WORKING PAPERS IN CHATHAM ISLANDS ARCHAEOLOGY

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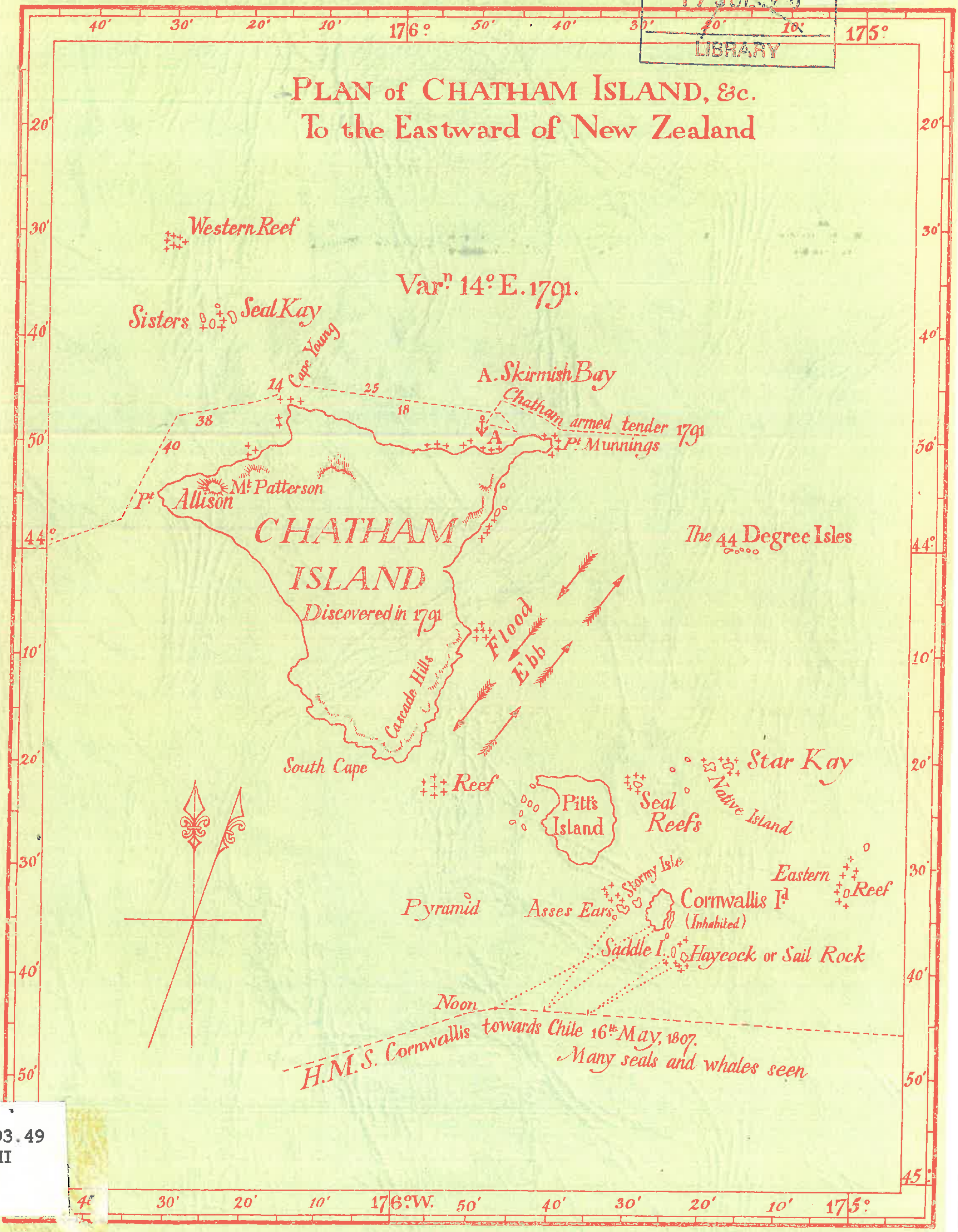

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WORKING PAPERS IN CHATHAM ISLANDS ARCHAEOLOGY 7

PREHISTORIC FUR SEAL EXPLOITATION ON THE SOUTHWEST COAST OF CHATHAM ISLAND

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Earlier papers in the series are:

1. Smith, I.W.G. and P. Wernham,
   "Survey of Archaeological Sites: Te Awapatiki to Hapupu, Hanson Bay, Chatham Islands". 1976.
2. Weiss, Dr B. (translated K.J. Dennison)
   "More than Fifty Years on Chatham Island". 1976.
3. Park, G.S.
   "The Dendroglyphs and Petroglyphs of the Chatham Island". 1976.
4. Houghton, P.
   "The Human Skeletal Material from Waihora (CH283)". 1976.
5. Sutton, D.G.
   "An Alternative Research Strategy for the Study of Prehistoric Human Skeletal Remains". 1977.
6. Hamel, G.
   "Vegetation and Archaeology on Chatham Island". 1977.

FOREWORD

This number of Working Papers is a reprint of Ian Smith's B.A. Honours dissertation (1976). It includes sections on the behaviour of modern seal populations as the basis of interpretation of archaeological material, the development of a method for ageing and sexing seal bone, and the excavation and analysis of a seal bone midden on the Southwestern coast of Chatham Island.

This work marks the beginning of Ian's Doctoral research. It is expected that this study will clarify the Pre-European distribution of New Zealand fur seal breeding colonies, prehistoric hunting strategies and butchering patterns, and the importance of seals as a food source to the prehistoric people here.

I have included this number in the Working Paper series because of the importance of these problems to archaeologists and because of the interdisciplinary nature of the research. Comments will be welcomed.

D.G. Sutton.
Acting Editor.

ACKNOWLEDGEMENTS

The completion of this study was dependent upon assistance, advice and encouragement from many people. I would like to extend particular thanks to Doug Sutton for his encouragement to begin this research, and for his continued assistance and interest throughout.

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The assistance of all those involved in the programme of archaeological research in the Chatham Islands, and particularly in the excavation of CHC is gratefully acknowledged.

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Thanks are also due to Mr. R. J. Scarlett (Canterbury Museum) for identifying the bird bone; Mr. T. D. Nugent and Mr. G. M. Mason for identifying the shells.

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INTRODUCTION

The New Zealand fur seal, <u>Arctocephalus forsteri</u> (Lesson 1828), is the most commonly occurring seal in New Zealand and the Chatham Islands. Before the activities of European sealers in the late 18th and early 19th centuries they were more numerous and probably more widely distributed than they are today (Gaskin 1972:45-50, 158-162; Wilson 1974:22-3). As such they would have provided a substantial potential food resource for the prehistoric inhabitants of New Zealand and the Chatham Islands.

It was recognised at least as early as 1871 that the fur seal had been exploited in prehistoric New Zealand (von Haast 1871: 78). In the ensuing century there has been little advancement in the assessment of the nature of this exploitation. Fur seal remains have been identified from archaeological sites over the entire length of the country, from Houhora in the north (Shawcross 1972:607) to Stewart Island in the south (Knight 1970:79). It has been implied, but not explicitly demonstrated that they were more commonly found in early rather than late sites (for instance Lockerbie 1959:82-4; Green 1970:46-7). However, there have been no comprehensive attempts to move beyond mere recognition of the presence of fur seals in sites and to interpret this presence in terms of prehistoric human behaviour.

This lack of attention to the fur seal can be accounted for in part by the inadequacy of the available information on its behaviour. More complete interpretations of fur seal exploitation require consideration of the factors that would have limited where and when it was available for hunting. Such information has only recently become available, and thus former studies must inevitably have been incomplete.

The difficulty in acquiring adequate comparative osteological collections of fur seal material, and the consequent lack of osteological studies has further hampered attempts at interpretation. Leach (1976:183) has pointed to the difficulty in using fur seal remains as an indicator of seasonal human activity because the basic osteometric work on age and sex determination had not been done.

This study attempts to overcome some of these problems. The first major objective is the development of a basis for interpreting evidence of prehistoric fur seal exploitation. In order to achieve this the currently available data on fur seal behaviour will be reviewed, with particular emphasis on the aspects of this behaviour that would have limited prehistoric hunting of this animal.

Secondly, efforts will be directed towards establishing an osteometric method of determining the age and sex of fur seals. These two objectives are interrelated in that many of the aspects of fur seal behaviour that would have influenced their exploitation by man are age and sex specific. In order to fruitfully employ this information in the interpretation of fur seal remains from archaeological sites it is essential that the age and sex of these fur seals can be determined.

The research on which this study is based was undertaken within the wider context of the University of Otago, Anthropology Department's programme of research in the Chatham Islands. Thus emphasis has been placed on developing a basis for interpreting the pattern of fur seal exploitation in the Chatham Islands. With some minor amendments this basis for interpretation should be equally applicable to New Zealand situations.

As a part of this research a concentrated fur seal midden on the South West coast of Chatham Island was excavated. The excavation of this site, and the subsequent analysis of the archaeological evidence will be discussed in order to elucidate the pattern of fur seal exploitation on the South West coast of Chatham Island. In the achievement of this third objective the basis for interpretation and the osteometric method of age and sex determination will be employed.

CHAPTER ONE

THE NEW ZEALAND FUR SEAL: A BASIS FOR INTERPRETATION

1.1 INTRODUCTION

Until recently there has been little information available on the behaviour of the New Zealand fur seal. This has limited the extent to which prehistoric fur seal remains have been able to yield information about their human exploiters. However, recent studies of the population structure, distribution, abundance, breeding biology and behaviour of the fur seal have provided much of the necessary background information. In this Chapter the aspects of this research relevant to the reconstruction of prehistoric fur seal exploitation patterns in the Chatham Islands are outlined.

Most of the information presented in this discussion derives from studies of the fur seal on the main islands of New Zealand, as little research has been undertaken in the Chatham Islands. Except where differences are known to occur, it will be assumed that the fur seal behaviour patterns that have been recognised on the New Zealand mainland are substantially the same on the Chatham Islands. While there has been no intensive research into the effects on fur seal behaviour of geographical isolation and environmental differences, there are some indications that this assumption is justified. Where comparable data is available for both the New Zealand and Australian populations of *A. forsteri* the environmental differences and geographical separation appear to have produced no significant behavioural changes (Wilson 1974: 60-1).

The following discussion is not intended to be a comprehensive account of fur seal behaviour. The concern is to demonstrate that certain aspects of this behaviour would have influenced man's exploitation of the fur seal, and to indicate the ways in which this information can be used to interpret the patterns of fur seal exploitation exhibited in archaeological sites.

1.2 AGE/SEX CATEGORIES

Studies of fur seal behaviour rely heavily on the division of the population into several age/sex categories. Each of these categories includes fur seals that exhibit substantially similar and consistent behaviour patterns. The categories used in this study follow the conventions outlined by Miller (1971), except that his two groups, Juveniles and Neuters, are combined into a single category called here Juveniles. The reason for this is primarily pragmatic. The osteometric technique developed in this study (Chapter Three) for determining the age and sex of fur seals is not yet sufficiently precise to permit the distinction between these two groups. It would appear that no important information is lost through combining these two groups. The behavioural differences between Juveniles and Neuters that have so far been identified (Crawley & Wilson 1976:5-6, 13-4, 16, 26) are not of the kind that would influence their exploitation by man.

The age/sex categories used in this study are as follows:

Pups: Fur seals of either sex less than 1 year old, distinguished primarily by their size and facial characteristics.

Juveniles: Fur seals of either sex older, larger and better developed than pups, but smaller and younger than Adult females.

Adult females: Female fur seals of breeding age, distinguished by their size, slender neck and facial characteristics.

Sub-adult males: Male fur seals larger and heavier than Adult females but smaller and lighter than Adult males.

Adult males: Fully grown male fur seals capable of holding a breeding territory. They are distinguished by their size, heavy neck and mane of long guard-hairs.

Except for the division between Pups and Juveniles, these categories are not defined on the basis of chronological age. They are primarily behavioural groupings that have been developed through long observation of fur seals. This has an important implication for the development of a method of age and sex determination. The determination of exact chronological age is not an essential requirement of such a method. All that is necessary is a technique for placing fur seals in one or other of the 5 age/sex categories defined above. A method for doing this will be developed in Chapter Three.

However, it is useful to have some indication of the age ranges of each of these categories. A small number of individuals have been accurately aged by counting the annual growth rings in their canine teeth (see Appendix 1). No Pups were aged by this method, butthey are by definition less than 1 year old. Juveniles range from 1year to about 3 or 4 years. Females reach sexual maturity at about this age, and are fully grown shortly thereafter. Sub-adult males range from 3 or 4 years to 7 or 9 years. Sometime between 7 and 9 years males reach their full size and achieve breeding (i.e. Adult) status. Because these age ranges are based on a small number of specimens they must be regarded as tentative. It is not known for how long fur seals live.

1.3 DISTRIBUTION

The range of distribution of the fur seal imposes an important restriction upon its exploitation by man. Obviously fur seals can be hunted only in the areas where they occur. In this section the distribution of fur seal colonies in the Chatham Islands will be outlined. In doing this some reference will be made to the New Zealand situation in order to elucidate a number of important trends.

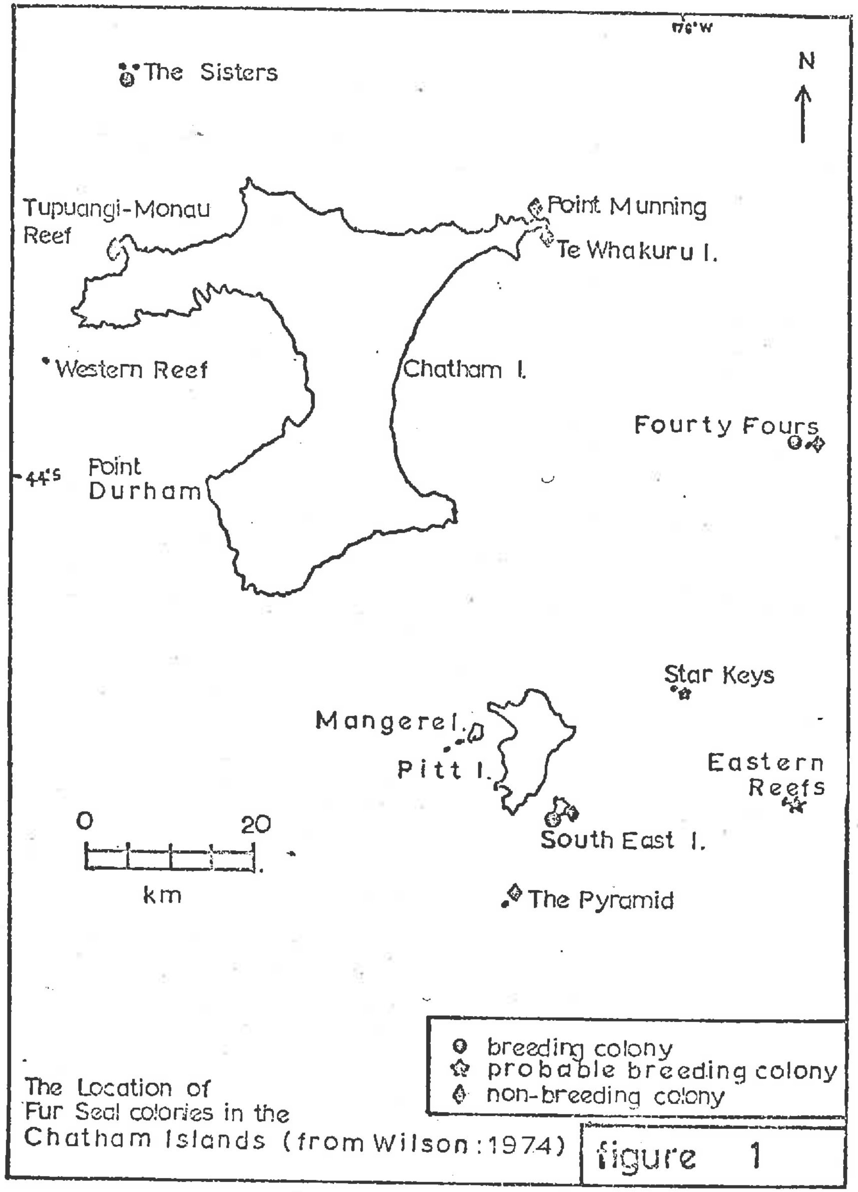
There are two major types of fur seal colonies; breeding colonies and non-breeding colonies. These will be described in greater detail in later sections of this Chapter. The concern here is with the areas in which each occurs. After discussing the distribution of each of these types of colonies, consideration will be given to the extent to which these distribution can be extrapolated back into the prehistoric period.

a. Breeding distribution

Breeding colonies have a more restricted distribution than do non-breeding colonies. In the Chatham Islands they are found only on the smaller islands of the group (figure 1). They occur on The Sisters, The Fourty Fours, and at two places on South East Island. Breeding has not been observed but almost certainly occurs at colonies on The Star Keys, and The Eastern Reef (Wilson 1974:26-27). There are no breeding colonies on Pitt Island or Chatham Island.

New Zealand breeding colonies have a similarly restricted distribution. They are found only in the Foveaux Strait- Stewart Island area, Fiordland and Westland (ibid:23-6).

These distributions appear to be limited primarily by two meteorological factors. High summer air temperatures and long hours of sunshine appear to effect breeding fur seals adversely as they cannot retreat to the sea to cool off as freely as do non-breeding fur seals (ibid:37-8). Thus breeding colonies are restricted to areas with low summer air temperatures and relatively short hours of sunshine. The location of breeding colonies in areas exposed to cooling winds is probably a result of these factors.



The Location of Fur Seal colonies in the Chatham Islands (from Wilson:1974)

figure 1

b. Non-breeding distribution

Both in New Zealand and the Chatham Islands non-breeding colonies are more widely distributed than are breeding colonies. Chatham Islands non-breeding colonies occur on the small islands - The Sisters, The Fourty Fours, and The Pyramid - and also on the main island at Tupuangi-Monau Reef, Point Munning and Te Whakuru Island (figure 1). Small groups of fur seals have also been observed on Mangere Island, The Castle, The Western Reef, and at Okaire Point (ibid:196-201).

The wider distribution of non-breeding colonies is more evident in New Zealand, where they are found all around the coast of the South Island, around the Wellington area, and at a few places on the West coast of the North Island as far north as the Three Kings Islands (ibid:28-9).

This wider distribution would appear to be an adaptation that allows fur seals to exploit food resources over a much wider area than that in which they are able to breed (ibid:35). Non-breeding colonies north of the breeding range in New Zealand are fully occupied only during the winter when a northward migration of males takes place (ibid:72-5). The difference between these distributions in the Chatham Isalnds is not as marked simply because the area does not have such a long coastline, and thus there is not the same opportunity for a seasonal migration pattern of the same proportions.

c. Discussion

There are good reasons for believing that the modern distribution of fur seal colonies will accurately reflect the locations of many prehistoric colonies. Two aspects of fur seal behaviour tend to limit the growth of new colonies, and to maintain those already in existence. They have a strong tendency to return

to the colony at which they were born, and females almost always breed at a colony at which they have previously given birth to a pup (ibid:120). Thus, the colonies evident today are likely to have been in existence for a long period of time.

Because of the decimation of the fur seal population by the European sealers in the late 18th and early 19th centuries the present distribution almost certainly under-represents the prehistoric distribution of fur seal colonies. There are a number of approaches to determining the possible locations of former colonies.

One such approach involves the study of records left by sealers and early European explorers as to the location of fur seal colonies. This is not often a very successful approach, chiefly because the sealers were not inclined to leave accurate records of the locations of colonies. In part this reflects the competitive nature of the sealing operations. It also results from an Act of the New South Wales Government in 1805 which prohibited the operation of sealing vessels south of latitude 44° 39' (Gaskin 1972:47). The sealing vessels continued to operate south of this latitude, both in New Zealand and the Chatham Islands, but falsified any records that were kept of their activities.

A perusal of the records of sealing activities in the Chatham Islands compiled by Richards (1962) indicates that there were colonies on Pitt Island, where none occur today. However, the exact location of these colonies, and the presence of any others not extant today cannot be ascertained.

The archaeological record can serve to indicate the approximate location of former colonies. When fur seal bones are present in a site, especially if a large number of individuals are represented, the location of a colony nearby can be postulated. Confirmation of this possibility can be given by the location near to the site of an area that fulfils the habitat requirements of a fur seal colony. These habitat requirements will be outlined in the following section of this Chapter. However, care must be taken in such reconstructions because of the possibility that the fur seals in such a site were hunted at a colony some distance away, and brought to the site for consumption.

1.4 HABITAT

Although individual fur seals occasionally haul out on a wide variety of different coasts (Wilson 1974:56) the bulk of the population are found at regular colonies. These colonies occur only in locations that fulfil a specific set of habitat requirements.

In reconstructing prehistoric patterns of fur seal exploitation it is useful to be able to postulate the location of the colony, or colonies, that were under exploitation. As indicated above, this is especially important when there are no present day colonies in the area.

Breeding and non-breeding colonies have somewhat different habitat requirements, and these will be outlined to provide a basis for determining the locations of former colonies. The major habitat differences between Chatham Island and New Zealand colonies will be noted.

a. Breeding colonies

Five features are common to the majority of breeding colonies in the Chatham Islands (ibid:56-7).

(i) They occur on rocky coasts, generally exposed to the West or South West.

(ii) Protection from heavy seas is provided by large rocks along the seaward fringe, or by off-lying rocks, reefs or islets.

(iii) They usually allow access to higher ground, where Adult females and Pups may retreat in heavy seas. Areas vegetated in tussock or scrub are often utilised for this purpose.

(iv) They have tide pools where the fur seals can cool off in hot weather. This is not always the case on New Zealand breeding colonies.

(v) They are always situated on topographically irregular, or eroded rocks. Chatham Island breeding colonies tend to be on more regular, less eroded sites than are their New Zealand counterparts.

While beaches composed of large angular boulders are often used as breeding colonies in New Zealand, only two such localities are exploited for this purpose in the Chatham Islands despite the presence of numerous beaches of this sort (ibid:56-7).

Breeding colonies never occur on sandy or pebble covered beaches. Smooth, rounded boulders are seldom utilised.

b. Non-breeding colonies

Non-breeding colonies have less stringent habitat requirements. They are generally on more sheltered coasts, and the major requirement appears to be ease of access to and from the sea (ibid: 49). A variety of coasts are utilised for this type of colony in the Chatham Islands, but the major feature of all of them appears to be a relatively even rocky platform or slope (ibid:57).

This differs from the New Zealand situation where shelving rocky ledges and boulder beaches are the most common non-breeding colony sites (Crawley & Wilson 1976:9).

c. Discussion

The use of the above criteria in postulating the locations of former colonies implies the assumption that the habitat requirements of colonies in the prehistoric period were substantially the same as they are today. It has been suggested for a number of other species of fur seal that the use of exposed, eroded and (to man) inaccessable coasts for breeding colonies is a direct result of human predation (Peterson 1968; Peterson et. al. 1968). There is no evidence to suggest that this is the case for the New Zealand fur seal (Wilson 1974:60).

A more probable reason for the use of exposed and eroded coasts is the need for the fur seal to cool off during hot weather. Exposed coasts are more likely to have cooling winds than are any other type of coast, and the eroded nature of these colony sites provide shade from the direct sunlight (ibid:59-61). As the thermo-regulatory needs of the fur seal are unlikely to have altered greatly it can be assumed that they would have had a preference for similar habitats during the prehistoric period.

This raises a further question with respect to both habitat and distribution. Because both are influenced by meteorological factors, climatic change during the prehistoric period may have altered the distribution and specific location of colonies. No attempt has been made to assess the effects of climatic change in this study, but it is an area that does warrant further attention.

1.5 POPULATION STRUCTURE

The distributions and habitat requirements of each type of colony have been outlined. The population structures of each of these will now be described. Each type of colony has a distinctive age/sex structure to its population, and regular seasonal changes in these take place. This directly limits the proportions of each age/sex category available for hunting by man at each type of colony, and at any time of the year. It will be demonstrated that the relative proportions of each age/sex category represented in an archaeological site can indicate, in certain circumstances, the type of colony that was under exploitation, and the time of year at which this took place.

The fur seal's year can be divided into two seasons; Summer (November to February), and Winter (March to October). This division is based on fluctuations in the relative proportions of each age/sex category at both types of colonies. Observers of fur seal behaviour have identified four seasons, subdividing the summer into three periods; November, December, and January-February (ibid; Chapter 6). However, this subdivision is based on relatively small scale changes in population structure. Therefore it is unlikely that prehistoric exploitation in say, November, could be distinguished from exploitation in January through analysis of the population structure of the fur seal remains in an archaeological site. Thus only the two broader seasons will be considered here.

The population structures of each type of colony will be discussed in turn.

a. Breeding colonies

Fur seals are present all year round at breeding colonies, with Pups and Adult females being the numerically predominant age/sex categories. Changes in the population structure revolve around the breeding activities which take place in the summer.

Summer: Adult males begin to arrive at the breeding colonies in late October and early November. By the end of that month they may make up 30% of the population (ibid:97). At this time Adult females are relatively scarce, probably because they are feeding heavily at sea before giving birth to their Pups (Crawley & Wilson: 13). Their numbers increase rapidly in early December, and they soon make up about 50% of the total population.

The birth of Pups begins in November, reaching a peak in early December. By the end of December they make up about 25%

of the population. Because of the increase in the number of Pups and Adult females, the proportion of Adult males in the population gradually declines throughout December to about 20% or 25% (Wilson 1974:97). Other age/sex categories form only a small percentage of the population at this time.

Breeding takes place during December and early January, generally following about a week after the birth of each females pup. Adult males leave the colonies during January, having completed their breeding activities. Adult females remain the dominant age/sex category throughout January. Pups comprise between 35% and 50% of the population at this time, depending on how many of the Adult males have left. Juveniles and Sub-adult males remain scarce (ibid:98).

The proportion of Adult females begins to decline in mid or late February as they leave the colony to make feeding excursions at sea. They return at intervals to feed their Pups. With the absence of their mothers, Pups become the dominant age/sex category by the end of February (ibid).

<u>Winter</u>: The population structure changes very little during the winter. About half the population are Pups, and about a third Adult females. Adult males are seldom seen at breeding colonies during the winter. The remainder of the population is made up of small numbers of Juveniles and Sub-adult males. Juveniles may be more abundant in the early winter (ibid).

During winter the number of fur seals present at a breeding colony may be as low as half the number present at the height of the breeding season. This is only partially a result of the absence of Adult males. At any one time during the winter a large number of Adult females may be at sea feeding, and thus not present at the colony. Pups are weaned sometime after June or

July and begin to leave the colony for short periods, further reducing the number of fur seals present.

b. Non-breeding colonies

These have been defined as colonies at which 60% or more of the population are males(ibid:99). Males often make up 80% or 85% of the population, and at some non-breeding colonies they are the only fur seals seen.

In the Chatham Islands non-breeding colonies are probably occupied all year round. However, in New Zealand non-breeding colonies well north of the breeding range are abandoned during the summer (ibid:72-6). The concern here is only with those non-breeding colonies occupied all year round.

<u>Summer</u>: During the summer Sub-adult males are the dominant age/sex category, forming up to 90% of the population, although the average figure is nearer to 75% (ibid:95). Adult males are present in large numbers only in early November when they make up over 40% of the population. For the rest of the summer they are scarce as they are at the breeding colonies. Similarly, Adult females and Pups do not form a significant proportion of the population. The number of Juveniles varies considerably, ranging from 0% to 50%, but averaging about 20% (ibid).

<u>Winter</u>: Sub-adult males continue to be the dominant age/sex category during the winter. In general they make up 56% to 84% of the population, although at some non-breeding colonies they have been known to comprise the whole population (ibid:100). Adult males make up about 20% of the population and Juveniles about 10%. Adult females seldom appear at non-breeding colonies. Pups are slightly more common, although never making up more than 10% of the population. In some parts of New Zealand an influx of Juveniles during August and September is sometimes

recorded, although this is not a regular phenomenon (ibid:100-2).

c. Discussion

The preceding outline indicates a number of general trends in the seasonal abundance of each age/sex category at both breeding and non-breeding colonies. From this data certain interpretations of the fur seal remains in archaeological sites can be made.

The first stage of this interpreation involves determination of the type of colony that was under exploitation. Adult females and Pups are always present at breeding colonies, usually making up a large proportion of the total population. They seldom appear at non-breeding colonies. Thus, if a large proportion of the fur seals in a site belong to one or both of these categories exploitation of a breeding colony can be inferred.

When a large proportion of the individuals are Sub-adult males, exploitation of a non-breeding colony can be inferred. This age/sex category are the predominant group at non-breeding colonies, and seldom appear in large numbers at breeding colonies.

These inferences can sometimes be confirmed through consideration of possible locations of the colony in the manner outlined in the previous section of this Chapter.

After establishing the nature of the colony, the season of year at which exploitation took place can be ascertained. Where exploitation of a breeding colony has been established, the presence of Adult males in the site is a good indication of summer exploitation. It has been shown that they are present at breeding colonies only at this time of year.

Adult males are present at non-breeding colonies only in winter, and thus their presence in a site at which exploitation

exploitation.

Juveniles occur at both types of colonies in relatively small numbers at all times of the year. Their seasonal movements are not well understood (ibid:74), and thus it is difficult to interpret their presence in a site in terms of seasonal hunting activities. Their presence in a site at which exploitation of a breeding colony has been established probably suggests winter exploitation, but summer activity is also possible. Similarly, their presence in a non-breeding colony exploitation site probably indicates summer exploitation, but winter exploitation cannot be excluded. In these circumstances corroborative evidence is essential before confidence can be placed in the determination of seasonality.

There are considerable difficulties in this type of reconstruction. The quantity of fur seal remains in a site influences the accuracy with which interpretations can be made. Individual fur seals and small groups sometimes haul out on almost any sort of coast (ibid:56), and occasionally appear in harbours and rivers (ibid:56). These visits can occur at any time of year. When small numbers of fur seals are found in a site they could represent exploitation of such irregular and occasional visits. In such circumstances it is not possible to accurately assign seasonality to the exploitation activities. As a general rule, the greater the number of fur seals in a site the more likely it is that they were hunted at a regular colony, and the more accurately seasonality can be assigned.

A second problem concerns the length of time represented by an archaeological deposit. Where a site, or layer represents a long period of occupation it is possible that more than one structure of the fur seals in the site will be a combination of the individuals from each period of hunting, and indications of seasonality may be masked. Reconstruction is more reliable, therefore, when a short period of occupation is involved.

Consideration must also be given to the possibility that certain age/sex categories were hunted in preference to others. If selective hunting of this sort took place, then the population structure of the fur seals in the site would not accurately reflect the composition of the population available for hunting at the particular type of colony at the time of year at which exploitation took place. Thus, determination of the type of colony under exploitation and of seasonality may be difficult.

This problem can be overcome, to some extent, by using only positive evidence for the purpose of reconstruction. Interpretations based upon the presence of certain age/sex categories, rather than their absence are less open to error through the problem of selective hunting. For instance, the presence of Adult males in a site at which a breeding colony was exploited provides positive evidence that this exploitation took place during summer. However, their absence in such a site need not necessarily indicate winter exploitation, because the fur seal hunters may have deliberately avoided taking Adult males.

1.6 SUMMARY

The aspects of fur seal behaviour most relevant to the reconstruction of prehistoric exploitation patterns have been reviewed. The distribution, habitat requirements and population characteristics of each type of colony were outlined in order to demonstrate the ways in which they could be used to interpret the fur seal remains from archaeological sites. Some of the major difficulties with this form of reconstruction were discussed, and

means of avoiding these problems considered. In the following Chapters this basis for interpretation will be employed in the reconstruction of the pattern of fur seal exploitation exhibited by the archaeological evidence from a site on the South West coast of Chatham Island.

CHAPTER TWO

METHODS OF DATA COLLECTION AND ANALYSIS

2.1 INTRODUCTION

The importance of explicitly outlining the methods used in the excavation and analysis of archaeological data cannot be overemphasised. Excavation is a destructive process and while the recovery of all potential information from a site would be desirable, it is seldom, if ever possible. Both the quantity and the quality of the information recovered is determined, to a large extent, by the techniques employed in excavation and in subsequent analysis.

Some of the limitations and difficulties imposed upon the reconstruction of prehistoric economies by the various methods of obtaining and interpreting faunal material have been outlined by Payne (1972a; 1972b). He indicates that some of these problems can be circumvented by providing precise information on the objectives of an excavation, the methods of excavation and sample recovery, and the techniques of analysis (Payne 1972b:80). This allows the reader to assess at least some of the biases involved in the study, and facilitates comparisons between sites.

In this Chapter the methods employed in this study are described. Firstly the location of the site is described and the objectives of its excavation outlined. The excavation procedures and methods of analysis are discussed and some of the limitations that these methods imposed upon the study are indicated.

2.2 EXCAVATION OF CHC

CHC (no site number) is located 1.5 km south of Point Durham on the South West coast of Chatham Island (figure 2). It is about 70 metres from the sea, on a low terrace on the north

CHC- Location map

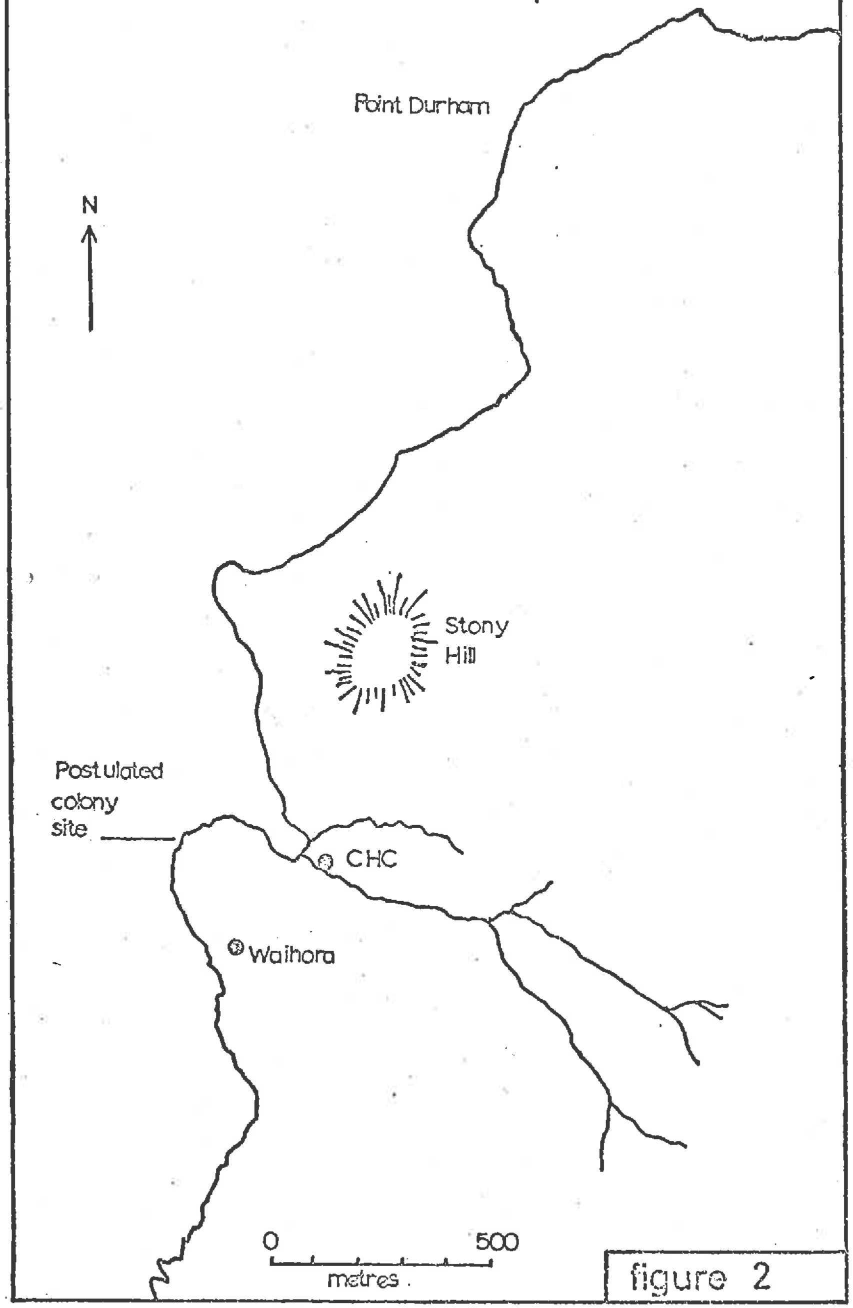


figure 2

bank of a small stream. Immediately inland of the site is a large partially drained peat swamp. The area is presently in grass, and grazed by sheep and cattle.

About 300 metres to the south is the large Waihora site (provisional site number CH 283), excavated in 1974-5 and 1975-6. On the coast between these two sites is a small flat rock platform which may once have been the site of a fur seal colony. This postulated colony site will be discussed further in Chapter Four.

The site was discovered in January 1976. A series of test pits laid out on a 5 metre grid revealed an area of charcoal-blackened soil some 60 x 14 metres in extent. Fire-shattered stones and a small number of flakes were observed in some of the test pits. Near to the centre of the site was a concentrated midden, composed almost entirely of fur seal bone. This midden covered an area of about 50 metres^2.

The decision to excavate this site was made for one primary reason. This was to gather a large sample of fur seal bone from an archaeological context in order to investigate the nature of prehistoric fur seal exploitation on the South West coast of Chatham Island. In keeping with this objective the excavated area was confined to the concentrated fur seal midden. No attempt was made to extend investigations to other parts of the site, or to investigate the relationship between the midden and the rest of the site. While this imposed certain restrictions on the cultural interpretation of the site as a whole, it was a deliberately undertaken policy made necessary by the limitations on the time available both for excavation and for the subsequent analysis of the material.

A 6 x 6 metre area, with a 50 cm baulk was laid out in the centre of the midden. The basic horizontal unit in excavation was initially intended to be the metre square, but when the extremely compacted and concentrated nature of the midden was realised each metre square was subdivided into 4 50 x 50 cm squares. This allowed greater control to be maintained over the horizontal distribution of the midden material.

The difficulties of controlled excavation of a densely compacted midden, combined with the pressures of time and poor weather eventually required that only the northern half of the area originally laid out could be completely excavated. The remainder of the site was taken down only to the surface of Layer 1. Thus the fur seal material that forms the basis of this study all derives from a 12.5 metre^2 area. This represents about one quarter of the area of concentrated fur seal midden in the site.

a. Stratigraphy

The following statigraphic units were observed during excavation.

Sub-turf soil: Immediately underlying the turf was a medium-brown soil. This contained a number of tree roots but no cultural material. In the northwest corner of the site a charcoal-blackened soil lensed under the brown soil. A similar, but larger area of black soil appeared at the southern end of the site. In this case it was not possible to determine any definite surface between the black and brown soils, as they appeared to grade into each other over a distance of 10 to 15 cm. It was presumed that this colour difference in the Sub-turf soil reflected a difference within the under-lying layer. However, as the southern end of the site was not excavated below this level, this could not be confirmed.

Both areas of black soil appeared to be related to the charcoal-blackened soil covering the rest of the site.

Layer 1: This was differentiated from the Sub-turf soil by the presence of cultural material. The soil matrix was identical to that above, giving the impression that the Sub-turf soil was an upward growth of the Layer 1 soil. The cultural material was predominantly bone, but fire-shattered stones, charcoal, a small amount of shell and a number of flakes were also present.

The majority of the bone was broken. The broken pieces of individual bones were often found in close proximity to each other in such a manner as to suggest that breakage had occurred in the ground as a result of considerable downward compression.

This layer varied between 3 and 12 centimetres in depth.

Natural: The cultural material rested upon a hard, compacted brown soil. In the surface of this soil were considerable quantities of small (1-3 cm diameter) pebbles.

b. Excavation procedure

Specific procedures were developed for the recovery and recording of each component of the site. Each of these will be described in turn.

Bone: The procedures for collecting bone material were directed towards three purposes. Firstly, it was intended to recover as much of the bone as possible. A second concern was to facilitate the reconstruction of broken bones. Finally it was hoped that information on butchering practices might be obtained by recording those parts of the fur seal skeletons that were in articulation.

All complete bones and large fragments of broken bones from each 50 x 50 cm square were removed from the soil, bagged and labelled. Where several fragments of a single broken bone were recognised they were bagged together to assist in the reconstruction of the bone.

The smaller fragments of bone were separated from their soil matrix by wet sieving. A $\frac{1}{4}$ inch mesh sieve was used for this purpose. Experiments with smaller meshed sieves indicated that their use would have been too time consuming. While some of the smaller bone fragments must certainly have been lost by this method, the loss of potential information would not have been great, since most of the fragments small enough to have been lost would have been unidentifiable.

For two reasons the recording of information on articulation was not particularly successful. Most of the people involved in the excavation had a limited knowledge of fur seal osteology, and may not have recognised the articulation of bones every time that it occurred. Many of the bones that may have been in articulation when they entered the site would not have appeared as such at the time of excavation. This was because of the movement and breakage of bones as a result of the compression of Layer 1. When articulation was recognised the articulating bones bagged together and labelled appropriately.

Teeth: Because of the large mesh size of the sieves used in separating the smaller components of the midden from the soil, there was considerable danger in losing many of the smaller fur seal teeth. The problem was partially overcome by removing teeth from the soil and small bone fragments before sieving. It is difficult to assess the effectiveness of this method of recovery, and consequently fur seal teeth have not been used in the calculation of minimum numbers.

Shell: The small quantity of shell in the site was removed prior to sieving, bagged seperately and labelled.

Wood: Most of the wood in the site was in the form of tree roots. This was retained for identification because of its potential use in environmental reconstruction.

Charcoal: Charcoal was present only in Layer 1. Samples were collected for two purposes. Only two samples of sufficient size for C^{14} dating were located. These were removed from the ground with a clean trowel and bagged in plastic without being handled by the excavator.

Samples were also collected for identification. These were procured by collecting all the charcoal scattered through a 50 x 50 cm square. Such samples were collected from half the excavated squares.

Artefacts: Only three small chert flakes fell into this category. The exact location of each was recorded.

Total samples: Total samples were retained from 15% of the squares during the excavation of Layer 1 for the analysis of components likely to have been lost through sieving. A single total sample was retained from the Sub-turf soil layer.

2.3 LABORATORY ANALYSIS

Laboratory analysis concentrated on the fur seal component of the site. Only limited attention was paid to the other components. This was dictated by the small amount of time available for the study, and by the overwhelming predominance of fur seal bone in the excavated material.

The first stage of analysis involved completion of the breakdown into components that was begun in the field. All bone, teeth, shell and wood was removed from the total samples. Then the bone material from each square was divided into 7 categories: fur seal, sea lion, elephant seal, leopard seal, rat, bird, and fish. Teeth were separated into elephant seal, leopard seal, and fur seal/sea lion. This was only a preliminary identification process, final speciation being undertaken during later stages of analysis.

The analysis of each component will be discussed in turn.

a. Fur seal bone: identification and minimum numbers

The analysis of this material was directed towards establishing the minimum number of individuals present, the relative proportions of body parts in the site, and the age/sex structure of the fur seals in the excavated sample.

Although identification of all fur seal bone would have been desirable to achieve these aims it was not possible. The limited time and the fragmentary nature of much of the bone imposed severe restrictions on the quantity of material that could be identified. Most of the phalanges, metacarpals, metatarsals, vertebrae, ribs and crania were too fragmentary to identify and side accurately.

Ten bones were chosen for identification: mandible, scapula, humerus, radius, ulna, pelvis, femur, patella, tibia, and fibula. All of these could be identified with relative ease, even when broken. This pragmatic consideration aside, the choice of these particular bones was guided by the three aims outlined above. Each is represented only twice in any one individual, thereby simplifying the calculation of minimum numbers. Together these bones represented most parts of the body, providing a basis for determining the proportional representation of these body parts in the site. Finally, two of these bones, humerus and ~~radius~~ femur, were those by which age/sex determinations were to be made.

Identifications were made with the use of the University of Otago, Anthropology Department's comparative collection. Each identified bone or fragment was recorded on a prepared form (figure 3). For the six limb bones, identified bones were placed in one of the eleven categories on the Identification Record Form.

FIGURE 3

IDENTIFICATION RECORD FORM

SPECIES:............

SITE:............ LAYER:.............. SQUARE:...........

Bone		C	C*	PE	P	P-PE	C-PE	M	C-DE	D-DE	D	DE
humerus	right	....	....	...	.....	....	....	...	....	....	..	....
	left	....	....	...	.....	....	....	...	....	....	..	....
radius	right	....	....	...	.....	....	....	...	....	....	..	....
	left	....	....	...	.....	....	....	...	....	....	..	....
ulna	right	....	....	...	.....	....	....	...	....	....	..	....
	left	....	....	...	.....	....	....	...	....	....	..	....
femur	right	....	....	...	.....	....	....	...	....	....	..	....
	left	....	....	...	.....	....	....	...	....	....	..	....
tibia	right	....	....	...	.....	....	....	...	....	....	..	....
	left	....	....	...	.....	....	....	...	....	....	..	....
fibula	right	....	....	...	.....	....	....	...	....	....	..	....
	left	....	....	...	.....	....	....	...	....	....	..	....
mandible	right	....										
	left	....										
scapula[1]	right	....										
	left	....										
pelvis[2]	right	....										
	left	....										
patella	right	....										
	left	....										

1. Only glenoid cavity identified.
2. Only acetabulum identified.

KEY:

C	- complete
C*	- complete, both epiphyses unfused
PE	- proximal epiphysis
P	- proximal end, epiphysis fused
P-PE	- proximal end, epiphysis unfused
C-PE	- complete, proximal epiphysis unfused
M	- medial shaft fragment
C-DE	- complete, distal epiphysis unfused
D-DE	- distal end, epiphysis unfused
D	- distal end, epiphysis fused
DE	- distal epiphysis

FIGURE 4

CALCULATION OF MINIMUM NUMBERS

SPECIES:............

SITE:.............. LAYER:...........

Bone		1	2	3	4	5	min. no. per side	min. no. per bone
humerus	right	....	....	....	...	......	....	....
	left	....	....	....	...	......	....	
radius	right	....	....	....	...	......	....	....
	left	....	....	....	...	......	....	
ulna	right	....	....	....	...	......	....	....
	left	....	....	....	...	......	....	
femur	right	....	....	....	...	......	....	....
	left	....	....	....	...	......	....	
tibia	right	....	....	....	...	......	....	....
	left	....	....	....	...	......	....	
fibula	right	....	....	....	...	......	....	....
	left	....	....	....	...	......	....	
				mandible		right	....	....
						left	....	
				scapula		right	....	....
						left	....	
				pelvis		right	....	....
						left	....	
				patella		right	....	....
						left	....	
				Maximum minumum number				

KEY:
1 = C + PE + P + (C-DE)

2 = C + C* + P + (F-PE) +'(C-PE) + (C-DE)

3 = C + C* + (C-PE) + M + (C-DE)

4 = C + C* + (C-PE) + (C-DE) + (D-DE) + D

5 = C + (C-PE) + D + DE

These categories provided a means of recording both the portion of each bone that was present and the state of epiphyseal fusion of these bones.

The four remaining bones were recorded in a somewhat different fashion. Only complete patella were recorded, and each was assigned to either the left or right side. Fragmentary patella were not recorded because it was not possible to assign them accurately to one side or the other. As there were no complete scapulae or pelves in the site, a single prominent part of each bone was selected for identification. These were the glenoid cavity for scapulae, and the acetabulum for pelves. Only fragments of these two bones containing these parts were identified, to overcome the problem of counting as separate individuals fragmentary pieces of the same bone.

In the case of mandibles this problem was not adequately overcome. Because of the fragmentary nature of almost all specimens of this bone, no single distinctive part proved suitable for this purpose. An attempt was made to estimate the number of right and left mandibles in each square. However, as parts of any one broken mandible may have been present in another square, this procedure almost certainly produced an inflated total number of mandibles.

The minimum number of individuals represented by each of the six limb bones was calculated using a method based on that presented by Leach (1976:426-9). The number of individuals represented by either the right or left side of each of these bones was determined through five different combinations of the eleven categories into which the identified bones had been placed (figure 4). Each of these combinations added together only the portions of bones that could not have come from a single individual. The largest total given by these combinations represented the maximum minimum number for that side. When this procedure had been undertaken for both sides, the maximum minimum number for each bone was determined from the larger of the totals for each side.

The minimum numbers for the remaining bones were calculated simply by adding the total numbers of each identified in each square. Since only a selected distinctive portion of patella, scapulae and pelves were identified, there was no need to employ a complex method of determining the minimum numbers as was necessary for the limb bones. The difficulty experienced in identifying and calculating the number of mandibles has already been mentioned, and thus the minimum number calculated for this bone was an inflated total.

The maximum minimum number of fur seals in the excavated portion of the site was simply the largest total calculated for any particular bone.

b. Fur seal bone: age/sex determination

Osteometric methods of determining age and sex have been developed for a number of animals (e.g. Bryden 1972). However, no such method is available for the New Zealand fur seal. An earlier study of a small sample of prehistoric fur seal remains (Smith 1975) indicated the potential for development of such a method for fur seals, but was hampered by the lack of comparative material of known age and sex. In order to overcome this, efforts were made to build a suitable comparative collection. As the fur seal is a protected species, the supply was limited to the occasional specimen washed up dead on the beach, and to the limited number taken for research purposes by the Zoology Department, Univerisity of Canterbury.

Details of the comparative collection acquired from these two sources are presented in Table 1. The sex of each specimen was ascertained by physical examination, and ages were determined from growth rings in their canine teeth (see Appendix 1).

The small sample size, and inadequate coverage of the five age/sex categories made this collection unsuitable for the development of osteometric criteria for age and sex determination. Thus, an alternative approach was taken. The fur seal bones from CHC were examined to discover whether groups of individuals that might represent each age/sex category could be recognised.

Two bones were chosen for this analysis: humerus and femur. Previous investigations had indicated that these bones were suitable for this purpose (ibid), and furthermore, they were more commonly complete, or able to be reconstructed, than were any other bones in CHC.

This analysis involved three stages. First, the fragmentary humeri and femora from each square were reconstructed. No attempt was made to match fragments from different squares as this would have been too time consuming. A total of 138 complete and 87 fragmentary femora, and 133 complete and 76 fragmentary humeri were obtained.

The second stage of analysis involved the division of these bones into three groups on the basis of epiphyseal fusion. These groups were as follows:

(i) those with both proximal and distal epiphyses fused
(ii) those with only the distal epiphysis fused
(iii) those with neither epiphysis fused.

No specimens of either bone were found to have the proximal epiphysis fused and the distal epiphysis unfused.

TABLE 1

N.Z. FUR SEALS IN THE COMPARATIVE COLLECTION

Ref.No.	Sex	Age	Age/sex Category
FA 21	?	7 weeks*	Pup
FA 23	male	?**	Adult male
FA 870	male	15 years	Adult male
FA 873	male	14 years	Adult male
FA 933	male	8 years	Adult male
FA 934	male	10 years	Adult male
FA 935	female	3 years	Adult female
FA 951	male	15 years	Adult male
FA 954	male	?**	Adult male
FA 975	male	10 years	Adult male

* approximate age only

** age not able to be determined

The limited evidence afforded by the comparative collection suggests that in both males and females fusion of the proximal epiphysis in both femora and humeri begins at about the same time as the attainment of adult status. The single Adult female (FA 935) was known to have just begun breeding for the first time before being taken, and had therefore just achieved adult status (Mattlin 1976: pers. comm.). In this individual, the proximal epiphyses of both femora and humeri had just begun to fuse. The state of fusion of these epiphyses in the youngest Adult male (FA 933) was only slightly more advanced. Thus it was assumed that all bones falling into group (i) were from adult individuals.

Groups (ii) and (iii) were classified as sub-adult. The lack of sub-adult comparative specimens did not permit an assessment of the approximate ages at which fusion of the distal epiphyses began.

The third stage of analysis involved measurement of these bones. A maximum of four measurements was taken on Adult femora and humeri, depending on their state of completeness. Three measurements were taken on Sub-adult femora, and two on Sub-adult humeri. These measurements are defined in Appendix 2. Measurements were also taken on the comparative specimens.

Subdivision of group (i) into Adult male and Adult female, and of groups (ii) and (iii) into Sub-adult male, Juvenile and Pup was undertaken through a statistical analysis of the measurements taken on the bones within each group. The results of this analysis, and a discussion on their interpretation will be presented in the following Chapter.

c. Analysis of material other than fur seal bone

Other sea mammal bone: The bones of Southern Elephant Seal (*Mirounga leonina*), Leopard Seal (*Hydrurga leptonyx*), and New Zealand Sea Lion (*Neophoca hookeri*) were identified with the use of comparative specimens in the Otago Museum. All cranial material and limb bones were identified, and minimum numbers were calculated by the method outlined above.

Age and sex were determined only for the elephant seal crania, because of the limitations of the comparative material.

Sea mammal teeth: The post-canine teeth of elephant seals and leopard seals were identified by comparison with Otago Museum specimens. Minimum numbers were calculated by dividing the total number of teeth identified for each species by the number of post-canines in one individual of that species.

The remaining teeth were not analysed because of the difficulties in accurate identification. Fur seal and sea lion teeth are morphologically very similar, and while it is possible to make some distinctions on the basis of size, it is not possible to speciate all teeth accurately. The development of an accurate method of differentiating fur seal and sea lion teeth would be a considerable advantage, as once speciated these teeth could be used for age determination using the method outlined in Appendix 1.

Bird bone: All bird bone was identified by R.J. Scarlett, Canterbury Museum. Minimum numbers for each species were calculated using the method outlined by Leach (1976:426-9).

Other material: The rat bone, fish bone and shell were identified using the Otago University, Anthropology Department's comparative collection. Minimum numbers were established using the method described above. Time did not permit study of the wood, charcoal

or artefacts.

CHAPTER THREE

RESULTS

3.1 INTRODUCTION

Results are discussed in five sections. First, the minimum number of fur seals excavated from CHC is presented and a theoretical number for the whole site is estimated. The proportional representation of various body parts in the site is discussed.

In the second section a statistical analysis of the measurements of the CHC fur seal bones is presented, and from this metrical croteria for age/sex determination are developed. The third section presents an analysis of the CHC population structure as derived from the preceding analysis.

The remaining two sections present the minimum numbers of species other than the fur seal, and discuss the age of CHC.

3.2 THE MINIMUM NUMBER OF FUR SEALS

The method by which minimum numbers were calculated was presented in the previous Chapter. Numbers thus calculated for each bone are presented in table 2. The figure of 151 individuals calculated for mandibles cannot be accepted as a reliable minimum number for reasons outlined in the previous Chapter. The second highest figure, that of 130 for humeri, is accepted as the maximum minimum number of fur seals represented in the excavated portion of CHC.

The 12.5 metre^2 area of midden excavated represented about a quarter of the total area of concentrated fur seal midden in the site. If it can be assumed that there was a consistent distribution of individuals over this area, then a theoretical minimum number of 520 fur seals can be postulated for the whole site.

The proportional representation of various body parts can be

TABLE 2

MINIMUM NUMBER OF FUR SEALS IN CHC

Bone	Side	Min.no. per side	Min.no. per bone
humerus	right	130	130
	left	118	
radius	right	103	120
	left	120	
ulna	right	102	118
	left	118	
femur	right	118	118
	left	105	
tibia	right	99	99
	left	81	
fibula	right	72	72
	left	65	
mandible	right	151 *	151 *
	left	142 *	
scapula	right	80	85
	left	85	
pelvis	right	90	90
	left	71	
patella	right	98	98
	left	92	
		Maximum minimum number	130

* inflated total
(not considered for
max. min. number)

assessed from the minimum number of individuals represented by each bone (table 2). Excluding the unreliable result for mandibles, these range from 130 for humeri, to 72 for fibula. This range is perhaps more an observed than a real one. The bones giving lower numbers of individuals are all less robust than the ones giving higher numbers of individuals. Therefore they are likely to have been more fragmentary, and consequently more difficult to identify and side accurately. Tibia, fibula, scapula and pelvis all fit into this category.

It is difficult to assess quantitatively the effects that this would have had on the relative proportions of all fragments of each bone that were able to be identified. The impression gained during the sorting and identification of this material was that all bones were present in more or less equal quantities. Given that the bones representing the least numbers of individuals were those most difficult to identify, this impression would seem to be validated by the figures in table 2.

From this can be drawn the conclusion that all parts of the body represented by these bones were present in the site in more or less equal quantities. If time had permitted further analysis, all other bones could have been identified and the proportional representation of other body parts documented. However, this was not possible.

.3.3 AGE/SEX DETERMINATION

In the previous Chapter the difficulties encountered in developing criteria for age/sex determination from the comparative material were outlined. An alternative approach using the femora and humeri from CHC was proposed. Firstly, the bones were divided into three groups according to their state of epiphyseal fusion. These bones were then measured and the metrical attributes of each group were examined to determine whether distinct cluterings could be recognised that could be equated with the 5 age/sex categories defined in Chapter one. The measurements used in this analysis are defined in Appendix 2. All measurements were taken in centimetres.

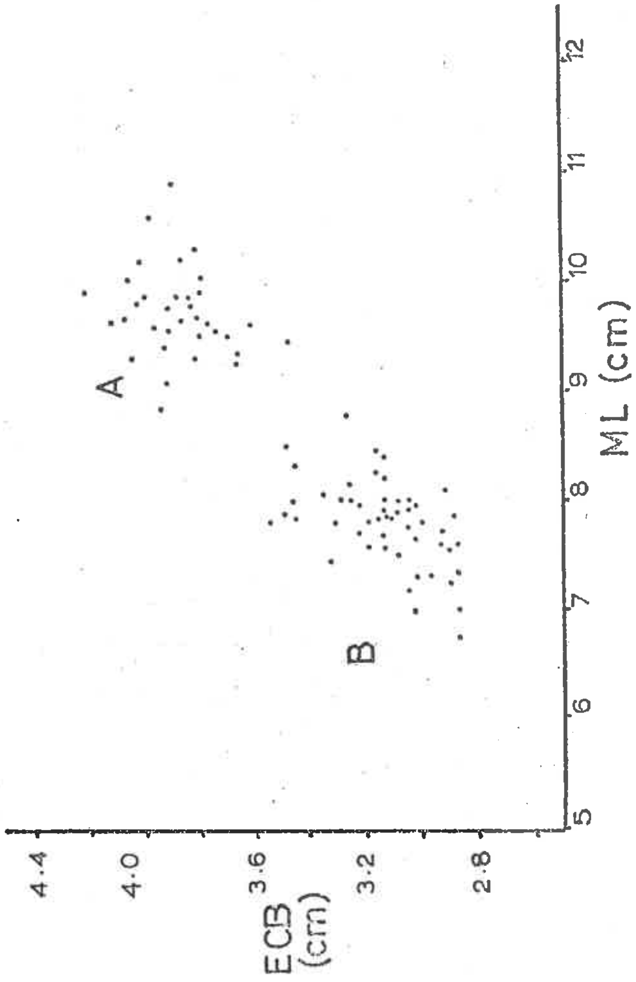
The results of this analysis are presented, discussing each group in turn.

a. Femora: Adult

It has already been argued that femora with both proximal and distal epiphyses fused represent adult individuals. The 94 femora of adult age from CHC were measured, and when their Maximum lengths (ML) were plotted against their distal Epicondylar Breadths (ECB) two distinct groups were apparent (figure 5). These were named group A and group B. On each of the four measurements taken on these bones the differences between the means of groups A and B were highly significant(table 3a).

The most likely explanation for this grouping is sexual dimorphism. There are considerable differences between live Adult males and Adult females on all measures of size. For example, Adult males weigh from 180 to 200 kg and average about 2 metres in nose-to-tail length, while Adult females weigh only between 50 and 90 kg and reach 1.5 metres in length (Miller 1975; Crawley & Wilson 1976). This size difference is most evident at the beginning of the breeding season when the male to female weight ratio is about 3.5:1 (Crawley & Wilson 1976). With this degree of dimorphism in live specimens, it would appear unlikely that there was not some degree of dimorphism in bone dimensions.

The proposition that group A represents Adult males was tested by comparison with the Adult males in the comparative collection. No significant differences were apparent on any of



Adult femora- Maximum length: Epicondylar breadth

figure 5

TABLE 3

T-tests for Adult femora measurements

3a. Comparison of Groups A and B

Measurement	Group	$\bar{x}$	s^2	n	t	p
ML	A	9.71	0.160	36	23.611	<.001*
	B	7.80	0.136	58		
ML(h)	A	9.33	0.168	35	21.938	<.001*
	B	7.55	0.115	51		
ECB	A	3.89	0.025	36	20.421	<.001*
	B	3.15	0.032	58		
STD	A	2.13	0.019	34	18.064	<.001*
	B	1.64	0.014	57		

3b. Comparison of Group A and Adult males (comparative collection)

Measurement	Group	$\bar{x}$	s^2	n	t	p
ML	Ad. ♂	9.89	0.057	15	1.620	>.1
	A	9.71	0.160	36		
ML(h)	Ad. ♂	9.45	0.052	15	1.057	>.1
	A	9.33	0.168	35		
ECB	Ad. ♂	3.94	0.009	15	1.124	>.1
	A	3,89	0.025	36		
STD	Ad. ♂	2.16	0.007	15	0.080	>.1
	A	2.13	0.019	34		

* significant

TABLE 3 (continued)

3c. Comparison of Group B and Adult female (FA 935)

Measurement	Group	$\bar{x}$	s^2	n	t	p
ML	FA 935	7.9			0.727	>.1
	B	7.8	0.136	58		
ML(h)	FA 935	7.65			0.860	>.1
	B	7.55	0.115	51		
ECB	FA 935	3.25			0.551	>.1
	B	3.15	0.032	58		
STD	FA 935	1.45			-1.198	>.1
	B	1.64	0.014	57		

the four measurements (table 3b). It was thus concluded that group A were Adult males.

Group B were compared with the single Adult female in the comparative collection (FA 935), and no significant differences were apparent on any of the four measurements (table 3c). The proposition that group B represented Adult females was thus accepted.

Several alternative propositions were considered, but rejected as explanations of the observed results. The possibility that more than one population were present in the sample, and thereby causing the clustering into two groups was rejected. Considerable confidence be placed in the assertion that all the bones in the sample came from individuals of a single species. The femora of all other species of seal known to have occurred in the Chatham Islands can be readily distinguished from those of the fur seal on the basis of morphology and size. A potential difficulty would arise if species of Southern Fur Seal other than the New Zealand fur seal were likely to have been included in the sample. However, the presence of other species of Southern Fur Seal in the Chatham Islands has never been recorded, and their distributions are sufficiently distant to preclude the possibility of their ever having occurred there (see King 1964:19-36). The possibility that the clustering into two groups was the result of the presence of more than one population in the sample can be safely rejected.

Similarly, age can be rejected as an alternative explanation. Once adulthood has been reached, and both proximal and distal epiphyses fused, the longitudinal growth of bone ceases. As all the individuals in groups A and B were adult (i.e. both epiphyses fused) it could not be accepted that group B might be a group of

individuals younger than those in group A.

Considerable skeletal size differences within a single population can be induced by individuals experiencing different planes of nutrition (McMeekan 1940, 1941). It was not possible to assess fully the proposition that groups A and B might represent fur seals raised on different planes of nutrition, as there was no available information on the factors that might have effected their nutritional plane. However, as it was probable that all the fur seals in CHC were members of a single colony (see Chapter Four), it would seem unlikely that such factors would have been operating. This explanation has thus been accorded a low probability of having influenced the observed results.

Genetic differences within a population can also cause size groupings, but this is not a common phenomenon (Payne 1972b: 74). As this has never been reported for fur seals it was not considered a likely cause of the clustering into groups A and B.

Sexual dimorphism therefore appeared to be the most likely cause of the size grouping, and thus group A have been classified as Adult males, and group B as Adult females.

b. <u>Femora: Sub-adult</u>

There were 31 femora from CHC with neither proximal or distal epiphyses fused. There were no specimens with only one epiphysis fused. Analysis of the measurements taken on these specimens indicated a clustering into three groups, called C, D, and E (figure 6). For each of the measurements taken the means of each group were significantly different (tables 4a and 4b).

Age and sex appeared to be the major factors influencing this grouping. For the same reasons as outlined above, differing nutritional planes, genetic differences, and the presence of more than one population in the sample were rejected as alternative

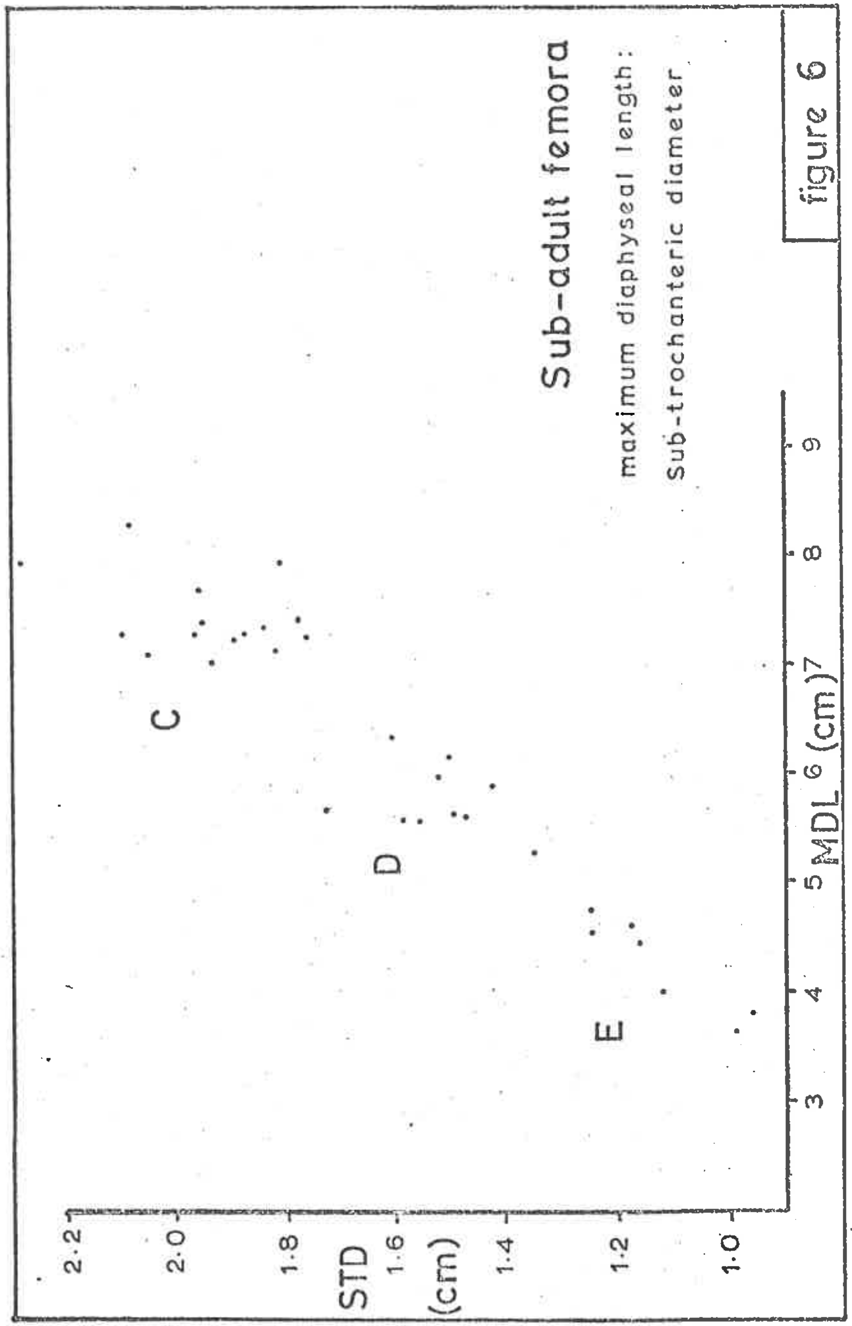


figure 6

Sub-adult femora

maximum diaphyseal length: Sub-trochanteric diameter

TABLE 4

T-tests for Sub-adult femora measurements

4a. Comparison of groups C and D

Measurement	Group	$\bar{x}$	s^2	n	t	p
MDL	C	7.42	0.13	14	3.195	<.01*
	D	5.75	0.09	10		
DDB	C	3.383	0.168	12	10.692	<.001*
	D	2.827	0.031	8		
STD	C	1.949	0.021	14	8.094	<.001*
	D	1.525	0.010	10		

4b. Comparison of groups D and E

Measurement	Group	$\bar{x}$	s^2	n	t	p
MDL	D	5.75	0.090	10	23.617	<.001*
	E	4.26	0.187	7		
DDB	D	2.827	0.031	8	6.270	<.001*
	E	1.917	0.116	4		
STD	D	1.525	0.010	10	8.030	<.001*
	E	1.129	0.012	7		

4c. Comparison of group C and Adult females

Measurement	Group	$\bar{x}$	s^2	n	t	p
STD	C	1.949	0.021	14	8.104	<.001*
	Ad.♀	1.640	0.014	57		

* significant

explanations.

Group C appeared to represent Sub-adult males. Their sub-adult status was ascertained from the unfused nature of their epiphyses. The Sub-adult male age/sex category was defined in Chapter One as the group of non-breeding males, larger and heavier than Adult females, and smaller and lighter than Adult males. Thus it might be expected that Sub-adult males would be larger in bone dimensions than Adult females.

The only measurement by which a direct comparison was possible was the Sub-trochanteric diameter (STD), as the other measurements taken on Adult bones were not possible on the unfused Sub-adult bones. When compared by this measurement, the presumed Sub-adult male group (group C) were significantly larger than the Adult female group (table 4c). Although there were no modern Sub-adult males in the comparative collection to provide further confirmation, the above evidence suggests that group C can be considered to be Sub-adult males.

Interpretation of the division between groups D and E was more difficult. While the division was visually apparent when represented graphically (figure 6), and statistically valid (table 4b), the classification of group D as Juveniles and group E as Pups was somewhat difficult to justify.

Sexual dimorphism would not appear to provide an adequate explanation of the size difference. Marked sexual dimorphism has not been observed in fur seal Pups (Crawley 1975; Crawley & Wilson 1976), or in Pups and Juveniles of other species of Southern Fur Seal (Bonner 1968). Indeed, it is impossible to determine the sex of live Pups and Juveniles accurately without an examination of their genitalia, because of the lack of sexual dimorphism in size (Mattlin 1976: pers. comm.).

Age therefore appeared to provide the most probable explanation. The Juvenile age/sex category was defined (Chapter One) as including fur seals greater than 1 year old, but smaller and younger than Adult females. Pups were defined as fur seals of less than 1 year. Without comparative specimens of known age it is difficult to be sure that the division between groups D and E corresponds exactly with this division between Juveniles and Pups. As the division must reasonably be expected to fall at or about this point the classification of group D as Juveniles and group E as Pups was tentatively accepted. Clarification of this problem must await further study of comparative specimens.

c. Humeri: Adult

As with femora, the fusion of the proximal epiphysis of the humerus appears to coincide with the attainment of Adult status. The 62 Adult humeri from CHC were measured and these measurements analysed. Plotting of their Maximum lengths (ML) against their Epicondylar breadths (ECB) indicated separation into two groups, A and B (figure 7). This division was not as marked as for Adult femora, but was still statistically significant (table 5a).

The discussion of a series of alternative explanations for a similar grouping in Adult femora applies equally here, and need not be repeated. From this the conclusion that group A represents Adult males, and group B Adult females follows. Comparison with modern specimens provided adequate confirmation of this conclusion. The means for all measurements taken on the Adult males in the comparative collection were not significantly different from those taken on group A (table 5b). Similarly, the group B measurements did not differ significantly from those taken on the single Adult female in the comparative collection (table 5c).

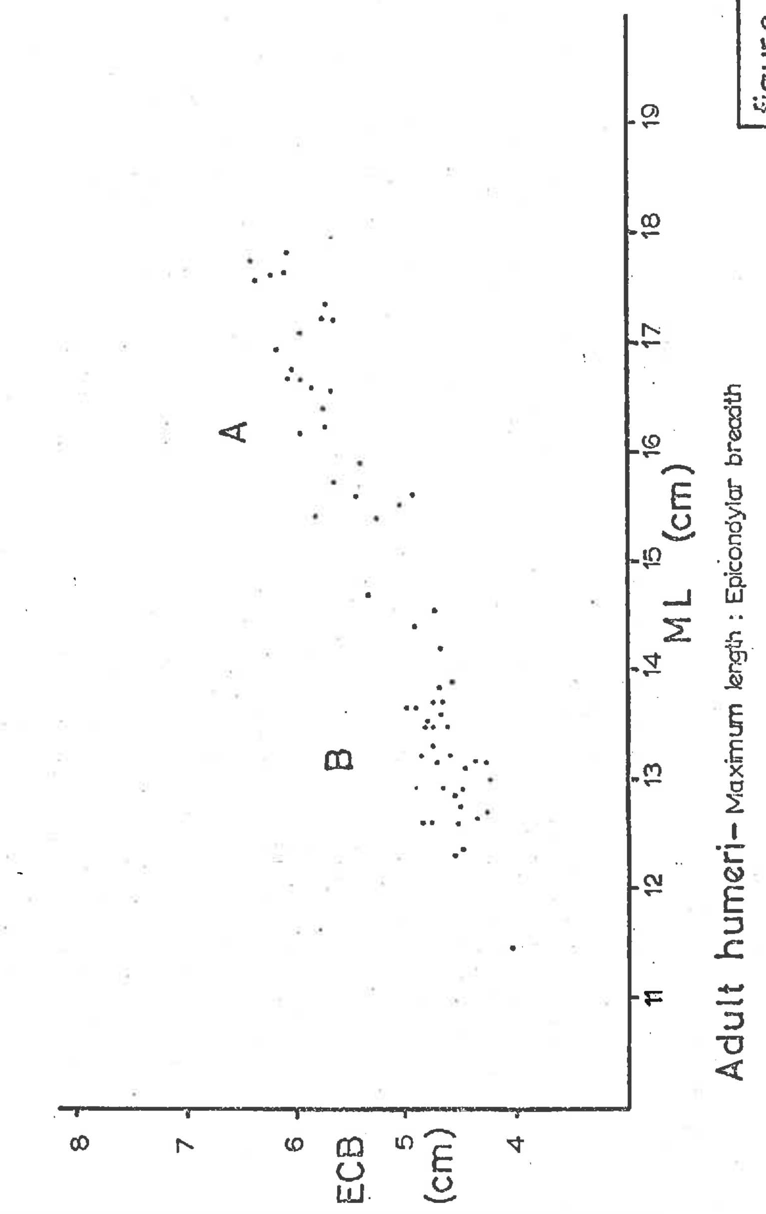


figure 7

TABLE 5

T-tests for Adult humeri measurements

5a. Comparison of groups A and B

Measurement	Group	$\bar{x}$	s^2	n	t	p
ML	A	16.62	0.640	26	17.87	<.001*
	B	13.27	0.448	36		
ML(h)	A	15.56	0.705	26	17.685	<.001*
	B	12.26	0.396	36		
ECB	A	5.78	0.144	25	14.511	<.001*
	B	4.65	0.052	36		
TDH	A	4.39	0.072	22	15.292	<.001*
	B	3.38	0.052	35		

5b. Comparison of group A and Adult males (comparative collection)

Measurement	Group	$\bar{x}$	s^2	n	t	p
ML	Ad.♂	16.90	0.253	15	1.231	>.1
	A	16.62	0.640	26		
ML(h)	Ad.♂	15.59	0.152	15	0.112	>.1
	A	15.56	0.705	26		
ECB	Ad.♂	6.00	0.322	15	1.477	>.1
	A	5.78	0.144	25		
TDH	Ad.♂	4.48	0.092	15	0.968	>.1
	A	4.39	0.072	22		

*significant

TABLE 5 (continued)

5c. Comparison of group B and Adult female (FA 935)

Measurement	Group	$\bar{x}$	s^2	n	t	p
ML	FA 935	13.70			0.631	>.1
	B	13.27	0.448	36		
ML(h)	FA 935	12.10			-0.246	>.1
	B	12.26	0.396	36		
ECB	FA 935	4.92			1.148	>.1
	B	4.65	0.052	36		
TDH	FA 935	3.40			0.082	>.1
	B	3.38	0.052	35		

---

d. Humeri: Sub-adult

On the basis of epiphyseal fusion the Sub-adult humeri from CHC fell into two groups. The first contained 9 specimens fused at the distal end, but unfused at the proximal end. The remaining 24 humeri were unfused at both ends. The age/sex status of each group will be considered in turn. In each case explanations for observed size groupings, other than age and sex, were considered unlikely for the reasons outlined in the discussion of Adult femora.

All of the specimens in the first group had fused distal epiphyses, and thus they could be compared with Adult humeri using the measurement of Epicondylar breadth (ECB). Although longitudinal bone growth would not have ceased until the proximal epiphysis fused, the age/sex category into which each specimen would fall on attaining adulthood could be ascertained through consideration of the dimensions of the fused distal ends of the bones.

Assuming their distributions to be normal, 95% of Adult males and Adult females would fall within two standard deviations of their respective means on any measurement. In order to determine the sex of these Sub-adult humeri their ECB's were compared with the mean ± 2 standard deviation ranges for both Adult categories. All but two specimens fell within the range for Adult males, and were larger than Adult females. The mean ECB for these specimens was significantly greater than that for Adult females, but not significantly different from that for Adult males (table 6a). It would appear reasonable to conclude that these were male specimens. Their Sub-adult status was indicated by the unfused nature of their proximal epiphyses, and thus they were classified as Sub-adult males.

TABLE 6

T-tests for Sub-adult humeri measurements

6a. Comparison of Sub-adult males (SAM) and Adult groups

Measurement	Group	$\bar{x}$	s^2	n	t	p
ECB	SAM	5.70	0.135	7	10.015	<.001*
	Ad.♀	4.65	0.052	36		
ECB	SAM	5.70	0.135	7	-0.488	>.1
	Ad.♂	5.78	0.144	25		

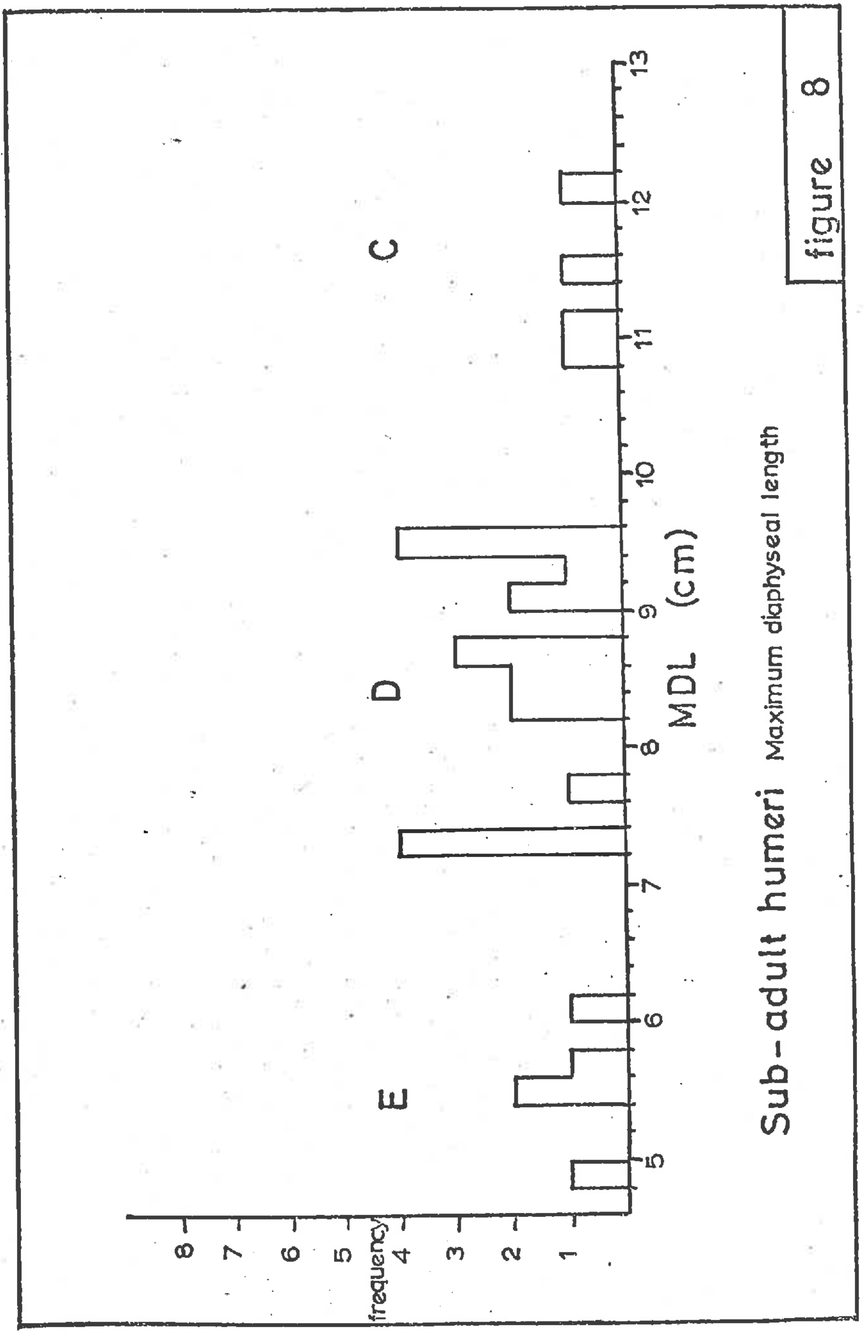
6b. Comparison of groups C and D

Measurement	Group	$\bar{x}$	s^2	n	t	p
MDL	C	11.34	0.310	4	6.579	<.001*
	D	8.49	0.668	19		
DDB	C	5.11	0.217	4	5.024	<.001*
	D	3.77	0.236	18		

6c. Comparison of groups D and E

Measurement	Group	$\bar{x}$	s^2	n	t	p
MDL	D	8.49	0.668	19	7.777	<.001*
	E	5.47	0.274	5		
DDB	D	3.77	0.236	18	3.591	<.01*
	E	2.73	0.034	3		

* significant



Sub-adult humeri Maximum diaphyseal length

figure 8

The two smaller specimens fell below the range for Adult males and within the range for Adult females. While they could possibly have been small Sub-adult males, they were more likely to have been 'Sub-adult females'. No such category was defined in Chapter One, and it was not considered useful to create such a category. These specimens were included in the Adult female category.

The remaining Sub-adult humeri were unfused at both ends. A frequency distribution of their Maximum diaphyseal lengths (MDL) indicated the presence of three distinct groups, C,D,and E (figure 8). The differences between these groups were statistically significant (tables 6b and 6c).

Two major difficulties arose in equating these groups with age/sex categories. Firstly, there was no suitable comparative material of known age with which to compare them. Furthermore, it was not possible to compare them directly with the Adult groups because none of the measurements taken on the Adult humeri could be replicated on these unfused Sub-adult specimens.

As the pattern of epiphyseal fusion, and the size grouping observed in humeri were essentially the same as those observed in femora it would seem likely that the interpretation of groups C,D,and E for femora could be applied to the Sub-adult humeri. Thus groups C, D, and E for humeri were tentatively classified as Sub-adult male, Juvenile, and Pup respectively. Confirmation of this interpretation must await comparison with specimens of known age and sex.

It will be observed that two groups of humeri were classified as Sub-adult males; one with distal epiphyses fused, and the other with both epiphyses unfused. All this means is that fusion of the distal epiphyses takes place, in males, during the Sub-adult male stage.

e. <u>Criteria for age/sex determination</u>

The behavioural age/sex categories considered useful in the study of prehistoric man's exploitation of the fur seal were outlined in Chapter One. In the preceding discussion it has been argued that these age/sex categories can be equated with a series of observed size groupings in the dimensions of humeri and femora. Using the metrical attributes of each of these size groups criteria were established that would define each of the 5 age/sex categories. The metrical attributes of each of these groups are presented in Appendix 3.

In order to develop defining metrical criteria for each age/sex category, the range of values observed for each size group on each measurement was considered. Assuming the distribution of individual values to be normal, 95% of all individuals would fall within 2 standard deviations of the mean for each measurement. While a small number of individuals would fall outside these limits they can be considered a reasonable estimate of the range for each age/sex category.

The procedure by which metrical criteria were established is best illustrated with an example. Consider the Maximum lengths of Adult femora. It was argued above that group A represented Adult males, and group B Adult females. Those measurements that were greater than, or equal to the lower limit for group A (i.e. the mean - 2 standard deviations) could be safely classified as Adult males. Those less than, or equal to the upper limit for group B (i.e. the mean + 2 standard deviations) could be safely classified as Adult females. Any individuals with measurements falling between these two limits could not be assigned to one or other category with confidence. Thus they were given an indefinite age/sex status and excluded from further analysis.

For some measurements the limits of two or three size groups overlapped. Individuals with measurements falling within these regions of overlap could not be assigned with confidence to any particular age/sex category, and thus were assigned an indefinite age/sex status and excluded from further analysis.

The metrical criteria thus established are presented in tables 7 and 8. Some comments on the use of these criteria are in order. They are organised on the basis of epiphyseal fusion. Before being subjected to analysis with these criteria, the bones must first be sorted into groups according to their state of epiphyseal fusion. For femora there are two groups: those with both epiphyses fused (Adults), and those with neither epiphysis fused (Sub-adults). Humeri are divided into three groups: those with both epiphyses fused (Adults), those with only the distal epiphysis fused (Adult female or Sub-adult male), and those with neither epiphysis fused (Sub-adults).

There are two situations in which the exact state of epiphyseal fusion cannot be ascertained. Medial shaft fragments of femora, on which both proximal and distal ends have broken away could fall into either the Adult or the Sub-adult category. A separate set of criteria for these specimens is provided (table 7c). Similarly, distal end fragments of humeri, on which the distal epiphysis is fused could be Adult males, Adult females, or Sub-adult males. Criteria for such specimens are provided in table 8d.

The time available for this study did not permit the use of more sophisticated statistical techniques in the development of these criteria. Multivariate techniques, such as principle component analysis (Tatsuoka 1971:144-9) may have provided more suitable criteria that would have enabled individuals assigned an

TABLE 7

Criteria for age/sex determination: femora

7a. Adult femora (proximal and distal epiphyses fused)

Age/sex category	measurement MLL	ML(h)	ECB	STD
Adult male	$\geqslant 8.91$	$\geqslant 8.51$	$\geqslant 3.57$	$\geqslant 1.88$
Ad. male/female *	< 8.91 > 8.54	< 8.51 > 8.23	< 3.57 > 3.51	< 1.88 > 1.85
Adult female	$\leqslant 8.54$	$\leqslant 8.23$	$\leqslant 3.51$	$\leqslant 1.85$

7b. Sub-adult femora (both epiphyses unfused)

Age/sex category	measurement MDL	DDB	STD
Sub-adult male	$\geqslant 6.70$	$\geqslant 3.181$	$\geqslant 1.725$
sam/juv/pup *		< 3.181 > 2.473	
sam/juv *	< 6.70 > 6.35		< 1.725 > 1.659
Juvenile	$\leqslant 6.35$ $\geqslant 5.15$		$\leqslant 1.659$ $\geqslant 1.349$
juv/pup *	< 5.15 > 5.12		< 1.349 > 1.325
Pup	$\leqslant 5.12$	$\leqslant 2.473$	$\leqslant 1.325$

7c. Medial shaft fragments (state of epiphyseal fusion uncertain)

Age/sex category	STD	Age/sex category	STD
Adult male	$\geqslant 2.239$	Juvenile	$\leqslant 1.400$ $\geqslant 1.349$
sam/ Ad.female *	< 2.239 > 1.400	juv/pup *	< 1.349 > 1.325
		Pup	$\leqslant 1.325$

* indefinite age/sex status

TABLE 8

Criteria for age/sex determination: humeri

8a. Adult humeri (proximal and distal epiphyses fused)

Age/sex category	measurement ML	 ML(h)	 ECB	 TDH
Adult male	≥15.02	≥13.88	≥5.11	≥3.85
Ad. male/female *	<15.02 >14.61	<13.88 >13.52	<5.11 >5.02	<3.85 >3.84
Adult female	≤14.61	≤13.52	≤5.02	≤3.84

8b. Sub-adult or Adult humeri (distal epiphysis only fused)

Age/sex category	measurement ML	 ECB
Sub-adult male	≥ 14.07	≥ 5.110
sam/Ad.female *	< 14.07 > 12.20	< 5.110 > 4.965
Adult female	≤ 12.20	≤ 4.965

8c. Sub-adult humeri (both epiphyses unfused)

Age/sex category	measurement MDL	 DDB
Sub-adult male	≥ 10.22	≥ 4.742
sam/juv *	< 10.22 > 10.13	< 4.742 > 4.678
Juvenile	≤ 10.13 ≥ 6.85	≤ 4.678 ≥ 3.103
juv/pup *	< 6.85 > 6.51	< 3.103 > 2.798
Pup	≤ 6.51	≤ 2.798

* indefinite age/sex status

TABLE 8 (continued)

8d. Distal fragments (epipyhis fused)

Age/sex category	measurement ECB
Adult male	≥ 6.473
Ad. male/sam *	< 6.473 > 5.110
Ad. male/sam/Ad. female *	≤ 5.110 ≥ 5.020
sam/Ad. female *	< 5.020 > 4.965
Adult female	≤ 4.965

* indefinite age/sex status

indefinite age/sex status by the present criteria to be categorized accurately.

3.4 THE CHC POPULATION STRUCTURE

The CHC fur seal population was divided into 5 age/sex categories using the above criteria. Only bones in a condition that allowed one or more measurement to be taken could be subjected to this analysis. This included 85% of the individuals represented by femora, and 78% of those represented by humeri. Each measurement taken on a particular bone was compared with the relevant criterion and assigned to an age/sex category. A small number of bones were assigned to one category by one measurement, and to another category by a second measurement. These were relegated to an indefinite age/sex status and excluded from assessment of the population structure.

After each bone had been assigned to a category, the minimum number of individuals represented in each category was determined. The percentage composition of the population was calculated from these minimum numbers (table 9).

All five age/sex categories were represented in the population. Almost half the individuals were Adult females, with Adult males making up about a quarter of the population. The remaining three categories were represented by more or less equal numbers of individuals. The significance of this population structure will be discussed in the following Chapter.

3.5 MINIMUM NUMBERS OF SPECIES OTHER THAN FUR SEALS

The minimum numbers calculated for all other species are presented in table 10. The fragmentary nature of most of the shellfish made positive identification and the calculation of all but a few impossible.

The age and sex of the elephent seals were assessed on

TABLE 9

CHC: fur seal population structure

Age/sex category	Minimum number					
	humerus		femur		maximum	%
	right	left	right	left		
Adult male	20	26	23	28	28	25
Adult female	44	37	50	46	50	45
Sub-adult male	4	6	7	10	10	9
Juvenile	11	14	8	6	14	12
Pup	8	1	5	10	10	9
				TOTAL	112	100
Ad.male/female *	-	-	3	1		
Ad.male/female/sam *	1	-	-	-		
Ad. male/sam *	8	7	-	-		
Ad. female/sam *	2	1	-	-		
sam/juv *	-	-	1	-		
sam/juv/pup *	-	-	5	-		
juv/pup *	1	3	-	-		

* indefinite age/sex status

TABLE 10

CHC: Minimum numbers of species other than fur seals

Sea mammals:	Minimum number
Southern Elephant Seal (*Mirounga leonina*)	12
Leopard Seal (*Hydrurga leptonyx*)	8
New Zealand Sea Lion (*Neophoca hookeri*)	2
Other mammals:	
Polynesian Rat (*Rattus exulans*)	5
Birds:	
Pitt Island Shag (*Stictocarbo punctatus featherstoni*)	7
Southern Diving Petrel (*Pelecanoides urinatrix chathamensis*)	2
Dieffenbach's Rail (*Rallus phillipensis dieffenbachi*)	2
Erect-crested Penguin (*Eudyptes pachyrynchus sclateri*)	1
Chatham Islands Blue Penguin (*Eudyptula minor chathamensis*)	1
King Penguin (*Aptenodytes patagonicus*)	1
Chatham Islands Mollymawk (*Diomedea cauta eremita*)	1
Petrel sp.	1
Puffinus sp.	1
small duck	1
small rail	1
Fish:	
Blue Cod (*Parapercis colias*)	1
Ling (*Genypterus blacodes*)	1
Spotty (*Pseudolabrus celidotus*)	1
Shell:	
Cookia sulcata	3
Haliotis iris	3
Haliotis sp.	*
Bivalves (unidentifiable)	*

* minimum numbers not able to be calculated

the basis of cranial morphology and size. Eleven were Sub-adult males, and the remaining one was Adult male. Age and sex were not determined for any other species.

The majority of the fish remains were in the form of vertebra: These were not identified because of the lack of comparative material. Only five paired bones from the head of the fish were identified (c.f. Leach 1976:176-9). This may have limited the range of species, and the number of individuals of each identified.

3.6 THE AGE OF CHC

At the time of writing C^{14} dates for CHC were not available. This imposed important limitations on the interpretation of the archaeological evidence from CHC. It was not possible to consider the site in a temporal context along with the other dated sites that have been excavated in the area. Consequently, the pattern of fur seal exploitation described in the following Chapter is based almost entirely on the evidence from CHC.

CHAPTER FOUR

DISCUSSION

The overwhelming predominance of fur seals in the excavated area of CHC is indicated by the minimum numbers calculated for each species represented in the site. While the excavated area formed only a small part of the whole site, considerable confidence can be placed in the assertion that fur seals were the major midden component. Test pits of the rest of the site revealed no other midden areas, and the unexcavated parts of the single midden appeared to be equally dominated by this single species. Thus it would appear that the activities at the site revolved around the exploitation of fur seals.

The minimum number of 130 fur seals in the excavated area, extrapolated to 520 for the whole site indicates that this exploitation was a large scale activity. The largest number of seals previously identified from a New Zealand site is 43 from Houhora, and it appears that these were not all fur seals (Shawcross 1972:607).

The large number of fur seals in CHC gave rise to the suggestion that they were hunted from a colony near at hand. As there are no present day colonies on the South West coast of Chatham Island a survey was undertaken along this coast from Point Durham to Point Gap to locate possible sites of former colonies. Only one location was discovered that fulfilled the habitat requirements of a fur seal colony. This was a small area of flat rock platform extending into the sea about 200 metres south of CHC.

The possibility that this area had been a colony site was further suggested by the results of an intensive site survey of the adjacent area. Only two sites containing quantities of fur seal bone were discovered (Sutton 1976: pers. comm.). Both of these, CHC and Waihora, were immediately adjacent to the postulated colony site (figure 2). Furthermore, the owner of the land reported that the only place that he had ever seen fur seals haul out along this coast was at this site.

This postulated colony site is a relatively small area in comparison to most fur seal colonies. Quantitative data on the population densities of fur seal colonies is not available, and thus the maximum population size for this site cannot be determined accurately. A subjective assessment, based on an acquaintance with several New Zealand colonies, and on a thorough perusal of the literature on fur seals suggests that this site would have had a maximum population of 50 to 100 individuals.

There is ample evidence that the fur seals in CHC were hunted at a breeding colony. Nearly half the individuals assigned to an age/sex category were Adult females. It was argued in Chapter One that the presence of this age/sex category in a site was a good indication of exploitation of a breeding colony. The presence of Pups in the site is a further indication of this.

Exploitation of a breeding colony is also indicated by the characteristics of the postulated colony site. All the habitat requirements of a breeding colony are fulfilled at this site. Although this does not preclude the possibility that the site was a non-breeding colony, it does seem rather unlikely. Non-breeding colonies are usually found on sheltered coasts, and the South West coast of Chatham Island does not fulfil this requirement.

The proximity of CHC to this postulated breeding colony site allows some interpretation of the nature of the activities

undertaken at the site. Butchering of fur seals appears to have been an important activity. The fur seals were presumably killed on the colony site, but it appears that they were not butchered there. Had they been butchered at the colony, it would be expected that those parts of their bodies not desired for food or some other use would have been immediately discarded, and therfore not represented in CHC. Although documentation of the proportional representation of body parts was not complete, there was no evidence to suggest that any body part was under-represented in the site. Thus, it can be concluded that the butchering activities took place at CHC. Although most fur seals are relatively large and heavy, Adult males weighing up to 200 kg (Crawley & Wilson 1976:2), personal experience in the killing and butchering of these animals suggests that it would not have been too difficult to transport their complete carcases the short distance from the presumed colony site to CHC.

This accords well with the limited ethnographic evidence on the pattern of fur seal exploitation by the Moriori. Shand (1911:8) states that carcases of the animals were removed from the colonies so as not to frighten away other fur seals.

Two alternative interpretations of the butchering process at CHC are possible. The more likely of the two interpretations is that the flesh of the animals was stripped from the bone, and the latter discarded. Alternatively, the animals could have been divided into portions of meat 'on the bone'.

Rejection of the second interpretation requires, first, some consideration of whether butchering was undertaken as preparation for immediate consumption, or as preparation for transporting the flesh to other sites before consumption.

There is no direct evidence that fur seal flesh was cooked and eaten at CHC, although the charcoal-blackened soils in some of the unexcavated parts of the site may relate to such activities. While this cannot be entirely ruled out on the available evidence, it is considered unlikely for a number of reasons.

The lack of occupational evidence in the site, and the highly specialised nature of the midden suggest that people were not living at the site for any extended period of time. The limited extent of the excavations of course requires that this conclusion be accepted with some caution. None of the bone in the excavated part of the site was burnt, suggesting that the cooking of fur seal flesh was not undertaken at the site. The large quantity of meat provided by even a single fur seal further reduces the likelihood that all the fur seals evidenced in the site were consumed there.

The more probable interpretation, therefore, is that CHC served as a site to which people went to kill and butcher fur seals and left taking only the parts of the animal that they desired. Obtaining the flesh of these animals would obviously have been one of the major purposes of this exploitation. The ethnographic evidence suggests that fur seal skins were also desired for use as clothing (ibid:6). Fur seal bone appears to have been seldom used in the manufacture of artefacts (Sutton 1976: pers. comm.), and thus there would have been little desire to take it away from the butchering site.

With these considerations in mind the nature of the butchering process evidenced at CHC can be examined in more detail. All of the identified bones in the site were represented in more or less equal numbers. If it is accepted that all, or most of the fur seal flesh was removed from the site before being

consumed, then this equal representation of bones in the site indicates that the butchering process involved stripping of the flesh from the bone rather than dividing the animals into portions of meat 'on the bone'. Had the latter process been undertaken, then it would be expected that some bones would have been under-represented in the site. This would apply especially to bones, such as humerus, radius and ulna, on which the largest cuts of meat would have been found. Thus, the archaeological evidence indicates that the former butchering process was undertaken.

A rationale for this procedure can be postulated. It was indicated above that obtaining the flesh and skins of the fur seal were probably the major reasons for their exploitation. It was also suggested that fur seal bone was a relatively unimportant by-product of this exploitation. Thus a butchering process that involved removal of the flesh from the bone would have been advantageous, in that the flesh would have been lighter and more easily transported, traded or stored.

The evidence from CHC, therefore, suggests that fur seal flesh was probably consumed in areas away from the colony sites where it was immediately available. It also leads to the hypothesis that fur seal flesh and skins may have been items of trade, and that the flesh may have been stored or preserved. The butchering method evidenced at CHC makes it difficult to test this hypothesis. The immediate separation of flesh from bone removes the potential means of documenting the transporting of the flesh to areas away from colony sites.

However, this hypothesis can be argued for on a number of other grounds. Fur seals must have been an important food resource in the Chatham Islands. Before European occupation there were no large land mammals, or large birds like the Moa.

Other than visiting Sea lions, Leopard seals and Elephant seals, and perhaps the occasional stranded whale, fur seals would have the only significant supply of mammalian meat. Fur seals would have been available only in the restricted number of areas in which there were colonies. Thus, it would seem likely that their flesh and skins would have been distributed over a wide area, and may possibly have been items of trade or exchange.

It is also difficult to determine evidence for storage or preservation. It has been suggested that these two activities are often associated with resources that were seasonally restricted in their availability (Leach 1969:76). Thus, it is now appropriate to consider the seasonality of the fur seal hunting activities evidenced at CHC. A basis for interpreting the seasonality of such activities was outlined in Chapter One. Caution was advised in the application of this to sites representing more than a short period of occupation. Therefore, before considering the seasonality of CHC, the evidence for its longevity will be assessed.

The excavated portion of the site contained only a single shallow layer of cultural material, and thus provided no stratigraphic evidence of prolonged or repeated occupation. The shallowness of the site is somewhat deceptive in this respect. It has been argued previously that the layer containing the cultural material had undergone considerable compression, and formerly would have been much deeper.

The large number of fur seals in the site is in itself suggestive of a long period of activity. It would seem unlikely that so many animals could be the product of one or a few seasons hunting. This is reinforced by the estimate of the size of the colony supposed to have been under exploitation. Although this

estimate must be accorded a high margin of error, it does suggest that the fur seals in CHC could not all have been acquired in a short period of hunting.

A further indication of the longevity of CHC is provided by analysis of the percentage nitrogen composition of 6 samples of fur seal bone from the site. A discussion of the technique of nitrogen dating of bone, and the results of this analysis are presented in Appendix 4. While this analysis cannot provide absolute dates for the site, or indicate a precise time span for the activities represented in the site, it does provide further confirmation that the fur seal hunting activities in the site took place over a considerable time period.

Having established with some degree of certainty that CHC represents more than a short period of fur seal hunting activity, it must be accepted that determination of the seasonality of these activities is somewhat difficult. As the fur seals in CHC represent the product of an unknown number of 'kills' over an unknown number of years, it is possible that indications of the seasonality of each period of activity would be masked. Bearing this difficulty in mind, some general conclusions about the seasonal nature of the hunting patterns evidenced at CHC can stil be made.

It has already been established that a breeding colony was under exploitation, and thus fur seals would have been available for hunting all year round. It appears that advantage was taken of this year round availability, as there are indications of both summer and winter exploitation.

Summer exploitation is indicated by the presence of Adult males in the site. They are present at breeding colonies in significant numbers only at this time of the year. Sub-adult males are also more common at breeding colonies at this time of the year, although they do not occur in large numbers. Their presence in CHC provides further evidence of summer exploitation.

The indications of winter exploitation are less well founded. Juveniles were the third most common age/sex category in CHC. It was suggested in Chapter One that they may be slightly more common at breeding colonies in the winter, and thus their relative frequency in CHC may suggest winter exploitation. This is also suggested by the size of some of the Pups in the site. The metrical method of aging fur seals developed in Chapter Three is not sufficiently sophisticated to allow Pups to be assigned an age in months. However, a subjective assessment of the size of some of the Pup bones in the site suggests that they are unlikely to have been newly born when killed. If this assessment is at all accurate, then these Pups could not have been hunted during the summer, and thus indicate winter exploitation.

The presence of Elephant seals and Leopard seals in the site suggest that it may have been utilised at times other than the summer. The Chatham Islands are well north of the breeding ranges of these two species, and visits to the north are usually made only during autumn or winter (Gaskin 1972:145, 148-9). Teal (1975:35) has argued for autumn or winter occupation of the Pleasant River site on the basis of the presence of Elephant seals, and Leach (1976:184) has suggested that the bones of both Elephant seals and Leopard seals in the Washpool Midden site may indicate winter occupation. Thus, the presence of these two species in CHC suggest that the site was utilised during autumn or winter.

The evidence for seasonality at CHC is rather difficult to interpret. Indications of summer exploitation of the fur seal colony are well founded, but the evidence for winter exploitation is rather more dubious. This is not at all suprising given the difficulties involved in determining the seasonality of fur seal hunting activities undertaken over more than a short period of time. Thus the question of the seasonality of CHC must remain in some doubt.

Perhaps the most striking result of the analysis of the population structure of the CHC fur seals, the small number of Pups in the site. They made up only 9% of all the fur seals assigned to an age/sex category. This is a surprisingly low figure when it is considered that they are the numerically predominant age/sex category at a breeding colony, except during the early summer.

Three alternative explanations for this observed result are possible. Pups may have been under-represented because their bones, being less robust and with unfused epiphyses, were less well preserved than those of older fur seals. If this were the case then only a small proportion of all the Pup femora and humeri would have been in a condition that permitted measurement, and thus only this small proportion would have been ascribed an age/sex status.

The only check on this sort of error in analysis was the impression gained during sorting and identification of the proportional representation of each age/sex category. The relative absence of Pups was observed during this stage of analysis, and few Pup femora or humeri too worn or fragmentary for measurement were noticed. Thus it would appear that explanation of the absence of Pups in these terms can not be accepted.

A second possible explanation requires that the fur seal hunting activities occurred only during the short period in early summer when Pups are relatively less common at breeding colonies. However, it is unlikely that exploitation occurred only during this restricted period. At this time Adult females are also relatively scarce at breeding colonies, and thus their predominance in CHC would not have been possible if hunting had taken place only at this time. Furthermore, it has already been argued that exploitation took place at other times of the year.

A more acceptable explanation is that selective hunting was employed in the exploitation of these fur seals. It is improbable that hunting by any predator (including man) is ever random (Jarman & Wilkinson 1972:94-5), and thus all hunting involves elements of selection. However, if the age/sex composition of the animals that were hunted differs markedly from the age/sex composition of the population available for hunting, then a process of conscious selection can be inferred (ibid). It has been demonstrated that the age/sex composition of the CHC fur seals does differ markedly from that in the available population. The marked absence in the site of Pups, the most abundantly available age/sex category, can be explained only in terms of selective hunting.

A possible reason for this selective hunting can be adduced. The majority of fur seals in the site are of Adult age, 70% being Adult males or adult females. This suggests that the size and amount of meat on the animals, in other words their economic value, were important factors in determining which individuals would be killed. The relative absence of Pups in the site therefore reflects their lesser economic value.

The small proportion of Juveniles in the site may also be explainable in these terms, although it must also reflect their limited availability at the breeding colony. Sub-adult males

would have had a higher economic value than Adult females, being larger and therefore providing more meat. Their low representation in CHC would have been a direct result of their restricted availability at the breeding colony under exploitation.

The pattern of fur seal exploitation exhibited at CHC can now be summarised.

Fur seals were an important resource in the Chatham Islands. They were the only regular supply of mammalian meat, and also provided skins for use as clothing. Regular exploitation of the fur seal was possible only at the restricted number of locations that supported colonies. One such colony appears to have been located on the South West coast immediately adjacent to CHC. This was a breeding colony, and thus fur seals were present and available for exploitation at all times of the year. Although there was some difficulty in determining the seasonal nature of the fur seal hunting activities evidenced at CHC, it appears that exploitation took place at various different times throughout the year.

Activities at the site centred around the butchering of fur seals. After killing the animals the hunters brought them to CHC and then prepared the flesh by stripping it from the bones. It has been argued that the flesh was taken away from the site, and perhaps distributed or traded over a wide area before being consumed. Some flesh may have been stored or preserved, but there is no direct evidence for this. These activities continued over a considerable period of time, resulting in the accumulation of a large and concentrated midden, composed almost entirely of fur seal bone.

The fur seal hunters were selective in their choice of prey, taking mainly Adult animals and leaving the more abundant

Pups. This choice would appear to reflect a preference for Adult individuals because they provided a greater quantity of meat than did younger individuals.

One can only speculate on the effect that this selective hunting pattern may have had on the continued survival of the fur seal population. The culling of breeding Adults from the population, if undertaken on too large a scale, could have drasticly reduced the size of the population at this colony and thereby restricted the availability of this resource. Without further evidence this possibility must remain mere speculation.

CHAPTER 5

SUMMARY, LIMITATIONS AND CONCLUSION

5.1 SUMMARY

In the introduction to this study three major objectives were outlined. The preceding Chapters have been organised around the attainment of these. In Chapter One the relevant aspects of fur seal behaviour were discussed with two purposes in mind. Firstly the aspects of fur seal behaviour that would have limited prehistoric man's exploitation of the fur seal were considered, and then from these a basis for interpreting the fur seal remains from prehistoric sites was developed.

This basis for interpretation was then used to elucidate the pattern of prehistoric fur seal exploitation on the South West coast of Chatham Island. The methods used in the excavation and analysis of the archaeological evidence from which this pattern was to be discerned were described in Chapter Two.

Chapter Three fulfilled two functions with respect to the objectives of this study. The results of the analysis of the archaeological data were presented, and in doing this an osteometric method for determining the age and sex of fur seals was developed.

The interpretation of these results was discussed in Chapter Four. From these results some conclusions about the pattern of prehistoric fur seal exploitation on the South West coast of Chatham Island were reached.

5.2 LIMITATIONS

There were a number of shortcomings and limitations which, to some extent, inhibited the achievement of the objectives of this study. In the main these were the result of the limited time available for both the excavation and analysis of the material under study.

Information on which the discussion of fur seal behaviour was based derived principally from studies of the fur seal on the New Zealand mainland. The extent to which these are applicable to fur seal populations in the Chatham Islands can not be assessed accurately. It was assumed that were no significant differences in the behaviour of Chatham Island and New Zealand fur seal populations. If further studies indicate that significant differences do occur, then some of the interpretations and conclusions arrived at herein may require reassessment. A similar limitation applies to the assumption that it is justifiable to extrapolate modern fur seal behaviour back into the prehistoric period.

The archaeological evidence on which much of this study is based derives from a small excavation into a highly specialised part of a much larger site. Interpretations based on a small and atypical part of a site must be considered with due caution. In the presentation and discussion of the archaeological evidence care has been taken to indicate the limitations imposed in this way.

Analysis of the archaeological data was incomplete. Other than the fur seal bone, components of the site were subjected to no more than identification and the calculation of minimum numbers. Furthermore, only selected portions of the fur seal material were analysed intensively. Had time permitted further study of this material, documentation of the pattern of fur seal exploitation may have been more complete.

The method of age/sex determination presented in Chapter Three was developed from a sample of fur seal bones from an archaeological site. Little comparative material of known age and

sex was available to provide a check on the reliability of this method. The statistical techniques employed in its development were relatively unsophisticated. With more sophisticated techniques, and further comparative material, a more accurate and useful method may be able to be developed.

Finally, the interpretation of the pattern of fur seal exploitation on the South West coast of Chatham Island was based on the evidence from only one site. Analysis of the fur seal material from further sites, particularly that from Waihora, may require some reinterpretations of the pattern described herein. Before the full implications of the conclusions reached in this study are realised, they must be evaluated in the wider context of the whole archaeological programme undertaken in the Chatham Islands.

5.3 CONCLUSION

Within the limitations outlined above, some conclusions can be drawn from this study. The concern here is not with the immediate results: conclusions have already been drawn about the pattern of fur seal exploitation evidenced at CHC. It is, rather, with the potential for determining aspects of prehistoric human behaviour from the remains of fur seals in archaeological sites.

With one or two notable exceptions, the fur seal has been ignored in studies of New Zealand's prehistory. It is generally to be found, relegated to the list of 'species identified'. Some reasons for this lack of interest were indicated in the Introduction, being mainly the lack of available information on which to base interpretations of its exploitation.

This study, it is believed, has gone some of the way towards overcoming this obstacle. A basis for the interpretation of the fur seal remains in archaeological sites has been developed, and some of the ways in which this can be employed in discerning aspects of prehistoric human behaviour have been demonstrated. However, the pattern of fur seal exploitation in only one small area has been studied, and that in a limited fashion. Conclusions about human behaviour have been limited to the determination of butchering techniques, selective hunting patterns, and to a lesser extent, seasonality.

The full potential of this approach has not been realised. A much broader perspective is required, placing the evidence of fur seal exploitation in the wider context of other economic and subsistance activities, and thus developing a more complete picture of prehistoric human behaviour.

This study is also relevant to some methodological considerations. In the interpretation of archaeological data it is important that due cognizance is taken of the means by which conclusions about human behaviour are arrived at. The use of information on the behaviour of the animals under exploitation in order to elucidate the patterns of human behaviour involved in this exploitation has been stressed previously (Higgs & Jarman 1972:12). One of the major concerns of this study was to develop and illustrate the usefulness of such an approach with respect to the fur seal, and hopefully to encourage its wider application.

APPEDIX 1

AGE DETERMINATION FROM ANNUAL GROWTH RINGS IN CANINE TEETH

A full discussion of the development and methods of age determination from annual layers in teeth and bone is presented in Klevezal and Keinenberg (1969). It is not intended to repeat this discussion here. The present purpose is simply to outline the method used in this study to prepare fur seal canine teeth for age determination. This method was adapted from that presented by Stirling (1969), and was developed with assistance from Mr. R. H. Mattlin (pers. comm.).

In all cases cross-sections were cut, although satisfactory age determinations can also be achieved with long-sections. The procedure employed was as follows:

1. Cut tooth at gum line. A rock saw was used for this purpose, but equally satisfactory results can be achieved with a hack saw.
2. Sand tooth with increasingly fine grades of wet-dry sandpaper.
3. Etch tooth in 5% formic acid in 10% formalin for 18-20 hours.
4. Wash in running water for 4 hours.
5. Add 3 or 4 drops of .88 ammonia to 75 ml. of distilled water and soak tooth for 4 hours.
6. Stain tooth for 3 to 5 seconds in 0.125% thionine solution. A water bath was used to maintain an exact temperature of 35°C.
7. Dry tooth at room temperature for 1 day.

Concentric rings of alternate light and dark bands should now be visible in the cross-section of the tooth. Magnification (x 10) and obliquely reflected light improve the resolution of these rings. Each pair of light and dark rings represents 1 years growth, and thus age is determined simply by counting these pairs of bands. The results of this technique of age determination on the specimens in the comparative collection are presented in table 1 (page 34).

APPENDIX 2

DEFINITIONS OF MEASUREMENTS

When this study was begun no system of measurements for the post cranial bones of the fur seal was available. Thus a series of measurements for femora and humeri were developed. All measurements of length require the use of an osteometric board and are signified (OB). Breadth and diameter are measured with vernier callipers, signified (C). All measurements are taken in centimetres.

Definitions of these measurements are presented below. They are organised in groups dependent on the state of epiphyseal fusion of the bone concerned.

FEMORA

a. Adult femora (proximal and distal epiphyses fused)

Maximum Length .ML (OB)

The maximum length from the most distal margin of the medial condyle to the most proximal margin of the greater trochanter. Place the medial condyle against the head of the osteometric board with the dorsal surface facing the board, and pivot at the distal end until the maximum length to the greater trochanter is achieved.

Maximum Length to Head ML(h) (OB)

The maximum length from the most distal margin of the medial condyle to the most proximal margin of the head. Proceed as above but pivot at the distal end until the maximum length to the head is achieved.

Epicondylar Breadth ECB (C)

The maximum breadth from the medial epicondyle to the lateral epicondyle.

Sub-trochanteric Diameter STD (C)

The distance from the medial margin of the shaft, from a point immediately below the lesser trochanter, to the lateral border of the shaft. This measurement is taken at right angles to the medial border of the shaft.

b. Sub-adult femora (neither epiphysis fused)

Maximum Diaphyseal Length MDL (OB)

The maximum length from the midpoint of the distal end to the midpoint of the proximal end. Place the distal end against the head of the osteometric board with the dorsal surface facing the board, and pivot at the distal end until the maximum length to the proximal end is achieved.

Distal Diaphyseal Breadth DDB (C)

The maximum breadth from the most medial margin of the distal epiphyseal surface to its most lateral margin.

Sub-trochanteric Diameter STD (C)

As for Adult femora.

HUMERI

a. Adult humeri (proximal and distal epiphyses fused)

Maximum Length ML (OB)

The maximum length from the most distal margin of the medial condyle of the trochlea to the most proximal margin of the greater tuberosity. Place the medial condyle of the trochlea against the head of the osteometric board with the ventral surface facing downwards, and pivot at the distal end until the maximum length to the greater tuberosity is achieved.

Maximum Length to Head ML(h) (OB)

The maximum length from the most distal margin of the medial condyle of the trochlea to the most proximal margin of the head. Proceed as above, but pivot at the distal end until the maximum length to the head is achieved.

Epicondylar Breadth ECB (C)

The maximum breadth from the medial epicondyle to the lateral epicondyle.

Transverse Diameter of Head TDH (C)

The maximum distance from the lateral to the distal margins of the head.

b. Sub-adult humeri (distal epiphysis fused, proximal epiphysis unfused)

Maximum Length ML (OB)

The maximum length from the most distal margin of medial condyle to the midpoint of the proximal end. Proceed as for Adult humeri, but pivot at the distal end until the maximum length to the midpoint of the proximal end is achieved.

Epicondylar Breadth ECB (OB)

As for Adult humeri.

c. Sub-adult humeri (neither epiphysis fused)

Maximum Diaphyseal Length MDL (OB)

The maximum length from the midpoint of the distal end to the midpoint of the proximal end. Place the distal end against the head of the osteometric board with the ventral surface facing the board, and pivot at the distal end until the maximum length to the proximal end is achieved.

Distal Diaphyseal Breadth DDB (C)

The maximum distance from the most medial margin of the distal epiphyseal surface to its most lateral margin.

APPENDIX 3

THE METRICAL ATTRIBUTES OF THE CHC FUR SEAL POPULATION

Adult males

measurement		N	$\bar{x}$	s	SE $\bar{x}$	SE s
femur	ML	36	9.71	0.40	0.07	0.05
	ML(h)	35	9.33	0.41	0.07	0.05
	ECB	36	3.89	0.16	0.03	0.02
	STD	34	2.13	0.14	0.02	0.02
humerus	ML	26	16.62	0.08	0.16	0.11
	ML(h)	26	15.56	0.84	0.16	0.12
	ECB	25	5.78	0.38	0.08	0.05
	TDH	22	4.39	0.27	0.06	0.04

Adult females

measurement		N	$\bar{x}$	s	SE $\bar{x}$	SE s
femur	ML	58	7.80	0.37	0.05	0.03
	ML(h)	51	7.55	0.34	0.05	0.03
	ECB	58	3.15	0.18	0.02	0.02
	STD	57	1.64	0.12	0.02	0.01
humerus	ML	36	13.27	0.67	0.11	0.08
	ML(h)	36	12.26	0.63	0.10	0.07
	ECB	36	4.65	0.23	0.04	0.03
	TDH	35	3.38	0.23	0.04	0.03

Sub-adult males

measurement		N	$\bar{x}$	s	SE $\bar{x}$	SE s
femur	MDL	14	7.42	0.36	0.10	0.07
	DDB	12	3.38	0.41	0.12	0.08
	STD	14	1.95	0.15	0.04	0.03
humerus[1]	ML	7	14.24	0.05	0.43	0.28
	ECB	7	5.70	0.14	0.06	0.04
humerus[2]	MDL	4	11.34	0.31	0.18	0.11
	DDB	4	5.11	0.22	0.13	0.08

[1] distal epiphysis fused
[2] neither epiphysis fused

Juveniles

measurement		N	$\bar{x}$	s	SE $\bar{x}$	SE s
femur	MDL	10	5.75	0.09	0.03	0.02
	DDB	8	2.87	0.03	0.01	0.01
	STD	10	1.53	0.01	0.01	0.01
humerus	MDL	19	8.49	0.67	0.16	0.11
	DDB	18	3.77	0.24	0.06	0.04

Pups

measurement		N	$\bar{x}$	s	SE $\bar{x}$	SE s
femur	MDL	7	4.26	0.19	0.08	0.05
	DDB	4	1.97	0.12	0.07	0.04
	STD	7	1.13	0.01	0.01	0.01
humerus	MDL	5	5.47	0.27	0.14	0.09
	DDB	3	2.73	0.03	0.02	0.01

APPENDIX 4

THE NITROGEN CONTENT OF FUR SEAL BONE SAMPLES FROM CHC

Some indication of the length of time that a bone has been buried in the ground can be gained through determination of the nitrogen content of the bone. The quantity of nitrogen in a bone decreases with the length of time that it is buried in the ground (Oakley 1969:36-7). As the rate of nitrogen loss can vary under different soil chemistry, temperature and humidity conditions it is not generally possible to ascribe an absolute date to a particular bone simply by determining the amount of nitrogen that has been lost (Hole & Heizer 1969:230). However, if these microenvironmental variables are constant, the relative ages of a number of bones can be estimated from their relative nitrogen contents.

Six samples of fur seal bone from CHC were subjected to anlysis for their percentage nitrogen contents. As all these samples derived from the same stratigraphic layer, and from within a 12.5 metre^2 area, it can be assumed that the factors influencing the rate of nitrogen loss, other than age, operated equally on each.

The percentage nitrogen composition of each of these samples is given below. The observed values ranged from 1.00% to 2.03%. Given the equality of all background variables, this range is indicative of a considerable difference in the ages of the earliest and the latest samples. A similar range in human bone would suggest a difference of approximately 300 to 400 years (Houghton 1976:pers. comm.). This cannot be applied directly to these samples of fur seal bone as the rate of nitrogen loss

in fur seal bone may not be comparable with that in human bone. While this data cannot be used to infer an absolute time span, it does suggest that the fur seal hunting activities evidenced at CHC took place over a considerable period of time.

provenance	% nitrogen content
CHC/1/18a	1.00
CHC/1/3d	1.13
CHC/1/1d	1.48
CHC/1/9a	1.48
CHC/1/13d	1.64
CHC/1/5c	2.03

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