence or absence of cortex was also recorded. The bone pieces were then inspected for visible human modification marks.
The technological typology used in the analysis of the whale bone fragments from Kahukura is based on the level of processing visible on the piece. Research on the Canadian Inuit bone and antler industries, which have focused on determining the reduction methods used in bone implement manufacture, provide a basis for constructing a set of typologies (see: Betts 2007, Morrison 1986, Nagy 1990). The reduction sequence of the Kahukura assemblage is broken into two levels for analytic purposes, and the pieces of bone are classed as being products of either primary or secondary reduction. In this assemblage, the artefacts are considered to be at or near the end point of the bone modification process, and the presence or absence of these items can indicate what levels of processing were occurring on site (i.e., just primary, just secondary, or both). Based on the shape of the fragment and the level of visible tool marks or evidence of working, the pieces were separated into four categories:

1.) Amorphous debitage
2.) Morphological flake debitage
3.) Prepared tabs
4.) Artefacts

Products of primary reduction

Products of secondary reduction

Figure 11: Measurement of the whale bone fragments.
Virtually all of the pieces of whale bone from Kahukura had evidence of some degree of industrial working, some of which was visible as marks on the bone, and some of which was evidenced by the characteristic shape of the fragments. When bone is worked, pieces can be chopped off. These pieces will not necessarily have a chop mark left on them, but can be identified by a common morphology. Pieces which have been chopped off a larger piece in a sequence of reduction were common in the Kahukura assemblage and fall into the debitage category. Amorphous and morphological flake debitage is considered to be the by-product of the whale bone processing which occurred at Kahukura, whereas prepared tabs and artefacts are the intended products of industrial bone working. These categories are described in further detail below.

**Primary processing types**

**Debitage** – Debitage is a word used to describe the by-product of stone tool making and re-touching, and includes the chips and fragments of stone that are produced from lithic reduction processes (Sullivan and Rozen 1985). In lithic studies, debitage analysis can provide important information for reconstructing stone technologies. The term ‘debitage’ is borrowed from lithics and applied to bone in this study based on the large number of bone fragments which had no identifiable evidence of working in the form of tool marks, but which shared a range of morphological characteristics. These characteristics indicated that the assemblage was largely made up of the by-products of industrial whale bone working, and had been formed through the process of a systematic reduction sequence unique to the material being used. Two categories of debitage have been identified from the Kahukura whale bone assemblage: amorphous and morphological flakes.

**Amorphous debitage** – Amorphous debitage pieces do not display any evidence of tool marks, and lack any identifying factors which show the processing method used in their creation. These pieces can be any shape (Figure 12).
Figure 12: Amorphous debitage fragments of whale bone from Kahukura (5 cm scale).

Morphological flake debitage – The term ‘morphological flake’ is used in this study to describe the unique type of bone debitage chips that make up a large proportion of the whale bone assemblage from the site. Although many of these pieces do not display direct tool mark evidence of their method of creation, morphological flakes have a distinct shape and often display a scar on their dorsal face which indicates that they were removed as part of a sequence of reduction involving the systematic removal of bone chips (Figure 13). Although most of these pieces are waste chips created during bone processing, some of these pieces have been used as blanks and display evidence of further working. It is important to note that, although these pieces resemble stone flakes, they do not exhibit the technical attributes typically seen on stone flakes which have been produced by impact or pressure flaking methods (e.g., bulb of percussion, striking platform), and thus are not true ‘flakes’. This category of bone fragments was created though the process of chipping – a manufacturing action which is described below.
Prepared tab – Tabs are pieces of bone which have been modified into a workable section through the actions of primary reduction, and are intended to be used as a blank for further working. These pieces are identified as uniformly shaped (often rectangular or square) with an even thickness (Figure 14). Prepared whale bone tabs are often shaped by using the sawing and snapping technique and then flattened using an adze or chisel tool to level and remove the cancellous bone from the quality cortical bone favoured for artefact manufacture (Betts 2007).
Secondary processing types

Artefacts – The word ‘artefact’ is used here to refer to the pieces of whale bone in the assemblage which have been subjected to extensive manufacturing modification. Although it could easily be argued that all of the bone fragments in the assemblage are artefacts, for the purpose of this study the word is only applied to the heavily modified pieces of bone which have been carved or shaped to create a form. These pieces exhibit a variety of modification techniques (Figure 15).
5.6. Evidence of Kahukura whale bone processing actions

Modification marks can occur on bone through the process of butchering or de-fleshing a carcass, or through the industrial processing of the bones. Six different modification marks were identified from the processing study of the Kahukura assemblage, all of which show the use of a modification action. These were: 1) chopping, 2) abrading, 3) cutting, 4) scraping, 5) sawing, and 6) chipping, all of which are described in further detail below. Manufacturing actions are defined here as a process of modifying or removing bone from a larger element or unit, with the exception of cutting. Cutting is considered to be evidence of flesh removal and may indicate that the meat was being removed for consumption or may have been part of the bone preparation process. Non-direct cultural modification was also recorded on the bone fragments in the form of human-associated animal attrition marks (dogs), and charring or burning (also defined below).

Chopping – The size and shape of adze chop marks distinguish them from other culturally inflicted tool marks. There are two types of chop marks: the first is where the bone displays a straight-walled edge where it has been sliced using considerable force (Figure 16). These marks are identified as being inflicted by an adze, as no other straight bladed tool has been identified in the Māori tool kit which could have created such a forcibly applied cut (Taylor 1984: 95). These marks are the product of the bone reduction process to reduce large bones into smaller pieces – possibly with the intention of further working. The process of chopping is similar to that of cutting wood, and can create bone chips as a by-product (Taylor 1984: 95). Adze chop marks can also leave hinges on the bone pieces where the tool has stopped or become hung-up.

The second type of adze chop mark is identified as being a relatively short, broad, linear depression which generally has a ‘V’ shaped cross-section (Fisher 1995: 19) (Figure 16 and Figure 17). These marks are created when a deliberate blow, struck on the bone surface for the purpose of removing part of the bone, has not resulted in the bone breaking. This type of mark may also be characterised by a margin of crushed bone where the impact has dented the cortical bone into the deeper cancellous bone. The length of these chop marks depend on the width of the tool blade that was used. Chop marks were identified
in the assemblage as either linear impact marks, or sheared bone surfaces. The location and orientation of the marks were recorded where possible.

Figure 16: Whale bone fragment from Kahukura showing chop marks (5 cm scale).

Figure 17: Whale bone fragment from Kahukura showing 'V' shaped surface chop marks (5 cm scale).
Abrading – This refers to a bone surface which has been modified by an abrasive force for the purpose of smoothing, shaping or polishing. Grinding is identified by a flattened surface which is unnaturally smooth or shiny, and has concentrations of light, randomly oriented, or criss-crossed striations (Figure 18). Sandstone grindstones were often used as an abrasive tool for the purpose of flattening, rounding or smoothing the surfaces of bone artefacts. Files made of rough stone were also commonly used to create rounded edges on fine artefacts, and their use results in the fine striations often seen on Māori bone artefacts (Taylor 1984). The locations of abrasion marks on the pieces of bone were recorded where possible.

![Figure 18: Worked whale bone from Kahukura showing surface abrasion marks (5 cm scale).](image)

Cutting – Cut marks are defined as narrow linear grooves caused by a thin, sharp-edged implement. They are generally made during the process of removing soft tissue from the bone, and are identified as relatively narrow, elongate, linear striations (Fisher 1995: 12). Cut marks usually display a ‘V’ shaped cross-section and have flat sides, although this depends on the type of tool that was used. A very sharp tool made from obsidian, for example, creates a deep and narrow ‘V’, whereas a thicker, retouched tool tends to leave more of a ‘U’ shaped groove (Binford 1981, Walker and Long 1977). A diagnostic feature of cut marks, universally identified by Shipman and Rose (1983) in all of the specimens in
their large sample, is the presence of fine, parallel striations running longitudinally in the edges of the cut mark made by microprojections. Marks on bone which resemble cut marks can be caused by a variety of factors such as animal attrition, contact with stone and plant damage. A ‘configurational’ approach is often used to distinguish genuine cut marks from striations made by other processes. This involves taking into account factors such as the proportion of bones that are marked, the number of striations on each specimen and the orientation of these relative to one another, the shape of the bone, the association with other cultural marks (such as polishing) and the range of shapes displayed by the cuts (Fisher 1995). Cut marks were recorded in the assemblage, and the number, orientation and location of the marks were recorded, as well as whether they were likely to be evidence of either butchery or industrial processing (Figure 19).

Figure 19: Whale bone fragment from Kahukura exhibiting two cut marks on the cortical surface (5 cm scale).

**Scraping** – Evidence of scraping is identified as a set of several closely spaced, parallel striations that are linear, elongate, and relatively narrow and shallow (Fisher 1995) (Figure 20). These marks can be created by scraping a stone tool across the surface of a bone, perpendicular to the edge of the implement. Binford (1981: 134) described the method of scraping by Nunamiut Eskimo to remove the periosteum from an area of bone
before striking the bone with a hammer stone for marrow removal. Periosteum removal allows for a more controlled breakage, and may be used for the removal of other soft tissues in preparation for bone breakage to be used for other purposes (Fisher 1995). Scrape marks can also be caused by sedimentary abrasion and distinguishing between human and non-human made scrape marks is very important for the interpretation of an assemblage (Olsen and Shipman 1988). Flake tools scraped across a bone surface leave longitudinal striations, and ‘chattermarks’ – tight corrugations which run perpendicular to the striations (Newcomer 1974, Olsen and Shipman 1988). Non-human scrape marks made by sandstone were found to leave many parallel striations of uniform depth (Olsen and Shipman 1988). Deliberate abrasion is usually repeated several times in one area, and leaves multi-directional striations. The presence and location of scraping was recorded on the pieces of whale bone from the Kahukura assemblage, along with the presence or absence of chattermarks.

Figure 20: Whale bone fragment from Kahukura showing scrape marks (5 cm scale).

**Sawing** – Sawing is defined as the creation of linear cut marks using a thin, abrasive or serrated stone tool in a back and forth motion to form a groove. Stone saws were commonly used for cross-cutting and thinning bone, and often in the creation of bone
tabs the pieces were sawn only deep enough to enable the tab to be broken off (Knapp 1941). The width and shape of saw marks are determined by the shape of the saw blade, and because the saw blade is repeatedly run through the bone, the shape and angle of the blade is easily determined. Saw marks were recorded in the assemblage and their location and orientation on the bone was recorded where possible (Figure 21).

Figure 21: Whale bone fragment from Kahukura showing a lateral saw cut (5 cm scale).

**Chipping** – Chipping is a method of reduction which leaves characteristic marks on the removed pieces. Chips are fragments of bone that have been chipped off a larger piece of bone in a sequence of reduction, probably using an adze or some other large chopping tool. Chipped bone pieces are identified as often being longer than they are wide, and exhibit dorsal marks resembling ‘flake scars’ where another chip has been removed before it in the sequence. Whale bone chips which morphologically resemble stone flakes have been described by Betts (2007) from a bowhead whale (*Balaena mysticetus*) bone processing site at McKinley Bay in the Canadian Arctic. At this site, bowhead ribs were reduced longitudinally to create cortical banks for further working, a process which created many small chips displaying a sequence of reduction similar to that of stone flakes being removed from a core (Betts 2007). Chipping was identified in the assemblage
as ‘morphological flakes’ (described above) as well as pieces which displayed ‘flake scars’ where a chip had been removed (Figure 22).

Burning – Burning causes the removal of organic material from bones. Bone which has been exposed to fire becomes blackened and charred, and if it is a prolonged exposure the bone will eventually become white and chalky in texture (Taylor 1984). Evidence of burning may be a result of cooking meat which is still attached to the bone, using the bones as a source of fuel, employing burning as a method of disposing of rubbish, or it may have occurred from accidental or non-deliberate exposure to fire (Nicholson 1993). Only the presence of burning was recorded in the assemblage, as the location of burning on a particular element was not possible to determine with the small fragments that made up the majority of the assemblage.
Animal attrition – Evidence of bone gnawing by dogs or rats is common in New Zealand archaeofaunal assemblages, and is identified though the characteristic traces that their teeth leave on bone surfaces. No rat-gnawed pieces of bone were observed in the Kahukura assemblage, but there were pieces that had evidence of dog attrition. Several studies have discussed the identification of animal attrition at length (Binford 1981: 44-49, Fisher 1995: 39-42, Shipman and Rose 1983), although the level of detail in these studies is often not relevant in New Zealand as species identification is not necessary. The main goal in this study is determining cultural modification from dog modification. The most obvious and diagnostic evidence of dog gnawing is circular puncture or perforation marks; these are a function of the strength of a bone relative to the strength of a dog’s jaw (Binford 1981), so in the case of whale bone, which typically has a relatively weak, spongy core, it is not surprising to find deep puncture marks made by dogs. Dog attrition can occasionally resemble human-made cut marks, but tooth marks are generally wider and shallower than cut marks left by a stone tool, and few ambiguous situations arise (Taylor 1984: 94). The presence of dog tooth marks were recorded in the assemblage, and the location of the marks on the bones were recorded where possible.

5.7. Associated stone artefacts
The stone artefacts from Kahukura provide an array of information pertaining to the processing of whales at the site. Stone would have been the tool material of choice used in flensing the carcass and in the industrial working of the whale bone, and the range of stone tools from the site, in conjunction with the taphonomical bone study, provides information as to how the processing was being done. A descriptive analysis of the lithic material from the site was carried out to answer the question of whether it was possible to identify any specific whale bone working tools. Features of the lithics that were analysed included the form, stone variety, and whether the item displayed use-wear or re-touching evidence. Use-wear and re-touching were considered evidence that the stone had been used as a tool, and were identified as damage (microchips) on the working surface or blade that were visible to the naked eye. The location of these lithic items, recorded by the total station, relative to whale bone working floor in Area 2, was also considered.
Chapter Six

Results of the Kahukura whale bone analysis

6.1. Introduction

The taphonomic analysis of the whale bone recovered from Kahukura was undertaken to determine the tools and methods used in the bone reduction, and to identify what level of processing was occurring at the site. If preliminary debitage and prepared tabs are highly represented in the Kahukura whale bone assemblage then the site was more likely to have been used for the procurement and primary processing of whale bone. In this scenario, prepared tabs would have been transported to another location to be further worked into artefacts. On the other hand, if secondary debitage and finished artefacts are equally represented at the site then this shows that all of the whale bone processing was occurring at the site. The stone tools recovered from the site also provide processing information. A high frequency of heavy duty tools such as adzes associated with the worked whale bone is likely to be synonymous with primary processing activities.

This chapter presents the results of the whale bone analysis. The chapter is organised into five sections: the first gives a summary of the main findings from the study, and the general features of the whale bone assemblage from Kahukura. In the second, the industrial modification evidence is given, which outlines the results of the processing study. In the third section, the whale bone from Area 2 is discussed as a discrete and cohesive assemblage and the results of the processing analysis are discussed with regard to this collection of pieces. The fourth section outlines the results of the spatial analysis of the whale bone fragments from Area 2. In the final section, the results of the lithic study are described.

6.2. Features of the Kahukura whale bone assemblage

A total of 3000 pieces of whale bone were excavated from the Kahukura site. Virtually all of the whale bone from the site came from Area 2 (N=2,967), and the whale bone pieces from this area were almost all restricted to Layer 4, which is a dense midden deposit that
was laid down during the main phase of occupation at the site. The whale bone from Area 2 is treated as a discrete feature for the purpose of analysis in this thesis, and is analysed separately from the pieces found in the remaining excavation areas of the site. This is because the bone from Area 2 was all found within a very close proximity and largely within the same layer, indicating that it may have been deposited in a very short space of time, possibly during an isolated and localised whale bone processing event. Out of the 3000 pieces of whale bone from the whole site, only one is a complete bone. The remainder of the assemblage is made up of bone pieces displaying varying degrees of fragmentation. The Kahukura whale bone assemblage differs, in this way, from other New Zealand whale bone assemblages which have been analysed (e.g., Taylor 1984, 2002), as nearly all of the bone pieces are very broken-up. The fragmented nature of the Kahukura assemblage limits certain taphonomic analyses in which identifiable elements are paramount – such as determining butchery processes. Bone fragmentation in the Kahukura assemblage has most likely occurred through human manufacturing actions being applied to the bones for the production of whale bone artefacts. However, it is possible that the whale bone assemblage was created by processes other than tool manufacturing, and alternative taphonomic agents must be considered in the analysis of this material.

Some possible factors which may have attributed to the fragmentation of the whale bone at Kahukura are explored here, and include butchery of the carcass for meat, grease removal, and carnivore gnawing, however it is very unlikely that butchery of the whale carcass caused the extensive bone fragmentation present in the assemblage, as the removal of meat from the bones of a southern right whale would not require the degree of bone breakage which is present in the assemblage. Studies of whale butchery have shown that the bones remain relatively intact and often only exhibit cut marks as evidence of flesh removal (e.g., Monks 2001). Furthermore, butchery does not explain the range of tool marks which have been applied to the bone pieces in the assemblage. Grease extraction is also not a strong contender for the cause of bone fracturing in the Kahukura assemblage, since the low incidence of charring (<0.5%) on the bones in the assemblage indicates that grease extraction or the use of the bone for fuel was probably
not carried out at the site. Dog gnawing is also discarded as a significant bone fragmentation agent at the site. Although dog gnawing is known to have a large impact on faunal assemblages, and has been identified in other whale bone assemblages in New Zealand (e.g., Taylor 1984), the low frequency of elements displaying identifiable dog gnawing marks (0.1%) shows that dogs were most likely not a significant taphonomic agent at Kahukura. Exclusion of these other possible taphonomic agents, in conjunction with the tool mark evidence present on many of the bone fragments, strongly suggests that the reduction processes which have been applied to the bone are human in origin, and were for the purpose of artefact manufacture.

The highly fragmented nature of the assemblage meant only four of the bone pieces were able to be identified to element: a proximal and a distal rib end, the end portion of a vertebral spine, and a left jugal bone (which forms part of the zygomatic arch in some cetacean species; see Figure 23). The jugal bone (Figure 24) was identified as probably deriving from a southern right whale (*Eubalaena australis*), and was identified through photographs of a North Atlantic right whale (*Eubalaena glacialis*) skeleton (E. Fordyce 2013, pers. comm.). The morphological similarities between the species justify using the northern right whale as a comparative species for southern right whale bone identification. The two pieces of rib bone were unable to be identified to species, however it is safe to say that, based on size, they derive from a medium to large whale species, and there is a strong possibility that they also derive from the same southern right whale as the jugal bone. The minimum number individuals present (MNI) of whales at Kahukura is one southern right whale. There is no evidence that more than one individual or more than one species were exploited at the site, as all of the bones which could be identified to element fit within the expected size range of the southern right whale species.
The element composition of the Kahukura whale bone pieces shows that the assemblage has resulted from the processes of selection, transport and secondary deposition, and is discernable from the composition of a bone assemblage expected at a primary death locality. The most likely scenario is that the bones were selected for their industrial
qualities and removed from a stranded animal as complete elements, and then carried a short distance to the site to be worked. The “schlepp effect” (Perkins and Daly 1968), which is defined as “the larger the animal and the farther away from the point of consumption it is killed, the fewer of its bones will get ‘schlepped’ back to the camp, village, or other area” (Daly 1969: 149), is also probably a factor in the low element diversity at Kahukura. The bone is assumed to have come from the opportunistically scavenged carcass of a stranded whale, rather than a purposefully hunted animal. As there is no evidence for the hunting of large whales at Kahukura, or generally in prehistoric New Zealand, the bone is assumed to have come from the opportunistically scavenged carcass of a stranded whale, rather than a purposefully hunted animal. There is a small chance that the animal may have been encouraged to strand using ocean-going waka to drive the whale inshore. The emphasis on fishing evidenced by the wide range of fishhooks found at the site and the midden being dominated by fish bone (Jacomb et al. 2010), indicates that the occupants of the site probably used sophisticated ocean-going vessels. Southern right whales are known to be slow-moving, docile creatures which were commonly found close inshore around the New Zealand coast prior to the advent of commercial whaling (Gaskin 1972, Patenaude 2003). A co-ordinated group of hunters using long spears may have been able to force the whale to strand on the beach, especially if the animal was old or sick or otherwise in a vulnerable state. Furthermore, the favourable coastal morphology at Kahukura, which is located in a sheltered and relatively enclosed bay, would have aided such an operation. Because of the large nature of the whale bones present, it is possible that a whale was stranded on the beach at Kahukura and select bones were removed from the carcass and only transported a short distance away from the beach to be worked. Another possibility is that a stranded whale was encountered by Kahukura occupants during an excursion and may have been butchered and the selected bones required for manufacturing then transported to their place of deposition by waka. It is unlikely that the bones were carried far by hand because of their weight.
6.3. Evidence of industrial working at Kahukura

The total whale bone assemblage (N=3000) from Kahukura is made up of 96% debitage, 3% prepared tabs, and 1% artefacts. Morphological flakes made up 22.6% of the debitage, and the remaining debitage (77.4%) is made up of amorphous fragments (Figure 25). The high proportion of whale bone debitage at Kahukura is direct evidence that bone reduction processing took place during the main occupation phase of the site, and this activity was highly localised within the Area 2 excavation unit. The whale bone from Area 2 was made up of 99.6% debitage, composed of 77.2% amorphous debitage and 22.3% morphological flake debitage (Figure 26). Prepared tabs and artefacts featured in just 0.4% of the Area 2 whale bone assemblage. The 33 pieces which came from excavation areas outside of Area 2 are composed of 64% amorphous debitage, 33% morphological flakes, and 3% prepared tabs (Figure 27). All of the artefact pieces were found in Area 2.

Figure 25: Types of bone pieces from the whole whale bone assemblage from Kahukura.
Figure 26: Types of whale bone pieces from Area 2, Kahukura.

Figure 27: Types of whale bone pieces from all other areas at Kahukura.
The Area 2 assemblage

Only 4.7% of the pieces excavated from Area 2 had evidence of tool marks. However, the morphology of the fragments as a cohesive assemblage allowed an insight into the methods employed in the creation of the fragments, even when tool marks were not present on the fragments. The most commonly identified processing technique was chipping (27% of the total assemblage). This was identified both by chipping marks left on the bone fragments, and by the presence of morphological flake debitage pieces, which are the products of the chipping method. Aside from chipping, all of the other identified modification actions featured in the Area 2 assemblage at a much lower rate. Chopping occurred on 1.6% of the Area 2 assemblage, and cutting, scraping, sawing and abrasion were all present on less than 1% of the pieces (Figure 28).

![Figure 28: Number of whale bone pieces in Area 2 with evidence of manufacturing actions (excluding chipping).](image)

**Chipping**

Chipping evidence was present on 22.7% of the total assemblage, with a total of 98.2% of fragments with chipping evidence being morphological flake debitage pieces. Most of the pieces classed as morphological flakes were below 100 mm long and 40 mm wide and
ovular shaped. As length was measured with the cortical grain, this shows that most of the chips were removed from the bone longitudinally. The tools used to carry out this method of processing would have needed to be sharp and robust, as a large amount of force would have to be applied to the bone to cause chips to be removed in this fashion. The physical evidence on the morphological flakes indicates that the bone was worked in a longitudinal sequence in which flakes of bone are removed one after the other down the length of the bone. This process creates the characteristic dorsal scar which is exhibited by many of the flaked bone pieces (Figure 29).

![Morphological flake with dorsal 'flake' scars in Area 2, Kahukura (5 cm scale).](image_url)

**Chopping**

Chopping was evident on 1.6% of the Area 2 assemblage. Chop marks were identified in the assemblage as either linear, ‘V’ shaped impact marks, or as sheared bone surfaces where a piece of bone had been sliced off. Two of the bone pieces which could be identified to element exhibited chopping marks; the proximal (Figure 30) and the distal (Figure 31) rib ends showed heavy chopping marks indicating that this was the method used to separate them from the rib shaft. Chopping as a method of bone processing was used on the Kahukura whale bone for the primary preparation of the bone for reduction, in which the rib ends were removed to create a section of bone that could be further reduced to make smaller workable portions. The only possible implement in the Māori
tool-kit which could be employed for heavy-duty chopping jobs seen in the Kahukura assemblage is an adze; no other tool could be safely used to create such deep cuts in the bone.

Chopping marks were most frequently identified on morphological flakes, with 70.2% of the bone fragments which exhibited chopping evidence being morphological flakes. There is a potentially ‘grey area’ between chopping and chipping, but although these two methods are closely related, bone pieces which have been chopped are generally larger and thicker, indicating that they were probably removed earlier on in the reduction sequence than morphological flakes, which were chipped. Chopping appears to have been a method used for reduction on a large scale, for removing unwanted bone portions, such as the rib ends. The chopping method is then used for breaking the desired bone sections into useful and workable parts which could be further reduced by transverse reduction, or chipping. This was probably done by holding the bone upright and chopping the end of the bone to cause it to split longitudinally, a process which has created thick pieces with chop marks at each end.

Figure 30: Proximal rib end showing adze chop marks where it has been removed from the rib shaft (5 cm scale).
One fragment of whale bone from Area 2 displayed marks which may have been made using a small chisel (Figure 32). This fragment displays two curvilinear lines chiselled into the cortex which are reminiscent of the typical koru motifs seen in Māori carving.

**Cutting**

Cutting was not a frequently applied method of bone processing applied to the Kahukura whale bone assemblage. Cut marks were present on only 0.6% of the total Area 2
assemblage. Cut marks are made using stone flake tools, and are most likely made on the bones during the removal of soft tissues (Figure 33). If the whale carcass was encountered when fresh, some degree of butchery must have occurred at the site, at least to remove the bones, and de-flesh them for further processing, but also possibly to remove meat for consumption. Butchery is defined as the removal of flesh, and the dismemberment of a carcass into sets of bones which may be discarded, transported or allocated to specific uses (Lyman 1994). Butchery marks left on bone from these processes can be divided into two types: cut marks and chop marks. Cut marks are made by sharp-bladed tools, whereas chop marks are made by heavy cutting tools which rely on impact force, such as adzes. Determining between butchery-related chop marks and industrial bone processing chop marks has not been attempted in this study because of the degree of fragmentation within the assemblage. Because so few of the pieces exhibited cut marks, and because of the lack of identifiable elements, identifying a pattern of cut marks which may have facilitated the interpretation of a butchering process was not possible. The presence of cut marks on the bone pieces in the assemblage show that the bones were probably fresh when they were obtained. If the carcass was found freshly dead, it is most likely that the meat would have been removed for consumption, but unfortunately this can only be speculated, as no archaeological evidence of whale meat consumption at Kahukura exists.

Figure 33: Bone fragment from Kahukura displaying cut marks (5 cm scale).
**Scraping**

Scraping was evident on just 14 of the whale bone pieces from Area 2, representing <0.5% of the assemblage. Out of all the recorded scrape marks in the assemblage, none of these exhibited chattermarks, which are used to identify human-made scrape marks on bone (Newcomer 1974). All of the scrape marks in the assemblage are small, isolated patches of tightly-packed striations which have uniform depth. The scrapes resemble marks made by scraping sandstone across the bone surface, and are interpreted to most likely have been caused by sedimentary abrasion rather than by the deliberate scraping of bone using a flake tool (Figure 34).

![Figure 34: Whale bone fragment from Kahukura displaying surface scrape marks caused by sedimentary abrasion (5 cm scale).](image)

**Abrading**

Abrasion was present on eight of the whale bone pieces from Area 2, making up just 0.26% of the assemblage. Out of the eight pieces of bone, four were artefacts, three were morphological flakes and one was a prepared tab. The high proportion of artefacts indicates that abrasion was probably not a method employed in the primary reduction of the whale bone at Kahukura, but was instead a secondary processing method used for finishing items. The low incidence of abrasion also indicates that secondary reduction may have not been a major activity at the site.
**Sawing**

Along with abrading, sawing was one of the least common manufacturing actions identified on the bone fragments at Kahukura, with only eight pieces (0.26%) in the assemblage displaying evidence of this method. The sawn items were made up of four morphological flakes, two prepared tabs, and two artefacts. The bone pieces which display sawing in the Area 2 whale bone assemblage have been cut with ‘V’ shaped blades, using the ‘saw and snap’ method. The saw and snap method is a way of separating sections of bone by making two lateral cuts into each side until the bone is weak enough to break into two pieces, a method that was recognised in early New Zealand sites by Knapp (1941: 5) as a common way of creating prepared tabs of moa and whale bone for fishhook manufacture. Sawing marks have been identified on industrially worked moa bone in New Zealand, and sawing has been identified as a primary method of separating workable sections from the irregular, articular ends of bones (Kooyman 1985).

**Animal attrition and charring**

Dog tooth marks were identified on only three of the fragments of whale bone from Area 2. The two bone pieces were the end of a vertebral spine (Figure 35) and a proximal rib end (Figure 36). All of these pieces represent discarded pieces with no industrial value and were probably specifically given to the dogs to chew. No rat gnawing was identified on any of the bone.

![Figure 35: The end of a vertebral spine showing dog tooth puncture marks (5 cm scale).](image)
Only 14 pieces of whale bone from Area 2 showed evidence of charring and all were debitage fragments. The small number of charred pieces shows that intentional burning, which would indicate the use of whale bones for fuel, was probably not an activity which occurred at the site. The charring on the fragments probably occurred through accidental contact with fire at the site.

6.4. Whale bone from other areas at Kahukura
A total of 34 pieces of whale bone were excavated from Areas 1, 3, 4, 5 and 6. Almost all of these pieces were debitage fragments made up of amorphous and morphological flake debitage, although six of these showed evidence of further working in the form of chipping, cut marks and sawing. One prepared tab was identified from Area 1.

6.5. A spatial analysis of the whale bone working floor in Area 2
A total of 2967 pieces of whale bone were excavated from Area 2, making up 98.9% of the total whale bone assemblage excavated from Kahukura. The high concentration of whale bone in this area may indicate that this is an area of the site in which whale bone processing was taking place. Using the Total Station points the locations of the primary processing by-products (amorphous debitage and morphological flake debitage pieces) were mapped using GIS software. Located in close association with the majority of the whale bone fragments was a large anvil stone, found in Area 2, Layer 4 (Figure 37).
anvil stone was interpreted in the field as having been used as a solid work surface for resting the bone on while it was manufactured into smaller pieces. Stones of this size do not naturally occur in the sand dune environment at Kahukura, and it is thought to have been carried onto the site specifically for the purpose of bone working.

Figure 37: Photograph of Area 2 showing the location of the anvil stone.

The map of Area 2 (Figure 38) shows that the whale bone was concentrated in the northern section of Area 2 and surrounded the anvil stone in a way that one would expect to see had the pieces been chipped off a large portion of whale bone which was held steady on the anvil stone. The anvil stone would have been used as a sturdy surface to rest the bone on as it was chipped, with the chipping by-products, or debitage, forming a circular scatter of whale bone fragments surrounding the anvil stone which is concentrated to the north of the stone. This pattern of by-product distribution indicates that the whale bone fragments were found in their original deposition positions and shows that a large amount of the whale bone working was probably carried out by a person facing in a north-northwest direction, causing the concentration of whale bone fragments to occur to the north of the anvil stone.
The pattern of whale bone identified in Area 2 indicates that it was a whale bone working floor, and because almost all of the fragments were found in a single spit it is most likely that the fragments of whale bone represent a single whale bone working session, rather than the constant use of the stone anvil over an extended period of time.

Figure 38: The distribution of whale bone in Area 2 with the location of the anvil stone.
6.6. Lithic analysis

A descriptive analysis of the stone artefacts from Kahukura was carried out to determine if there were any tools which may have been used specifically to work whale bone. A total of 322 stone artefacts were excavated from the site. Only 8 lithic items were recovered from Area 2 where the whale bone processing floor was located. The majority of the stone material was excavated from Area 3 (N=85) and Area 6 (N=104) (Figure 39). The most common items were stone flakes (N=250), followed by adze fragments (N=21) and grindstones (N=19) (Figure 40 and Table 5).

![Distribution of lithics at Kahukura](image)

**Figure 39:** Number of lithic artefacts from each excavation area.
Figure 40: Types of lithic artefacts excavated from Kahukura.

Table 5: Lithic artefact distribution in the Kahukura excavation areas.

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<th>Area 2</th>
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None of the stone tools from either Area 2, or the whole site in general, can be explicitly linked with whale bone working. Occupants of the site were most likely opportunistically using tools that they already had to process the whale bone, rather than making specific tools for the industrial work. Transverse reduction involving chipping flakes from a section of bone could easily have been done using an adze. These tools have sharp
blades, and they can be applied with the significant force which would be necessary to remove chips of bone. A total of 9 adzes were identified from Kahukura (Figure 41).

![Figure 41: Some of the adzes found at Kahukura (5 cm scale).](image)

Functionally, the adze is thought to have been a powerful woodworking tool used in tree-felling, bush-clearing, and the reduction of timber for use in building, as well as shaping and finishing waka (Best 1977). Woodworking actions that adzes were employed for include splitting, chopping and shaving wood (Best 1977). There are some similarities between lengths of whale bone and hard timber, and the working of the whale bone at Kahukura has numerous resemblances with wood which has been worked with an adze. The action of levelling a length of wood with an adze leaves characteristic transverse groove across the grain of the wood, which have been identified on the exterior of waka (Best 1977). Chopping and levelling of the whale bone was probably carried out with an adze in much the same way; some pieces display a similar transverse grooving pattern indicating they have been levelled with an adze (Figure 42).
Figure 42: Two whale bone pieces from Kahukura that have been levelled using an adze (5 cm scale).

Abrading was most likely done with grindstones, of which there were 19 sandstone examples from Kahukura. Cutting and sawing marks exhibited on some of the whale bone fragments would most likely have been done using flake tools. Stone flakes were the most common lithic items found at the site (Figure 43), but virtually all of these are unmodified flakes. Unmodified flakes would have been useful for cutting soft tissue from bones and cutting up meat, but would have been less useful in cutting bone (Davidson 1984). Unmodified flakes would have served the purpose of cutting soft tissue from bones in butchery, and cutting meat up quite well, but would have been less useful in cutting bone (Knapp 1941).

Figure 43: A selection of the stone flakes from Kahukura (5 cm scale).
Sawing was probably done using either modified flake tools which had serrated edges, or thin files. Serration allows for more controlled and free cutting, whereas flake tools without serration tend to catch in the groove making it difficult to repeat the motions needed to cut through a material (Skinner and Teviotdale 1927). Only one such tool was found at Kahukura, which may have been used in bone sawing. This was a round flake tool displaying retouching on the cutting edge (Figure 44).

Figure 44: Flake tool found at Kahukura which may have been used to work whale bone (5 cm scale).

The other stone tools found in Area 2 which may be associated with whale bone working in the vicinity include a large sandstone grindstone, although this was located in Layer 2, two layers above the main bulk of the whale bone and thus is more likely to be associated with a later phase of use at the site. The reason it is noted here is because the large size of the wear-surfaces on the grindstone indicate that it would have been suitable for working wide, flat objects like whale bone patu.

Retouching or use-wear on the lithic tools from Kahukura was identified on 82 of the lithic items, representing 25.4% of the whole assemblage indicating that just under three quarters of the lithic items found at the site were by-products of the manufacture of
other tools, or were simply not suitable for use. The lithic items which did display use-wear or retouching included adzes, adze fragments, flakes, grindstones, hammer stones, a chisel and a flake tool (Figure 45). It is quite plausible that these tools were used in the processing of whales and whale bones at the site, however further research is necessary to determine the exact materials that these tools were used for working.

Figure 45: Number of lithic items which display use-wear or re-touching evidence.
Chapter Seven

Discussion and conclusion

7.1. Introduction

This study examines the nature of whale bone processing in prehistoric New Zealand, and more broadly, investigates the relationship between whale strandings and Māori settlement patterns and lifeways. This research allows for broader interpretations of the use of whale bone within New Zealand prehistory. The key elements discussed in this chapter are the procurement, processing and use of whale bone as a material resource, and the distribution of whale bone in New Zealand archaeological sites compared to the geographical distribution of whale strandings.

In this thesis, consideration has been given to how whales were accessed, and what they provided in terms of resources. Whale carcasses were opportunistically exploited for both meat and industrial bone during New Zealand prehistory, and evidence of their use appears in archaeological sites throughout New Zealand. The distributional analysis component of this thesis was carried out to test the hypothesis that the geographic distributions of whale strandings would correspond on some level with the incidence of whale bone in archaeological sites, and could potentially indicate strategic settlement location selection, especially in areas such as Murihiku where resource levels were low. The use of stranded whales as a resource is ingrained in Māori tradition and mythology indicating a longstanding relationship between Māori and cetaceans, and the resources they provided. Many whale bone artefacts excavated from sites and now held in collections show the range of ways that this resource was used. The taphonomic analysis of the worked whale bone assemblage from Kahukura offers a unique window into the processing methods used on whale bone during prehistory, which until now has been an area of research which has received relatively little attention when compared to other bone resources, such as moa. The results of this study allow for interpretations of the
wider role of stranded whales as a resource in New Zealand prehistory, which are discussed here.

7.2. Whale procurement, processing and use at Kahukura

The whale bone from Kahukura represents a minimum number of one southern right whale which was obtained by the occupants of the site. There are two possible methods by which the bone may have been procured – the opportunistic scavenging of a stranded carcass, or active hunting of the whale at sea. Distinguishing between these two methods remains a fundamental problem for archaeologists (cf. McCartney 1980). The most likely method of acquiring whales during New Zealand prehistory was by the opportunistic exploitation of stranded animals. There are only two recorded strandings of southern right whales in New Zealand since 1978, and generally strandings of baleen whales are much rarer than those of toothed whale species. However, the prehistoric southern right whale population residing in the coastal waters of New Zealand would have been much greater than it is today. Prior to the arrival of European commercial whalers, who decimated the southern right whale population, the species was said to be frequently seen close to shore, and were known to inhabit the sheltered harbours of the New Zealand coast during their winter breeding season. The much higher population levels of this species during prehistory probably resulted in a more frequent stranding rate than is seen today.

Southern right whales are baleen whales, which do not mass-strand. It is most likely that the whale bone excavated from Kahukura represents either a single individual stranding, or a mother and calf, although there is no evidence indicating that a juvenile animal was present. The most frequent cause of live baleen whale strandings are disease or parasitism, which is thought to cause the animal to come ashore to seek refuge and to avoid drowning (Cordes 1982). The animal may, however, have died at sea after which the carcass floated ashore. Because of the presence of cut marks on some of the pieces of bone, which indicate flesh removal, it is most likely that the bone was derived from a live stranding or from a recently dead carcass rather than the bones having been washed up on the beach already separated from the flesh. The coastal location of the Kahukura
site would have been a prime position for maximising the potential for encountering a stranded whale. The Kahukura occupants were also moving offshore, evidenced by the variety of fish species in the middens (Jacomb et al. 2010), and thus probably had the opportunity to monitor a significant length of the coastline around Kahukura for stranded whales to exploit.

There is no evidence to suggest that prehistoric Māori were involved in active whale hunting. Such activities require specialist hunting equipment such as harpoons and suitable ocean-going vessels. No harpoons big enough for whale hunting have been identified in the New Zealand archaeological record; it is thought that the small harpoon points that have been identified in sites would have been more suitable for engaging in dolphin or shark hunting (Davidson 1984). Furthermore, the waka used by Māori during prehistory lacked the necessary stability and manoeuvrability that would have been a requirement for the pelagic hunting of medium and large whales. It is possible that on occasion groups of people may have encouraged whales to strand by herding them into enclosed bays and driving them onto shore, a method that is still used in the Faroe Islands to drive herds of pilot whales onshore: when a pod of pilot whales is sighted, several boats go out and herd them towards a sandy and gently sloping beach where they are driven ashore and butchered according to custom (Gibson-Lonsdale 1990). This method requires several boats and a high level of communication. However, it is unlikely that southern right whales would respond in a favourable way to herding, and harpoons or spear-points would probably also be required. If whales were hunted or regularly driven in to shore to beach, one would expect whale bone to be somewhat more ubiquitous in New Zealand archaeological sites, and it is safe to say that this was most likely simply not the case. Instead, the opportunistic scavenging of stranded whales is the only model which can be applied to the prehistoric New Zealand whale use. Although the rate of whale strandings is relatively low, the opportunistic exploitation of these events would have injected a relatively steady flow of whale bone into the prehistoric New Zealand economy.
Utilisation of a whale can involve consumption of the meat, non-food uses such as raw material manufacturing, and the redistribution of the resource (i.e. trade, exchange, gifts). Demonstrating that the whale bones recovered from a site represent an animal that was eaten is difficult, and requires evidence of butchery or cooking. Unlike other smaller animals, such as birds or fish, where the bones are discarded after the meat has been consumed, the size of whale bones often precludes the transport of them on site accompanying cuts of meat. This means that evidence of cooking is often not detectable in an assemblage of whale bone, and the presence of burnt or charred whale bone in a site is more likely to be related to grease extraction or the utilisation of the bones for fuel, rather than evidence of cooking. One piece of archaeological evidence which almost certainly signifies whale meat consumption at a site is the presence of whale barnacles (*Coronula sp.*). These have been identified at a handful of sites internationally (e.g., Álvarez-Fernández *et al.* 2013, Avery *et al.* 2008, Jerardino and Marean 2010, Kandel and Conard 2003), but as yet these have not been found in pre-European New Zealand archaeological contexts. There is a strong possibility of whale barnacles existing in prehistoric New Zealand archaeological sites, as they are commonly found on baleen whale species such as the southern right whale, which frequented New Zealand waters in much greater numbers during prehistory. These barnacles provide tangible evidence of whale skin being brought into the site probably attached to cuts of meat and blubber for food and oil. This kind of evidence can show definitively that people were utilising the whales for more than just the bone, something that almost certainly happened during New Zealand prehistory. However, given the current lack of archaeological evidence of whale barnacles, we must rely on what the bone remains can tell us about the nature of whale exploitation in New Zealand.

The evidence for whale meat consumption that most commonly occurs in New Zealand is the presence of butchery marks on whale bones. Butchery marks signify the process of flesh removal and the portioning of a carcass, and have been identified at a number of sites around New Zealand. The pilot whale remains from Twilight Beach displayed a clear pattern of body part survival and cut marks which Taylor (1984) attributes to butchery practices and the use of the bone for artefact manufacture. The locations of the cut
marks on the bone from Twilight Beach indicates that the meat was thoroughly removed from the carcass, and even the less productive sections of the carcasses were utilised intensively (Taylor 1984: 216).

A large whale, such as the southern right whale, offers around 30 tonnes of meat (Smith and Kinahan 1984). This volume of food is incomparable to any other food resource in New Zealand during prehistory, and would have been a bonanza for any group which encountered a stranded whale as long as the meat was fresh and edible, and meat preservation was possible. However, a major problem arises with the theory that stranded whales were opportunistically exploited for meat. Stranding causes trauma and stress which induces irreversible pathological changes in the tissue, causing the meat to have poor preservation qualities and to putrefy rapidly (Cawthorn 1997). With their thick layer of insulating blubber, whales often overheat quickly when stranded, which providing an ideal environment for bacterial reproduction leading to rapid decomposition (Cawthorn 1997, Taylor 1984). Meat from animals which have been swiftly killed putrefies slower than meat from a stranded whale because the meat from the former quickly becomes acidic, inhibiting bacterial growth and making it easier to preserve (Taylor 1984). Cawthorn (1997) noted that “In the Perano's whaling operation at Tory Channel, and similar operations in Nova Scotia, Newfoundland and western Norway, it was standard practice to open the abdomen of all whales taken as soon as they were secured to the catcher boat. This permitted cooling by sea water as the animals were being towed to the whaling station for processing. Twelve hours was considered the maximum post mortem time before decomposition began to affect meat and oil quality.” Unless several people were on hand when the stranding occurred to quickly strip the whale, then it is most likely the meat would have been unsuitable for human consumption. If the meat was edible and consumed at Kahukura, it seems highly unlikely that all 30 tonnes of southern right whale meat were eaten at once. Meat can be preserved by drying and storing, or by cooking it and storing it in fat, similar to the methods used with the preservation of birds (Anderson and Smith 1996).
Although butchery marks are present in the Kahukura whale bone assemblage, they are not present on the identifiable elements, and there are not enough of them to conclusively identify whether the meat was cut from the bone for consumption, or whether it was a case of cleaning the soft tissues from the bone so that they could be industrially worked. Archaeological evidence for the consumption of whale meat consistently remains just out of reach, and the occurrence of this activity at Kahukura unfortunately can only be speculated. In any case, the bone was an important part of the whale utilisation which occurred at Kahukura and the industrial processing of this bone has left a vast quantity of archaeological evidence of which the analysis has provided interesting information about the methods of bone processing and the tools involved.

Chipping was the most commonly used method of bone processing at Kahukura. It is thought that this process was primarily applied to the bone with adzes, and was employed to longitudinally reduce rib sections with the aim of creating smaller and more workable cortical blank portions. Ribs appear to have been the principal element selected for industrial working – this was identified by the chopped off proximal and distal ends of the ribs found at the site, and by the uniform flatness and shape of the bone flakes which indicate they were all struck from a long, smooth-surfaced portion of bone in a sequence of reduction. The chopped off rib ends of a medium-sized whale have also been identified at Twilight Beach (Taylor 1984) The rib remains of an unidentified medium-sized whale excavated from Twilight Beach exhibit some characteristics which closely mirror the treatment of the whale bone at Kahukura. Taylor (1984: 163) states that “both of the rib heads from the unidentified cetacean had clearly been chopped from their shafts, 12 and 15 cm, respectively from their proximal ends”. The presence of chips from the ribs indicated the chopping may have occurred on site before the shafts were removed elsewhere for use in artefact manufacture. The use of rib bones at both Twilight Beach and Kahukura indicates that ribs may have been the most sought after elements for industrial artefact manufacture.

This theory is at odds with the commonly held understanding that during New Zealand prehistory, and still today, the jaw-pan of sperm or other toothed whales was the most
highly prized whale bone element for industrial purposes (H. Parata 2013, pers. comm.). It makes sense that ribs were selected for industrial use over other elements – they provide long, uniform sections of bone which are largely smooth and flat, and right whales are known to have ribs with a dense cortical layer. However, the quality of rib bone for industrial use probably varies quite substantially between species. It is possible that with the arrival of European whalers Māori would have had increased access to sperm whale bone. This may have caused a refocus of species preference to the more ubiquitous and reliable bone sources that would have been available as waste from the commercial whaling operations. However, the southern right whale was also a major target of the commercial whaling operations and an influx of right whale bone probably occurred, so while the favouring of sperm whale jaw bone may be deeply rooted in Māori prehistoric tradition, archaeological evidence for this is yet to be identified. The nature of whale exploitation is probably species dependent. It may be that the whale bone from Twilight Beach is also derived from a southern right whale; if it were another species we might see the favouring of other elements occurring in the archaeological record.

The ribs of bowhead whales, which are morphologically similar to the southern right whale, were prized by Arctic Inuit for their use in the manufacture of a range of artefacts. Betts’ (2007) study of Mackenzie Inuit whale bone working showed that the transverse reduction of bowhead whale ribs created debitage fragments that look identical to the morphological flake fragments from Kahukura. In the transverse reduction process described by Betts (2007), first the rib ends are removed, then a series of chips are taken from the edges of the ribs to create rib cores, which are then sawn into a number of cortical blanks (Figure 46). The cortical blanks are largely flat sections of dense cortical bone which can be used to manufacture a wide range of artefacts. Bowhead whales and southern right whales are close relatives and have a similar morphology (Churchill et al. 2012, Rosenbaum et al. 2000), thus it is reasonable to assume that the ribs of southern right whales may have been prized for their industrial qualities in the same way that bowheads were prized by the Arctic Inuit. It is highly likely that the chipping method of bone processing at Kahukura was being applied to rib sections in a similar, if not identical, manner to the bone at the McKinley Bay site described by Betts (2007). It is most likely
that the rib ends found at Kahukura were removed from the rib shaft and the section between the two ends was reduced into several workable sections of bone, primarily through a reduction process of longitudinal chipping resulting in the creation of the large debitage assemblage of morphological flake fragments from Area 2.

Figure 46: Bowhead whale rib reduction sequence at McKinley Bay, Canada (from Betts 2007)
The activity of transverse reduction through longitudinally chipping at the rib sections appears to have occurred within the vicinity of the excavation unit Area 2. Virtually all of the bone fragments were excavated from this area and almost all of these pieces were by-products of reduction. The large anvil stone found in association with the whale bone in Area 2 may have served as a solid platform on which to stand one end of a rib section upright so that the person working the bone could hold it with one hand, leaving the other hand free to swing an adze at the bone edges. This would have been an ideal position, as the top of the rib end provides a good place to begin a sequence of chip removal working from the top down. A similar anvil stone was identified in association with a whale bone working floor at the Hakapureirei site in Murihiku, where the whale bone assemblage also showed evidence of chipping (Walter and Jacomb 2005). It is thought that these stones may have been commonly employed as solid workbench surfaces for working whale bone during New Zealand during prehistory.

Primary reduction, defined as the stages of reduction intended to prepare a material for artefact production, is thought to have been the main type of processing occurring at Kahukura. The majority of the whale bone assemblage is composed of waste fragments created as by-products of the processing, which raises the question of what the end product in all of this industrial processing was to be. This cannot be answered with certainty but some possibilities should be explored.

The whale bone at Kahukura provides very little evidence for secondary reduction, defined as the final stages of artefact manufacture in which shaping and finishing procedures are applied to the bone. The only definitive evidence is the presence of abrading marks. Abrading, which includes the shaping and polishing of bone using grindstones, is a finishing method in the manufacture of artefacts. Less than 1% of the whale bone pieces from Kahukura displayed evidence of abrading. Furthermore, there is a distinct lack of either partly finished or finished whale bone artefacts. If whale bone was a material that some of the Kahukura bone artefacts were made from then it may mean that artefact production was occurring on site for immediate use, however a lack of whale bone artefacts may indicate that semi-processed whale bone was being
transported elsewhere. Fishing was clearly a focal part of the subsistence strategy at Kahukura, and a large bone fishhook assemblage was recovered from the site (Brooks et al. 2010, Jacomb et al. 2010). Analysis of the fishhook assemblage, which characterised the taphonomic, technological and quantitative aspects of fishhook use at the site, did not identify any fishhooks manufactured from whale bone (see: Hickey 2012). Out of the 121 piece assemblage, 14 fishhooks were identified as ‘mammal: species unknown’, 22 fishhooks were identified as ‘possible mammal’, and one fishhook was positively identified as New Zealand sea lion bone (Hickey 2012). The other raw bone materials which made up the assemblage were moa, dog and, bird, along with several other pieces that were unidentifiable to either class or species. However, two of the artefacts identified in the Kahukura whale bone assemblage analysed in this study appear to be discarded pieces which may have been off-cuts from the process of fishhook manufacture (Figure 47).

![Figure 47: Shaped fragment of whale bone which may be a partly shaped fishhook (5 cm scale).](image)

Whale bone cortex would have been a suitable material for the manufacture of fishhooks; indeed, whale bone fishhooks have been identified at a number of archaeological sites in New Zealand (eg: Higham 1968, Lockerbie 1940, Sewell 1988,
Only five artefacts were identified in the whale bone assemblage from Kahukura, all of which were in the process of being shaped but had either broken during manufacture, or had been lost or discarded for some unknown reason. As well as the artefacts, eight prepared tabs were identified in the whale bone assemblage, of which seven came from Area 2. The prepared tabs are mostly small and roughly rectangular, having been shaped using either chipping and sawing methods, or a combination of the two. The largest prepared tab has the appearance of a possible rough-out of a ripi, or paua lever (Figure 48).

![Figure 48: Prepared tab which may have been intended to be used to make a paua lever (5 cm scale).](image)

It is possible that the prepared tabs were meant for on-site secondary processing into implements to be used by the Kahukura occupants. But the number of prepared tabs and artefacts found at the site are grossly out of proportion compared to the amount of whale bone that was being processed at the site, as evidenced by the large quantity ofdebitage. Clearly a large quantity of whale bone is unaccounted for at Kahukura. Most of the bone was most likely reduced into workable portions which were either been removed from site altogether, or were further processed in an area of the site which either remains unexcavated or has already been lost to the sea through erosion.

### 7.3. Comparisons with other worked whale bone assemblages in New Zealand

Cohesive whale bone assemblages that have been formed through the processes of industrial modification are very rare in New Zealand archaeological contexts. The only
Taphonomical study of whale bone from a New Zealand site was undertaken by Michael Taylor, as part of his MA research (Taylor 1984), who analysed the mammalian faunal assemblage from Twilight Beach, located near Cape Reinga in Northland. The Twilight Beach site was an eroding midden rich in marine mammal remains, and seven individual cetaceans were identified. Five of these were pilot whales (*Globicephala* sp.), one was a pygmy sperm whale (*Kogia breviceps*) represented by a tooth necklace, and the other was not able to be identified to species, but was too large to have been a pilot whale or pygmy sperm whale, and is thought to have been a medium-sized whale such as a right, humpback or sperm whale. The bone from all three whale species showed evidence of industrial modification. Two rib heads from the large, unidentified whale had been chopped from the rib shafts, and the presence of bone chips that had been removed from the ribs indicated that the processing had occurred on site. No trace was found of the rib shafts, and it is thought that these were removed to another site. The pygmy sperm whale teeth had been notched to enable them to be lashed together on a string, and were probably worn ornamentally. Cultural variables were identified on many of the cranial and post-cranial cetacean bones, evidence of the deliberate butchery and removal of the heads and the breaking up of the pilot whale crania using adzes and knives, as well as industrial working. The processing was recognised by the location and patterns of cut and chop marks on the surviving bone elements. Taylor (1984) notes that the most frequent tool marks on the Twilight Beach whale bone are adze marks, which suggests that the adze may have been a commonly employed tool in the industrial working of whale bone during New Zealand prehistory.

Most other whale bone assemblages from New Zealand archaeological sites consist of small numbers of highly fragmented pieces, which make the analysis of the processing methods across the board quite difficult. However, there are some noticeable similarities between much of the whale bone excavated in New Zealand sites. Evidence of the industrial working of whale bone was identified in the Houhora assemblage (Taylor 2002), a Northland site which is considered to be one of the earliest in the North Island (Furey 2002). Remains of a minimum of eight dolphins were identified, along with one unidentified medium whale (around the size of a sperm humpback or right whale), and
one small whale, thought to probably be a pilot whale. Some of the bone remains of the medium-sized whale showed evidence of industrial processing. Two fishhook blanks were identified as well as two struck flakes. Manufacturing actions identified included sawing, drilling, filing and adze flaking (Taylor 2002). Some of the medium-sized whale bone had been used for fuel, which was identified by the intense burning exhibited on some of the pieces, indicating that the bone was fresh when recovered. At Kings Rock in the Catlins, several pieces of whale bone were found, including a number of whale bone tabs, two of which had been drilled and were most likely fishhook blanks (Lockerbie 1940). The Kings Rock assemblage also featured some interesting whale bone artefacts including a lizard head amulet, a small “canoe or trough” shaped piece of which the function is unknown (Lockerbie 1940: 416), and whale bone fishhooks. The assemblage also contained whale bone working by-products described as bone chips and one splinter of “whale bone jaw” which had been flaked (Lockerbie 1940: 413).

Common features of industrially worked whale bone across New Zealand archaeological sites are the strong presence of whale bone tabs. The creation of prepared tabs is necessary for the economical use of bone resources, especially when using whale bone industrially, because the bones are originally very large and difficult to work with. Breaking large bones down into smaller, more workable portions was a common practice of industrial bone working in New Zealand prehistory, and was not restricted to just whale bone. Prepared bone tabs are most often associated with the manufacture of fishhooks, which were often shaped from the thin, rectangular bone blanks using grinding and drilling. The preparation of whale bone blanks appears to have commonly been done using the chipping method of transverse bone reduction. This differs to other bone materials in New Zealand, particularly moa bone, which was the most commonly utilised bone resource during the early period of New Zealand prehistory. Moa bone was also often processed into bone tabs for industrial working, but this was most commonly carried out by sawing (Kooyman 1985). The differing methods between the two bone resources may be related to their material properties: moa bone is a much denser and harder material than whale bone, and this density may make it too difficult to chip, instead necessitating sawing to separate workable portions of the bone. Chipping is less
labour intensive than sawing as bone can be removed faster and with less effort, although there is less control involved.

7.4. The distribution of whale strandings in New Zealand, and Māori settlement patterns

The presence of whale bone in New Zealand archaeological sites combined with the absence of whale hunting evidence shows that people were opportunistically utilising stranded whales for industrial bone and probably also meat, oil and other resources. All of the identified archaeological sites where whale bone has been excavated so far are located on, or very close to the coast. This indicates that stranded whales were being processed at their find location and salvaged bone was probably not transported very far away to be industrially worked. If opportunistically scavenged bone was not transported far from the whale stranding site, then we would expect to see archaeological concentrations of whale bone in areas where whales are known to strand more frequently.

The most commonly stranding whale species, taken from stranding records from the last 35 years (see Chapter 4), are pygmy sperm whales, long-finned pilot whales, Gray’s beaked whales, and sperm whales. The geographical distribution of whale stranding hot-spots varies between these species. Generally, pygmy sperm whale strandings are concentrated around the Northland and Kaipara coasts, around Hawke’s Bay, and in the Wellington region. Long-finned pilot whale strandings are more widely distributed, but have a strong concentration in the Golden Bay area. Gray’s beaked whales tend to strand more often in the North Island, particularly around the Bay of Plenty and Hauraki regions, with small hot-spots also occurring in Hawke’s Bay and Tasman Bay. Sperm whales show a strong concentration of strandings on the Kaipara coast. From these whale stranding trends, we would expect to see archaeological evidence of whale use also occurring in these areas. Concentrations of archaeological sites where whale bone has been excavated occur in Northland, Hauraki/Coromandel Peninsula, Golden Bay, Banks Peninsula and Murihiku. Archaeological sites in the Northland, Hauraki, Coromandel and Golden Bay regions correlate with the stranding locations of these commonly stranding
species. However, no whale bone has been identified in archaeological sites in the Hawke’s Bay region. This may, however, be caused by a lack of archaeological material as yet excavated from this area, as ethnographic accounts indicate that people in the Hawke’s Bay region valued stranded whales as a resource. Te Mahia Peninsula, the jutting peninsula at the northern margin of Hawke’s Bay, is mentioned in ethnographic texts as a known area where whales came ashore, and was even said to exude a drawing force which lead whales to beach there (see Chapter 3). There is a strong possibility that this legend is based on the high frequency of pygmy sperm whale strandings which occurs there, and most likely indicates Māori knowledge of whale stranding trends which has become merged with mythology.

Although the area is not totally devoid of whale strandings, the Murihiku region is not an area where whale stranding hot-spots exist in the modern whale stranding record. Yet the region has a significant number of archaeological sites with whale bone, much of which shows evidence of having been worked. The whale bone at Kahukura has been identified as being derived from a southern right whale; it is likely that this species was much more ubiquitous around the Murihiku coast prior to their population decimation during the early colonial period in New Zealand. Although baleen whales are not known to strand frequently (Brabyn 1991), it is possible that right whales strandings were more common during prehistory as a reflection of their higher population numbers, especially during the winter months when the whales were in close to shore for calving, making them a viable seasonal resource in Murihiku for Māori during prehistory – and a possible reason for settlement in Murihiku. This theory needs much more archaeological evidence before it can be truly explored however, and DNA profiling for whale bone in archaeological sites from Murihiku would show whether the southern right whale was a species that was commonly being exploited during prehistory in this region.

By the end of the 15th century, the decline in easily obtainable resources lead to a shift in focus to resources which experienced seasonal variation, necessitating the scheduling of movements by Māori and resulting in the rise of seasonal encampments. While whale strandings could not be predicted, the probability of there being access to whales
increased markedly in some areas during particular seasons, which may have encouraged seasonal coastal exploitation. The notion of seasonal occupation in the Murihiku region has been contested by archaeologists. Annual growth bands on shellfish from Wakapatu show that they died during the winter and this evidence, along with evidence for mutton birding, has been used to argue that Murihiku was probably seasonally occupied (Higham 1968). This view was challenged by Sutton and Marshall (1980) who demonstrated that Tiwai Point has evidence for occupation occurring all year round, which brings into question the seasonal evidence for other Murihiku sites. Jacomb et al. (2010) have argued that although many archaeological sites in the Murihiku region indicate they were occupied intermittently, these visits were not integrated into a seasonal pattern of economic activities. Kahukura has been interpreted as a camp for fishing and birding associated with larger settlement centres further north (Jacomb et al. 2010). The whale bone at the site probably represents the opportunist exploitation of a stranded southern right whale. It is unlikely that whales were incorporated into a seasonal economic strategy that saw the Murihiku coast settled during the winter months to take advantage of an influx of whale strandings. Stranded whales offer large quantities of resources, but they are relatively infrequent occurrences, even in areas where stranding hot-spots exist, and it would not have been a sensible economic strategy to rely on these events. Fishing was the main activity at Kahukura and whale strandings were probably no more than a lucky strike for the occupants of this site.

Whale bone in New Zealand archaeological sites represents chance encounters with stranded whales which may have supplemented the diet, and provided an influx of industrially workable bone. It is highly unlikely that people were moving to areas where whales were known to commonly strand to take advantage of the possibility of encountering these events. Instead, it is far more likely that people were basing their economy on sustainable food sources and using whatever material was available to them in their environment, which sometimes happened to be stranded whales.
7.5. Recommendations for future research directions

The analysis of the whale bone from Kahukura was based on the identification of modification features and using these features to reconstruct the processing methods applied to the bone during the occupation of the site. An experimental bone processing study would provide more information regarding the properties of whale bone and how this material reacts to tools that may have been used during New Zealand prehistory. The problem of access to whale bone was the major factor inhibiting the undertaking of an experimental archaeology study of whale bone processing, but this is a direction that could possibly be explored in the future.

Identification of the whale species that the bone at Kahukura was derived from hinged on the ability to taxonomically assign the jugal bone. With the lack of this bone taxonomic identification would not have been possible, as is the case with the vast majority of whale bone excavated from sites in New Zealand. It would be highly valuable to apply DNA analysis methods to New Zealand archaeological whale bone samples. This method of analysis would shed light on the species present in sites and could be used to determine whether specific species were favoured.

This thesis has explored the use of whale bone in New Zealand prehistory on an inter-chronological scale. This was because many of the sites used in the distributional study lack radiocarbon dates. However, it could be interesting to incorporate a chronological dimension into future research to identify any changes in the nature of whale use over time. Ultimately, more sites with whale bone are needed before data is available to gain a clearer picture of how whale bone was used in New Zealand prehistory.

7.6. Conclusions

The aims of this thesis were to identify the processing methods used for working whale bone in New Zealand prehistory and to test the hypothesis that Māori settlement choices may have been influenced by the presence of whale strandings in particular areas, such as Murihiku.
In terms of processing methods several key technological methods were identified in the Kahukura assemblage. The rib bone shafts were the main elements being worked on site, with the proximal and distal ends being discarded and given to dogs to gnaw on. The products of the primary processing of the whale bone were not present at the site and were probably removed to another location where secondary processing occurred. This reinforces the theory proposed by Jacomb et al. (2010) that Kahukura was a satellite site associated with larger settlements to the north, and may have been used intermittently or more permanently as a fishing camp. The occupants of Kahukura carried out primary reduction of the whale bone to create a number of cortical blanks which may have been transported back to their main centre of occupation which explains why there is little evidence for secondary reduction at the site.

The ribs of southern right whales, and perhaps other medium sized whales, may have been the preferred bone elements for industrial working during prehistory. These bones provided large quantities of workable cortical bone and were chipped into smaller, more easily manipulated sections using adzes. The use of specific whale bone working tools during New Zealand prehistory is unlikely because the low incidence of whale strandings would have meant that contact with stranded whales would have been rare. At Kahukura, tools such as the adze, which would have been available at hand, were probably used opportunistically in the majority of whale bone working cases. A small number of sites (e.g., Hakapureirei) have evidence of flaked cobble tools in association with worked whale bone, but these are probably isolated events and may relate to a local abundance of stones suitable for the quick creation of such tools.

The distributional study is qualitative but the results indicate some correlation between whale stranding hot-spots and the presence of whale bone in archaeological sites. The correlation is not strong enough; however, to conclude that whale stranding sites were influencing settlement patterns to any significant extent. Stranded whales were a resource that people would have encountered occasionally, but settlement patterns were not affected by whale stranding rates as these events were simply too unpredictable to be reliable. Māori people may have been aware that whale strandings happened more
frequently in some areas, such as Hawke’s Bay; as evidenced by the incorporation of whale strandings into the Māori mythology of Te Mahia Peninsula at Hawke’s Bay – an area where pygmy sperm whale strandings are frequently recorded. Whales as a resource were well understood and revered, but access to stranded whales was out of the control of Māori during prehistory in New Zealand. Although it may have been possible to identify hot-spots where whales would have stranded more frequently, these stranding numbers were just too low. Whenever strandings were encountered by prehistoric Māori they would have been celebrated and utilised to their full potential, but they were not relied on and they were not likely to have been factored into the Māori settlement and subsistence strategy.

The overall conclusion to be made about the utilisation of whale strandings is that Māori communities operated opportunistically. There is no evidence to suggest they organised their settlement patterns or seasonal rounds of activities based on whale stranding hot-spots, nor is there evidence for there being a specialised whale bone working tool kit. Indeed, one of the major tools implicated in whale working appears to have been the adze – a tool designed for wood working or garden clearance. Yet at the same time there is evidence in the record for effective and efficient use of this resource. Māori almost certainly understood where whale strandings were likely to take place, and when they encountered them they used the tools at hand to work the bone effectively. Furthermore they understood the physical properties of the various bone elements, selecting the cortically dense ribs for industrial working and employing an economical processing strategy to reduce the bones into workable sections. These sections were used to make the array of whale bone ornaments, weapons and tools that are seen in archaeological contexts throughout New Zealand.
References


Best, E. 1902. Notes on the art of war as conducted by the Māori of New Zealand, with accounts of various customs, rites, superstitions & c., pertaining to war, as practised and believed in by the ancient Māori. Journal of the Polynesian Society, 11(4), pp: 219-246.


Darwin, C. 1854. A monograph on the sub-class Cirripedia, with figures of all the species, London: Royal Society.


## Appendix one: archaeological sites with whale bone

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Number</th>
<th>Location</th>
<th>WB Artefacts</th>
<th>WB Worked</th>
<th>WB Unworked</th>
<th>Artefact types if present</th>
<th>Cetacean type (if known)</th>
<th>Species (if known)</th>
<th>References</th>
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<td>Dunedin</td>
<td>NO</td>
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<td>Catlins</td>
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<td>YES</td>
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<td>Trotter (1965)</td>
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<td>Smith (1985)</td>
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<td>Smith (1985)</td>
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<td>Trotter (1979)</td>
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<td>Smith (1985)</td>
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<td>Takamatua</td>
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<td>Christchurch</td>
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<td>dolphin hector’s dolphin</td>
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<td>Raglan coast</td>
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<td>Piece of flat shaped whale bone</td>
<td>Richie et al. (2009)</td>
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<td>Higham (1968)</td>
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<td>Jacomb et al. (2012)</td>
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<td>Barber (2004)</td>
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<td>Ivory fish hooks whale Higham (1968) and Smith (1985)</td>
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